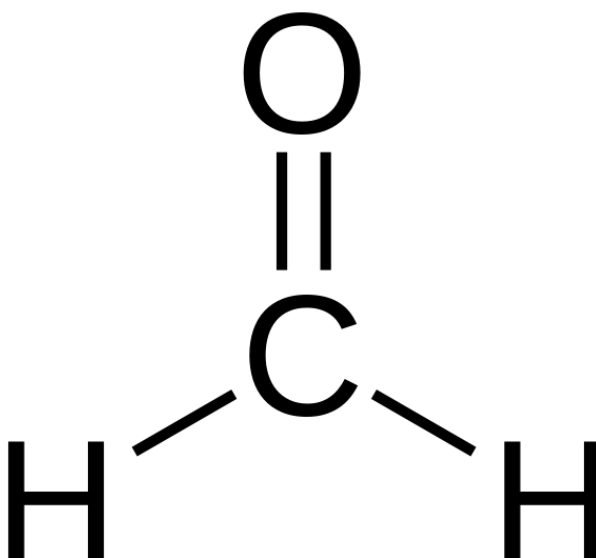

Draft Risk Evaluation for Formaldehyde

Systematic Review Supplemental File:

Data Quality Evaluation and Data Extraction Information for
Environmental Release and Occupational Exposure

CASRN: 50-00-0



March 2024

This supplemental file contains information regarding the data extraction and quality evaluation results for data sources that were considered for the *Draft Risk Evaluation for Formaldehyde* and that underwent systematic review. EPA conducted data extraction, and quality evaluation based on author-reported descriptions and results; additional analyses (e.g., statistical analyses) potentially conducted by EPA are not contained in this supplemental file. EPA used the TSCA systematic review process described in the *Draft Systematic Review Protocol Supporting TSCA Risk Evaluations for Chemical Substances* (also referred to as the '2021 Draft Systematic Review Protocol').

Data that met the RESO screening criteria during the full-text screening was extracted by three data types, general facility, occupational exposure, and environmental release, as explained in Section 6.2 of the 2021 Draft Systematic Review Protocol. Five different data quality evaluation forms were used depending on the data type and condition of use (COU), as explained in Appendix M of the 2021 Draft Systematic Review Protocol. All references with data points containing monitoring data (e.g., measured occupational exposures) underwent data quality evaluation as described in Section M.6.1, using the monitoring data quality metrics. All references with data points containing environmental release data (e.g., measured or calculated quantities of chemical release across facility fence line) underwent data quality evaluation as described in Section M.6.2, using the environmental release data quality metrics. All references with data points containing published models for environmental release or occupational exposure (e.g., published models used to calculate occupational exposure or environmental releases) underwent data quality evaluation as described in Section M.6.3, using the published models for environmental release or occupational exposure quality metrics. All references with data points containing completed exposure or risk assessments (e.g., completed exposure or risk assessments containing a broad range of data types) underwent data quality evaluation as described in Section M.6.4, using the completed exposure or risk assessments quality metrics. All references with data points containing reports for data or information other than exposure or release data (e.g., process description) underwent data quality evaluation as described in Section M.6.5, using the reports for data or information other than exposure or release data quality metrics. The extracted data and their data quality evaluation are available in the tables below.

Additionally, each data type and condition of use is evaluated independently within a given study; therefore, each reference may have more than one overall quality determination (OQD) to reflect the quality of each outcome and the exposures and releases more appropriately as described by the study authors. No OQD is determined for each reference, as a whole, if it contains data from more than one evidence stream.

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HERO ID	Reference	Page
Occupational Exposure		
Monitoring Data		
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Study Citation:	[Redacted] (1986). [Redacted] Report on nasal cancer among XXX employees.			
HERO ID:	10605380			
Conditions of Use:	Unknown			
EXTRACTION				
Parameter	Data			
Area sampling data:	<0.05 ppm 8 hour TWA, 0.1-0.05 ppm TWA, 2-3 ppm ceiling			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Uninformative	Sampling or analytical methodology is not specified and EPA is unclear if exposures were estimated or measured.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Country of origin is unspecified	
	Metric 3: Applicability	Uninformative	Occupational scenario is unknown.	
	Metric 4: Temporal Representativeness	Low	The data are more than 30 years old. Operations, equipment and worker activities are unlikely to represent current operations.	
	Metric 5: Sample Size	Low	characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., area) but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinantsof exposure for the sampled site or sector. Uncertainty not addressed.	
Overall Quality Determination		Uninformative		

Formaldehyde

Occupational Exposure

HERO ID: 10605389 Table: 1 of 1

Study Citation:	[Redacted] (2017). [Redacted] Review of XXX 2016 biological and air monitoring results.			
HERO ID:	10605389			
Conditions of Use:	not specified			
EXTRACTION				
Parameter	Data			
Area sampling data:	Attachment 2 (starting pg 7) has table in ppm, lowest is 0.001 and highest is 1.4 ppm			
Personal protective equipment:	respirators (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	It is not clear from where the data is from.
	Metric 3:	Applicability	Low	COU/OES not specified (possibly redacted) but it is an occupational scenario within a processing plant.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	AECOM, (2019). [Redacted] Industrial hygiene air sampling XXX, formaldehyde, XXX.		
HERO ID:	10602491		
Conditions of Use:	Processing: Reactant		
EXTRACTION			
Parameter	Data		
Worker activity description:	Task 1: Opening a 55 gallon drum of formalin... monitored for formaldehyde exposure over a 15-minute period as he opened a55 gallon drum containing formalin in the Detergent Process area. The passive badge was positioned within the sphere of his breathing zone. The task requires removal of the stinger from the old drum and placement in the new drum (p. 7)Task 2: Employee ___, a lab technician, was monitored for formaldehyde exposure as he performed a product finalization lab test. Activities performed during the sampling included titration and testing for pH, color and viscosity.(p. 8)		
Exposure route:	inhalation (p. 7)		
Physical form:	liquid, vapor (p. 7)		
Personal sampling data:	Task 1: The workers sampled wore a combination of passive assay monitors as well as filter cassettes and tubes attached to air sampling pumps. (p. 7)Task 2: Two passive badges were positioned within the sphereof his breathing zone to collect a 15-minute STEL and work task sample. (p. 8)		
Exposure duration:	The task... only takes about 3 minutes, but the employee was requested to wear the monitor for 15 minutes while in the general vicinity of the drums to characterize a 15-minute exposurewhich is then compared to a 15-minute regulatory limit. The 15-minute STEL sample was obtained to determine if there was any exposure while performing this task. (p. 7)		
Exposure frequency:	Task 2: The task he performed is performed infrequently, and the potential for formaldehyde exposure only occurs when performing the lab test. (p. 8)		
Personal protective equipment:	Task 1: The employee wore Ansell II gloves, safety glasses and a face shield in addition to his normal work uniform. (p. 7)Task 2: Safety glasses and a lab coat were worn as PPE. (p. 8)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (mod. OSHA 1007).
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3: Applicability	Medium	As site identification is not provided[redacted] nor additional process information, the COU of site is unclear. However with the worker activity, the information may be used for multiple COU.
	Metric 4: Temporal Representativeness	High	The assessment captures operations, equipment, and worker activities expected to be representative of current conditions. EPA has no reason to believe exposures have changed. The completed exposure or risk assessment is less than 5 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, worker activities and exposure type, but lacks additional metadata, such as exposure durations, exposure frequency, and/or operating conditions.
Domain 4: Variability and Uncertainty			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 10602491 Table: 1 of 1

...continued from previous page

Study Citation:		AECOM, (2019). [Redacted] Industrial hygiene air sampling XXX, formaldehyde, XXX.	
HERO ID:		10602491	
Conditions of Use:		Processing: Reactant	
Domain		EVALUATION	
		Rating	Comments
Metric 7: Metadata Completeness		Medium	The monitoring study provides only limited discussion of the variability and uncertainty in the determinants of exposure for the sampled site.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 5160116 Table: 1 of 1

Study Citation:	Agency for Toxic Substances and Disease Registry (ATSDR) (2010). Addendum to the toxicological profile for formaldehyde.			
HERO ID:	5160116			
Conditions of Use:	Multiple COUs			
EXTRACTION				
Parameter	Data			
Worker activity description:	Students and anatomy lab employees.			
Exposure route:	inhalation			
Physical form:	vapor/gas			
Personal sampling data:	10 laboratory technicians were exposed to estimated average formaldehyde concentrations ranging from 0.106±0.02 to 0.269±0.05 ppm. 34 students exposed for 2-3-hour periods to an estimated time-weighted average (TWA) concentration of 1.24±0.61 ppm (range 0.07-2.94 ppm) in a gross anatomy laboratory. Estimates of breathing zone formaldehyde concentrations in the anatomy laboratory ranged from 0.3 to 4.45 ppm, with a mean of 1.88±0.96 ppm.			
Area sampling data:	38 anatomy students (9 men and 29 women, mean age 24.9 years) exposed to 1.1+0.56 ppm formaldehyde for 2.5 hours/week for 14 weeks. The highest short-term exposure level was 10.91 ppm for a 12-minute interval.			
Exposure duration:	2-3 hour periods (see PBZ extraction above)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is ATSDR so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is applicable to student and anatomy labs as lab chemicals.
	Metric 4:	Temporal Representativeness	Low	Exposure data is over 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes exposure type, sampling duration and frequency, activities, exposure route and physical form.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Address variability by citing multiple different exposure studies. Does not address uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Aglan, M. A., Mansour, G. N. (2018). Hair straightening products and the risk of occupational formaldehyde exposure in hairstylists. Drug and Chemical Toxicology :1-8.			
HERO ID:	6196781			
Conditions of Use:	Personal care products (nail salons)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Blow drying phase of hair straightening (pg 3)			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	PBZ; STEL (15 min TWA) (pg 3): Group 1 (29 stylists involved in hair straightening for <5 years): 1.68+/-0.27 ppm; Group 2 (31 stylists involved in hair straightening for >5 years): 1.83+/-0.16 ppm (pg 4) pg 5-6 have data from other studies on FA exposure to salon workers, limited metadata however			
Exposure duration:	8 h shift (pg 3). Analytic method: HPLC with UV detection (pg 3)			
Number of workers:	60 in study (pg 3)			
Comments:	8 h shift (pg 3). Analytic method: HPLC with UV detection (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Egypt, a non-OECD country.
	Metric 3:	Applicability	High	Data are for personal care products (nail salons), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by comparing results to other data in literature, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 6196781 Table: 2 of 2

Study Citation:	Aglan, M. A., Mansour, G. N. (2018). Hair straightening products and the risk of occupational formaldehyde exposure in hairstylists. Drug and Chemical Toxicology :1-8.			
HERO ID:	6196781			
Conditions of Use:	Lab chemical; plastics material and resin MFG			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Ceiling: 5.02 ppm in lab workers, 1.09 in resin manufacturers (pg 6; secondary source so limited metadata) (unsure if PBZ or area)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Portugal (Viegas et al., 2010), an OECD country.	
	Metric 3: Applicability	High	Data are for lab chemical and plastic material and resin manufacturing, both in-scope occupational scenarios.	
	Metric 4: Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics (single values provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Sample type provided but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Low		

Study Citation:	Ahmad, I., Whitson, T.C. (1973). Formaldehyde: how much of a hazard?. Indian Journal of Medicine and Surgery 428(8):26-27.				
HERO ID:	15899				
Conditions of Use:	Textile Finishing				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	2-10 PPM				
Comments:	N-methylol is used as hydrolysis of his compound would release formaldehyde, but the article is not specific about the source of the formaldehyde.				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from Tennessee and maybe representative of the industry being evaluated.	
	Metric 3:	Applicability	High	The data are for textile processing which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1973, prior to the most recent PEL (1992) and more than 20 years old.	
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data only included sample type (i.e.; area sampling) but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination			Low		

Study Citation:	Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.		
HERO ID:	4325272		
Conditions of Use:	Hospital		
EXTRACTION			
Parameter	Data		
Area sampling data:	mean levels of formaldehyde ranging between 0.13 ppm in endoscopy wards and 0.96 ppm in pathology laboratories (Page 5/10)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		High	

Study Citation:	Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.		
HERO ID:	4325272		
Conditions of Use:	Museum laboratory		
EXTRACTION			
Parameter	Data		
Area sampling data:	0.140 (wet specimen activities)-0.38 ppm (anatomy) (page 5/10)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		High	

Study Citation:	Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.		
HERO ID:	4325272		
Conditions of Use:	Environmental Health laboratory at a university		
EXTRACTION			
Parameter	Data		
Area sampling data:	0.00025-0.0003 ppm		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 4325272 Table: 4 of 12

Study Citation:	Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.			
HERO ID:	4325272			
Conditions of Use:	Physics laboratory at a university			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.0009-0.0029 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.		
HERO ID:	4325272		
Conditions of Use:	Research laboratory at a university		
EXTRACTION			
Parameter	Data		
Area sampling data:	0.0043-0.0047 ppm		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		High	

Study Citation:		Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.		
HERO ID:		4325272		
Conditions of Use:		Physiology laboratory at a university		
Parameter		EXTRACTION		
Area sampling data:		0.0036-0.0051 ppm		
Release or emission factors:		nan		
Domain		Metric		EVALUATION
				Rating
				Comments
Domain 1: Reliability		Metric 1:	Sampling and Analytical Methodology	High
		Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.		
Domain 2: Representativeness		Metric 2:	Geographic Scope	Low
		The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.		
		Metric 3:	Applicability	High
		Metric 4:	Temporal Representativeness	High
		The data are for an occupational scenario within the scope of the risk evaluation. The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.		
		Metric 5:	Sample Size	Medium
		Distribution of samples is characterized by a range with uncertain statistics.		
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Medium
		Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.		
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	High
		The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.		
Overall Quality Determination		High		

Study Citation:	Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.			
HERO ID:	4325272			
Conditions of Use:	Biochemistry laboratory at a university			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.0022-0.0034 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.			
HERO ID:	4325272			
Conditions of Use:	Chemistry laboratory at a university			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.0009-0.0044 ppm			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.		
HERO ID:	4325272		
Conditions of Use:	Biology laboratory at a university		
EXTRACTION			
Parameter	Data		
Area sampling data:	0.0014-0.0028 ppm		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 4325272 Table: 10 of 12

Study Citation:	Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.			
HERO ID:	4325272			
Conditions of Use:	Microbiology laboratory at a university			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.0023-0.0087 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.			
HERO ID:	4325272			
Conditions of Use:	Histology laboratory at a university			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.0053-0.0064 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.	
Overall Quality Determination		High		

Study Citation:	Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.			
HERO ID:	4325272			
Conditions of Use:	Anatomy laboratory at a university			
EXTRACTION				
Parameter	Data			
Worker activity description:	In medical colleges, cadavers for gross anatomy laboratories are usually prepared by using formaldehyde as embalming fluid. In the presence of cadavers and during the process of dissection, formaldehyde vapors are emitted from the cadavers, resulting in the exposure of medical students and their instructors to elevated levels of formaldehyde in the laboratory.			
Personal sampling data:	average personal exposure levels were 0.80, 0.45, and 0.51 ppm for instructors and 1.02, 1.08, and 0.89 ppm for students for the three sessions			
Area sampling data:	0.003-0.004 ppm 8-hr TWA (in the absence of a cadaver); 0.024-0.024 ppm 8-hr TWA (in presence of a cadaver); 0.07 to 2.94 ppm during dissecting operations; airborne concentrations of formaldehyde in the gross anatomy varying between 0.59 and 1.72 ppm with a mean of 0.97; immediately after removing the cadavers' plastic covering, formaldehyde concentrations in the dissection room increased sharply and reached a peak point of 0.62 ppm after 10 min of starting of the class, After 30 min of achieving the peak, the formaldehyde level started decreasing gradually to a level of 0.11 ppm; room averages of formaldehyde concentrations were 0.45, 0.38, and 0.68 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty				
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Study Citation:		Ahmed, H.O. (2011). Preliminary study: Formaldehyde exposure in laboratories of Sharjah university in UAE. Indian Journal of Occupational and Environmental Medicine 15(1):33-37.		
HERO ID:		4325272		
Conditions of Use:		Anatomy laboratory at a university		
		EVALUATION		
Domain		Metric	Rating	Comments
	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			Medium	

Study Citation:	Ahrenholz, S. H. (1988). Health Hazard Evaluation Report HETA 87-266-1860, U.S. Department of the Treasury, Bureau of Engraving and Printing, Washington, D.C, January 1988.
HERO ID:	1318521
Conditions of Use:	Multiple

EXTRACTION	
Parameter	Data
Worker activity description:	Loads of currency are brought into the mechanical examination areas. Two stacks of 10,000-32 subject sheets, are opened by the bookbinder, separated on a vibrating table, and shingled out onto the currency feeder as needed to maintain a continuous flow of the sheets through the mechanical examining unit and past the examiners. The examining units have four examiners who examine the face (front) and backs of the currency sheets.
Exposure route:	Inhalation
Physical form:	vapor
Personal sampling data:	Regular Currency Production:8/19 Machine 972 A3 Face examiner N.D. A1 Face examiner N.D. A3 Back examiner Trace A1 Back examiner Trace Book binder N.D.8/20 Machine 972 A3 Face examiner Trace A1 Face examiner N.D. A3 Back examiner N.D. A1 Back examiner N.D. Book binder N.D. 8/19 Machine 978 A1 Face examiner N.D. A3 Back examiner N.D. A1 Back examiner N.D. Book binder N.D. Stacker N.D. 8/20 Machine 978 A3 Face examiner N.D. A1 Face examiner N.D. A3 Back examiner N.D. A1 Back examiner N.D. Book binder N.D. Test Currency Production:8/19 Machine 976 A3 Face examiner N.D. A1 Face examiner N.D. Book binder N.D. Regular Currency Production:8/20 Machine 976 A3 Face examiner N.D. A1 Face examiner N.D. Book binder N.D.
Area sampling data:	Regular Currency Production:8/19 Machine 972 A3 Face examining station Trace 8/20 Machine 972 A3 Face examining station N.D. 8/19 Machine 978 A3 Face examining station N.D. 8/20 Machine 978 A3 Face examining station N.D. Test Currency Production:8/19 Machine 976 Air knife-initial currency feed N.D. A3 Face examining station N.D. Above A3 Back feed line N.D. Regular Currency Production:8/20 Machine 976 Air knife-initial currency feed N.D.8/20 Machine 976 A3 Face examining station N.D. 8/20 Machine 976 Above A3 Back feed line N.D. Regular Currency Production:8/19 Machine 972 A3 Face examining station 0.25 mg/m38/20 Machine 972 A3 Face examining station 0.20 mg/m38/19 Machine 978 A3 Back examining station 0.17 mg/m38/20 Machine 978 A3 Face examining station 0.13 mg/m3Test Currency Production:(3)8/19 Machine 976 A3 Face examining station 0.17 mg/m3 Above A3 Back feed line 0.18 mg/m38/20 Machine 976 A3 Face examining station 0.18 mg/m3 Above A3 Back feed line 0.16 mg/m3
Engineering control:	Lower exhaust takeoffs closer to the floor. Increase hold times and storage condition of freshly printed currency prior to inspection.
Comments:	The source of the formaldehyde is most likely due to the presence of a melamine-formaldehyde resin used in the currency paper. The work conducted by the bureau concerning aldehyde levels associated with the various test currency samples demonstrated little variation in formaldehyde concentrations among regular production currency, test currency printed with the test inks, blind embossed currency paper (no ink but run through the press), and unprocessed blank currency paper.

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	NIOSH study - but used a method developed by the Technical Services Division of the Department of Treasury which was similar to but not as accurate and Method 3500.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (printing operation) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1987 - prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed and my not have been consider in the Department of Treasury's methodology.

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Formaldehyde

Occupational Exposure

HERO ID: 1318521 Table: 1 of 1

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Study Citation:	Ahrenholz, S. H. (1988). Health Hazard Evaluation Report HETA 87-266-1860, U.S. Department of the Treasury, Bureau of Engraving and Printing, Washington, D.C, January 1988.		
HERO ID:	1318521		
Conditions of Use:	Multiple		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Results from individual sampling events were provided which could be used to evaluate variability between locations and jobs. Uncertainty was not discussed, and may not have been included in the Treasury Department’s methodology.
Overall Quality Determination		Medium	

Study Citation:	Ahrenholz, S. H. (1987). Health Hazard Evaluation Report HETA-86-0125-1853 Empire-Detroit Steel Division, Mansfield, Ohio. :24.			
HERO ID:	8197551			
Conditions of Use:	Processing aids, not otherwise listed			
EXTRACTION				
Parameter	Data			
Worker activity description:	Job titles on the tandem mill were assistant roller, entry operator, first sticker, second sticker, recorder, utility man, #14 crane operator, stocker, tractor operator, and motor room operator. Job titles on the reversing mill were roller, assistant roller, utility man, helper(bander), #13 crane operator, and stocker. (4/24)			
Exposure route:	inhalation (5/24)			
Physical form:	mist (1/24)			
Area sampling data:	Area formaldehyde concentrations ranged from 0.003 up to 0.06 mg/m3. (9/24)			
Number of workers:	40 workers (4/24)			
Personal protective equipment:	Personal protective equipment required in the cold rolling mill area included hard hats, safety glasses, and sound leather shoes. Respiratory protection was not required except for some clean-up operations. (4/24)			
Engineering control:	Side exhaust take-off hoods are present between the tandem mills on the side opposite the work stations. An exhaust hood is also located on the uptake side of the number five mill on the tandem mill operation above the winding reel. Exhaust hoods are located on the reversing mill to remove vapors and mists. (4/24)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for processing aids not otherwise listed, which may be in the scope of the scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Akbar-Khanzadeh, F., Mlynek, J.S. (1997). Changes in respiratory function after one and three hours of exposure to formaldehyde in non-smoking subjects. Occupational and Environmental Medicine 54(5):296-300.			
HERO ID:	626546			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	medical students in gross anatomy laboratory			
Personal sampling data:	0.3-4.45 (ppm) See Table 4 (pg. 3/5) for additional data			
Area sampling data:	0.59-1.72 (ppm) See Table 4 (pg. 3/5) for additional data			
Number of workers:	Sample size: 50 students			
Personal protective equipment:	98% of the exposed subjects wore protective gloves and laboratory coats, and 18% wore goggles.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method. (NIOSH 3500)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old.
	Metric 5:	Sample Size	High	Mean, standard deviation and range are given.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency, exposure duration.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by both personal and area sampling.
Overall Quality Determination		Medium		

Study Citation:	Akbar-Khanzadeh, F., Park, C.K. (1997). Field precision of formaldehyde sampling and analysis using NIOSH method 3500. American Industrial Hygiene Association Journal 58(9):657-660.			
HERO ID:	6194874			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Gross anatomy laboratory of a medical school (3/5)			
Exposure route:	Inhalation (3/5)			
Area sampling data:	The concentrations of formaldehyde ranged from 0.05 to 1.72 ppm with a mean ± standard deviation of 0.95 ± 0.31 ppm. (2/5)			
Exposure duration:	29 days			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data from more than 20 years back (1997).
	Metric 5:	Sample Size	High	Statistical distribution of samples is well characterized (number of samples, range, mean, SD).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling on different days, and by using a NIOSH and OSHA method.
Overall Quality Determination		High		

Study Citation:	Akbar-Khanzadeh, F., Vaquerano, M.U., Akbar-Khanzadeh, M., Bisesi, M.S. (1994). Formaldehyde exposure, acute pulmonary response, and exposure control options in a gross anatomy laboratory. American Journal of Industrial Medicine 26(1):61-75.		
HERO ID:	32742		
Conditions of Use:	Laboratory Use		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	Breathing zone TWA 1.24 ppm mean (0.07-2.94 ppm) SD 0.61; Direct Reading 1.37 ppm mean (Range 0.90-1.75 ppm) SD 0.27, additional data are provides for body structure examined		
Area sampling data:	TWA area 1.65 ppm mean (range 1.0-2.3 ppm) SD 0.92		
Number of workers:	34		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling and analytical methodology is abased on OSHA 52 which is similar to NIOSH method 2541
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1994, after the most recent PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability by including standard deviation and data ranges in the results. The study addresses uncertainty in the sampling and analytical method.
Overall Quality Determination		High	

Study Citation:	Akinyemi, P.A., Adegbenro, C.A., Ojo, T.O., Elugbaju, O. (2019). Neurobehavioral Effects of Organic Solvents Exposure Among Wood Furniture Makers in Ile-Ife, Osun State, Southwestern Nigeria. 9(22):190604.			
HERO ID:	5975067			
Conditions of Use:	Processing: Wood Products manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Spray painting in furniture manufacturing			
Exposure route:	Inhalation			
Area sampling data:	Median= 2.0 mg/m3, Mean TVOC= 4.4 /- 0.6 mg/m3			
Personal protective equipment:	Safety boots, waterproof apron, safety goggles, hand gloves, nose mask, respirators with air filters, face shield and headcover. 65.6% of participants did not use PPE.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 5975067 Table: 1 of 2

...continued from previous page			
Study Citation:	Akinyemi, P.A., Adegbenro, C.A., Ojo, T.O., Elugbaju, O. (2019). Neurobehavioral Effects of Organic Solvents Exposure Among Wood Furniture Makers in Ile-Ife, Osun State, Southwestern Nigeria. 9(22):190604.		
HERO ID:	5975067		
Conditions of Use:	Processing: Wood Products manufacturing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Akinyemi, P.A., Adegbenro, C.A., Ojo, T.O., Elugbaju, O. (2019). Neurobehavioral Effects of Organic Solvents Exposure Among Wood Furniture Makers in Ile-Ife, Osun State, Southwestern Nigeria. 9(22):190604.			
HERO ID:	5975067			
Conditions of Use:	Commercial Use: Electrical and electronic products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Electronic Technicians			
Exposure route:	Inhalation			
Area sampling data:	Median= 0.07 mg/m3, Mean TVOC= 0.3 +/- 0.3 mg/m3			
Personal protective equipment:	66.3% of participants did not use PPE.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			Medium	
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 5975067 Table: 2 of 2

...continued from previous page

Study Citation:	Akinyemi, P.A., Adegbenro, C.A., Ojo, T.O., Elugbaju, O. (2019). Neurobehavioral Effects of Organic Solvents Exposure Among Wood Furniture Makers in Ile-Ife, Osun State, Southwestern Nigeria. 9(22):190604.		
HERO ID:	5975067		
Conditions of Use:	Commercial Use: Electrical and electronic products		
		EVALUATION	
Domain	Metric	Rating	Comments

Study Citation:	Al-Hemoud, A., Al-Awadi, L., Al-Khayat, A., Behbehani, W. (2018). Streamlining IAQ guidelines and investigating the effect of door opening/closing on concentrations of VOCs, formaldehyde, and NO2 in office buildings. Building and Environment 137:127-137.			
HERO ID:	5972174			
Conditions of Use:	Building and construction materials (office building)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office building workers-A significant source of formaldehyde exposure indoor includes off-gassing from new furniture, carpets, wood floorings, glues, and adhesives (pg 2)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	"Average concentration levels for formaldehyde during pre, post-, and summer as previously shown in Table 9 were 14.76 ppb, 10.83 ppb, 40.60 ppb, respectively (pg 7) Table 9 presents the same data as above plus F and sig, Table 12 presents data for door open vs. door closed (pg 9)"			
Engineering control:	Ventilation mode of the selected offices is maintained by a hybrid system; that is a combination of a central air conditioning (AC) and a split unit system. The central AC system has provisioned for a fixed fractional (10%) air exchange rate; while the split unit system cools the recirculating room air and provides no means of fresh air (100% recirculation, with the evaporator located indoor and the condenser located outdoor). Indoor air for three pollutant concentrations (VOCs, formaldehyde, NO2) was examined when doors were either open or closed, and the AC was either switched on or off during midweek and weekends. Temperature settings during the AC on-mode were fixed at either 17 °C or 26 °C during three periods (pre-, post, summer) (pg 3)			
Comments:	Method: GC/FID; passive sampling during the same period of VOC sampling. Diffusion samplers were used as recommended by the manufacturer (IVL Swedish Environmental Research Institute) (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Kuwait, a non-OECD country
	Metric 3:	Applicability	High	Data are for building and construction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure/sampling duration and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling for multiple seasons.
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Formaldehyde

Occupational Exposure

HERO ID: 5972174 Table: 1 of 1

...continued from previous page

Study Citation:	Al-Hemoud, A., Al-Awadi, L., Al-Khayat, A., Behbehani, W. (2018). Streamlining IAQ guidelines and investigating the effect of door opening/closing on concentrations of VOCs, formaldehyde, and NO2 in office buildings. Building and Environment 137:127-137.		
HERO ID:	5972174		
Conditions of Use:	Building and construction materials (office building)		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 2556400 Table: 1 of 1

Study Citation:	Alaves, V.M., Sleeth, D.K., Thiese, M.S., Larson, R.R. (2013). Characterization of indoor air contaminants in a randomly selected set of commercial nail salons in Salt Lake County, Utah, USA. International Journal of Environmental Health Research 23(5):419-433.			
HERO ID:	2556400			
Conditions of Use:	Use of personal care products			
EXTRACTION				
Parameter		Data		
Worker activity description:		Performing manicures and pedicures		
Exposure route:		Inhalation		
Physical form:		Vapor		
Area sampling data:		0.017 (ppm)		
Exposure duration:		"the majority of establishments sampled were open from eight to a maximum of 12 h daily, with 10 h being the most common"		
Number of workers:		76,000 (BLS 2008)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	High	All laboratory analyses and equipment (Summa Canisters, Sorbent Tubes, and air pumps) were provided by ALS Laboratory Group (Murray, UT). ALS Laboratory is an American Industrial Hygiene Association accredited laboratory for these particular analyses.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Study was conducted in 2010
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Study took into account such information including ambient conditions, customer volume, presence of ventilation, etc. Also provide are all discrete data as well as mean, standard deviation, and variance.
Overall Quality Determination			High	

Study Citation:	Alexandersson, R., Hedenstierna, G. (1988). Respiratory hazards associated with exposure to formaldehyde and solvents in acid-curing paints. Archives of Environmental Health 43(3):222-227.			
HERO ID:	31634			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	fitting, grinding, filling, coating, packing and maintenance activities			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.40 mg/m3 daily mean (range 0.12-2.60 mg/m3) mean Peak 0.70 mg/m3)			
Exposure duration:	8 hour work days			
Number of workers:	38 exposed individuals			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling and analysis methods was not specifically documented, but samples were made using 2,4-dinitrophenylhydrazine (2,4-DNF) followed by desorption using di-ethyl ether and determined quantitatively with fluid chromatography.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - OECD Member
	Metric 3:	Applicability	High	The data are for surface coating using acid hardening lacquer which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 2010, after the most recent PEL (1992) but 20 years old.
	Metric 5:	Sample Size	High	The data are disaggregated by worker activity and includes number of samples daily average and range and average peak exposure and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range by worker activity which can be used to assess variability. The study did not provide a discussion of uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Alexandersson, R., Hedenstierna, G. (1989). Pulmonary function in wood workers exposed to formaldehyde: A prospective study. Archives of Environmental Health 44(1):5-11.			
HERO ID:	31914			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	kitchen cabinet fabrication			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Pg.4 Formaldehyde: 1980- 0.42±0.27 mg/m3; 1984 - 0.5±0.12 mg/m3;Total dust: 1980- 0.3±0.7 mg/m3; 1984 - 0.1±0.3 mg/m3; Respirable dust: 1980- 0.1±0.2 mg/m3; 1984 - 0.1±0.2 mg/m3			
Exposure duration:	3to 4 15 minute samples during the the work day			
Number of workers:	47 (exposed) 20 (control) / 5 years later 34 (exposed) 18 (control)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - OECD member
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - published 1989 but data is from 1980 and 1984
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - average value and range provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty
Overall Quality Determination		Medium		

Study Citation:	Alexandersson, R., Hedenstierna, G., Kolmodin-Hedman, B. (1982). Exposure to formaldehyde: effects on pulmonary function. Archives of Environmental Health 37(5):279-284.			
HERO ID:	626548			
Conditions of Use:	Use of Floor coverings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Carpentry shop workers			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.45 mg/m3 mean (range 0.05-1.62 mg/m3)			
Particle size characterization:	0.5 mg/m3 (range 0.3-0.7 mg/m3)			
Exposure duration:	nan			
Number of workers:	47			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified though it was noted that samples were obtained by subject-carried filter pumple and analyzed using liquid chromatogra-phy.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - OECD member
	Metric 3:	Applicability	High	The data are for carpentry which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1982, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean value and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provides range values which can be used to evaluate variability, but uncer-tainty was not discussed
Overall Quality Determination			Medium	

Study Citation:	Alexiou, S. D., Petrolekas, P. D. (2002). Conducting an industrial hygiene program. :1521-1526.			
HERO ID:	5954812			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Process plant – personnel handling chemical agents during dispensing, sampling, and production			
Exposure route:	inhalation			
Physical form:	gas			
Personal sampling data:	Concentrations of formaldehyde (ppm) recorded during dispensing was 1.8, during sampling was 1.2, and during production was 0.6.			
Personal protective equipment:	Respiratory protection equipment recommended to people handling formaldehyde together with providing sufficient training and instructions so as to recognize potential problems and avoid needless exposure situations.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country. other than the U.S
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	data is between 10 and 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Allaire, S., Bourbeau, J., Brisson, C. (1997). Prevalence of the sick building syndrome symptoms in office workers before and six months and three years after being exposed to a building with an improved ventilation system. Occupational and Environmental Medicine 54(1):49-53.			
HERO ID:	6012181			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office workers (1/5)			
Exposure route:	inhalation (2/5)			
Area sampling data:	Total formaldehyde concentrations were below 2 ug/m3 for all three years of sampling. (4/5)			
Number of workers:	1359 included in final study (3/5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3:	Applicability	Low	Data are for ambient air in offices, which is similar to the in-scope occupational scenario of the use of inks and toners in photocopiers..
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology and in conclusion paragraph but variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Almaguer, D. (1988). Health Hazard Evaluation Report HETA 87-307-1917, Downing Displays, Inc., Cincinnati, Ohio, August 1988.			
HERO ID:	1316871			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Display boards for sales promotions are assembled. Metal channeling is cut to size and metal slivers are cleaned from the surface with 1,1,1-trichloroethane while wearing protective gloves. Adhesive is purchased in 55 gallon drums and dispensed into paint roller pans as needed. The adhesive is applied to the cardboard backing using paint rollers.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Personal samples showed airborne concentrations of formaldehyde ranging from 0.23 ppm to 0.28 ppm for five It should be noted that because of a power outage normal work activities were discontinued and all samples collected were for a period of less than one and one-half hours. It is believedthat the nondetectable levels on 6/16/1987 were due to the short sampling period and the fact that part of the sampling period was during the power outage when no work could be accomplished. All samples had ND, workers included framer, gluer, and contact paper.6/22/1987Gluer 0.28 ppmGluer 0.24 ppmGluer 0.26 ppmGluer 0.23 ppmTransparencies 0.28 ppm			
Area sampling data:	Two area samples collected near the glue cabinet, above the drying rack and at the production supervisor’s desk showed airborne concentrations of formaldehyde of 3.3 ppm, 0.68 ppm and 0.23 ppm, respectively.Area - glue cabinet 3.3 ppm (6/16/1987)Area - drying rack ND (6/16/1987)Area - prod. supervisor’s desk ND (6/16/1987)It should be noted that because of a power outage normal work activities were discontinued and all samples collected were for a period of less than one and one-half hours. It is believedthat the nondetectable levels on 6/16/1987 were due to the short sampling period and the fact that part of the sampling period was during the power outage when no work could be accomplished.Area - drying rack 0.68 (6/22/1987)Area - prod. supervisor’s desk 0.23 (6/22/1987)			
Number of workers:	4			
Personal protective equipment:	Gloves			
Engineering control:	Substitute adhesive with low formaldehyde content ahesiveDrying rack should be isolated.Glue cabinet should be ventilated to the outside air			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	NIOSH study - Method 2502, NIOSH website indicates that this method is withdrawn and no longer used, information states the 2541 method has better sample stability and ease of personal sampling.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario (adhesive) within the scope of the risk eval-uation but the report under recommendations make reference that the formaldehyde function is a biocide, which would be non-TSCA. The scenario is still similar to use of adhesive within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1987 - prior to the PEL (1992) and more than 20 years.
	Metric 5:	Sample Size	Medium	results from individual sampling events were provided, summary statistics can be devel-oped using these data. Low sample size
Domain 3: Accessibility/ Clarity				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1316871 Table: 1 of 1

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Study Citation:	Almaguer, D. (1988). Health Hazard Evaluation Report HETA 87-307-1917, Downing Displays, Inc., Cincinnati, Ohio, August 1988.			
HERO ID:	1316871			
Conditions of Use:	Multiple			
Domain		Metric	EVALUATION Rating	Comments
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, worker activities.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Medium	Variability was limited, but results for each sampling event were included, which is useful in evaluating variability between jobs and locations. Report indicates some dependence of exposure on batch of adhesive used but most estimates are for two batches. As this study used a NIOSH methodology it was assumed that uncertainty was considered in the method.
Overall Quality Determination			Medium	

Study Citation:	Almaguer, D. (1986). Health Hazard Evaluation Report HETA-85-48-49-1658 Lausen Engine Division, New Holstein, Wisconsin.			
HERO ID:	8684552			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Assembling brake pads. (4/16)			
Exposure route:	inhalation (8/16)			
Physical form:	gas (8/16)			
Personal sampling data:	Personal samples for formaldehyde were below the LOD of 2ug/sample. (8/16)			
Number of workers:	200 administrative workers, 1200 production workers, and 50 maintenance workers (4/16)			
Engineering control:	Local exhaust ventilation was provided at the Sub-assembly Brake Pad area. The adhesive was applied to the brake pads within a local exhaust ventilation hood and was cured in a sealed oven which was local exhaust ventilated. Assembly of the brake pad and bracket was conducted at the sub-assembly machine which was equipped with local exhaust ventilation.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for brake pad assembly, which is similar to the in-scope occupational scenario adhesives and sealants in wood product manufacturing.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker activity provided, but missing exposure duration, frequency, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Almaguer, D., Alterman, T., Blade, L. M., Hurrell, J. J. (1995). Health hazard evaluation report HETA 93-0154-2527, Truman State Office Building, Jefferson City, Missouri.			
HERO ID:	81269			
Conditions of Use:	Use of Furniture and Furnishings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office work			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.007 - 0.008 ppm			
Number of workers:	72			
Comments:	because the concentrations were low, the source of the emissions was not identified, but it was implied that the concentrations may be due to off-gassing of compressed wood product which may be covered by other regulations			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (office work) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	This report was developed in 1995, 3 years after the PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	actual results of sampling provided - no summary statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include sample type (area) and duration of sampling, but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	concentrations were low and ranged from 0.007 to 0.008 ppm so there was little variance in the data. Assumed that uncertainty was addressed in the NIOSH methodology.
Overall Quality Determination		High		

Study Citation:	Almaguer, D., Blade, L. M. (1990). HETA 88-153-2072 October 1990 Buckeye Hills Career Center Rio Grande, Ohio.
HERO ID:	8149120
Conditions of Use:	Other: Fumigant (Non-TSCA)

EXTRACTION

Parameter	Data
Worker activity description:	Employees at Cosmetology Clinic- use of paraformaldehyde fumigant products that offgas formaldehyde
Exposure route:	inhalation
Physical form:	off-gas
Area sampling data:	Table I- General-area air samples for airborne concentrations of formaldehyde (pdf pg. 12)Ranges from <LOQ to 15.2 ppm
Engineering control:	is served by 15 separate heating, ventilation, and air-conditioning (HVAC) system

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Three different sampling surveys were done using different sampling and analytical methods, but all were NIOSH approved.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Uninformative	The data are from an occupational scenario that does not apply to any occupational scenario within the scope of the risk evaluation (non-TSCA-Pesticide Use).
	Metric 4: Temporal Representativeness	Low	The data were collected before the most recent PEL establishment.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site. The monitoring study addresses uncertainty in the exposure estimates and uncertainty can be determined from the sampling and analytical method.

Overall Quality Determination**Uninformative**

Study Citation:	Almaguer, D., Boiano, J. M. (1986). Health Hazard Evaluation Report HETA-1985-0018-1759 American Crystal Sugar Company, Moorhead, Minnesota.			
HERO ID:	8684542			
Conditions of Use:	Agricultural chemicals in agriculture, forestry, fishing, and hunting			
EXTRACTION				
Parameter	Data			
Worker activity description:	Charging bags of paraformaldehyde			
Exposure route:	Dermal and inhalation.			
Physical form:	Vapor			
Personal sampling data:	Utility man charged 6 bags of paraformaldehyde (1/17/85): 0.33 mg/m^3.Utility man charged 6 bags of paraformaldehyde (1/18/85): 0.66 mg/m^3.			
Exposure duration:	8 hrs/day			
Exposure frequency:	The facility operates 7 days/week from mid September to mid March and 6 days/week the rest of the year.			
Number of workers:	690 workers are employed by the Moorhead facility.			
Personal protective equipment:	Supplied air respirators.			
Engineering control:	NIOSH recommends the use of portable local exhaust ventilation.			
Comments:	Area sampling for formaldehyde was not performed due to limited sampling media.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Uninformative	Data are for an occupational scenario outside of the scope of the risk evaluation. EPA determined as reported in the scope, the use of formaldehyde in sugar refinery is FIFRA.
	Metric 4:	Temporal Representativeness	Low	Before the most recent PEL, more than 20 years ago.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability addressed by comparing results from multiple days, uncertainty is addressed with the given sampling methods.
Overall Quality Determination		Uninformative		

Study Citation:	Almaguer, D., Boiano, J. M. (1986). Health Hazard Evaluation Report HETA-85-045-1762 American Crystal Sugar Co., Crookston, Minnesota.			
HERO ID:	8684548			
Conditions of Use:	Sugar manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Utility men in the diffuser and carbonation area. (25/41)			
Exposure route:	inhalation, dermal (11/41)			
Physical form:	vapor, solution, and resins (11/41)			
Personal sampling data:	Two diffuser operators had personal breathing concentrations of ND and 0.04 ppm formaldehyde. An employee charging 5 bags of paraformaldehyde had personal breathing concentrations of 0.07 ppm. (36/41)			
Area sampling data:	General area concentrations of formaldehyde were 0.05 ppm in the diffuser operators station, 0.23 ppm in the paraformaldehyde tank, 0.25 ppm on the catwalk above the diffuser, and ND in the knife station and picker station. (37/41)			
Exposure frequency:	7 days/week from September to March, and 6 days/week in the offseason. (6/41)			
Number of workers:	375 workers (6/41)			
Engineering control:	The possibility of substituting formaldehyde with a bactericide that is less toxic should be investigated. (18/41)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation (sugar manufacturing)
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination			High	

Study Citation:	Almaguer, D., Klein, M. (1991). HETA 89-170-2100 February 1991 Northwest Vocational School , Cincinnati, Ohio.
HERO ID:	8143964
Conditions of Use:	Chemical Substances in Treatment/Care Products - Personal care products

EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	May 17, 1989Cosmetology dispensary 0.19 ppmManicuring supplies cabinet 0.55 ppmFacial room shelve 0.18 ppmFacial room, inside cabinet 0.50 ppmCosmetology Lab, west end 0.46 ppmCosmetology Lab, east end 0.15 ppmCosmetology reception desk 0.053 ppmCosmetology classroom #307 0.18 ppmFormaldehyde fumigant mixing 11 2.9 ppmCosmetology dispensary 0.90 ppmMay 18, 1989Cosmetology dispensary 0.73 ppmManicuring supplies cabinet 0.18 ppmFacial room shelve 0.11 ppmFacial room, inside cabinet 0.52 ppmCosmetology Lab, east end 0.18 ppmCosmetology Lab, west end 0.11 ppmCosmetology reception desk 0.064 ppmCosmetology classroom #307 0.11 ppmCounselor's office 0.037 ppm
Exposure duration:	up to 10 hours per day
Exposure frequency:	40 hours per week
Number of workers:	13 to 15 students plus an instructor (full capacity is 20 students plus an equal number of patrons)
Engineering control:	The air supply and exhaust systems for the Bathroom and Dispensary should be designed so that these areas remain under negative pressure relative to all other spaces served by this AHU. Additionally, the system should be designed so that all spaces served by the Cosmetology AHU are under negative pressure relative to the remainder of the building.The exhaust air-flow from the Dispensary should be 10% greater than the supply-air flow rate into this room (i.e., through the ceiling diffusers). Similarly, this requirement applies to the Bathroom exhaust.The combined exhaust air-flow from the Bathroom and the Dispensary exhaust systems should always be 10% greater than the outside-air-intake flowrate to the AHU. The design-specification exhaust air flow capacity of the Bathroom and the Dispensary exhaust systems should be selected to be a total of 1475 cfm, which is 10% greater than the outside-air flowrate of 1340 cfm required for the space under the greatest-expected occupancy projected (as discussed previously in this section). The design specification intake-air flow capacity of the AHU must be at least 1340 cfm. VENTILATION CONTROL SYSTEMSSeveral methods can be used to control the required amount of outside air provided to the Cosmetology Laboratory, Reception Room, Dispensary, and Classroom. A constant amount of outside air may be supplied to these areas based on the maximum number of occupants (students, instructors and patrons) or a control system may be installed to provide varying amounts of outside air depending on the number of occupants present in these areas at any given time. The choice of which type of control system to install will depend on the amount of money the school is willing to budget for this project.1. The least expensive system is a constant volume system which opens the outside air damper to a preset position when the AHU is turned on. This preset level should be based on the maximum number of occupants and should provide enough outside air to meet the ASHRAE recommendations. Although this type of system is the least expensive to install, it is the most expensive to operate because the outside air provided needs to be tempered and generally, the system would provide more outside air than needed to meet the ASHRAE recommendations.2. The next level of control has two preset levels. The outside air damper opens to the first preset level when the AHU is turned on and a timer circuit opens the damper to a second preset level during the hours when the Cosmetology Classroom is occupied. The first preset level should be based on the maximum number of occupants (including patrons) expected in the Cosmetology Laboratory, Reception Room and Dispensary. The second preset level should be based on the maximum number of occupants expected when both the Cosmetology Laboratory areas and the Cosmetology Classroom are occupied. While this control system is more energy efficient than the system described above (item 1), energy is still wasted tempering air for patrons who may not be in the space.3. The highest level of control requires the outside air damper to be opened to a preset level determined by the maximum number of students and instructors present in the Cosmetology, Dispensary and Reception areas. This control system is equipped with a timer control system to increase the amount of outside air provided when the Cosmetology Classroom is occupied. The amount of outside air supplied to the Cosmetology Laboratory areas is increased by the use of a manual switch located in the Cosmetology Laboratory. The switch allows the outside air damper to open wider and can be either an incremental or on-off switch. The instructor should be the person responsible for determining if more outside air is needed due to increased numbers of patrons, odors, etc. Since this is a manual switch, a warning device should be used to remind the instructor to reset the switch to the original position or reset the warning device if more time is needed.

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability			

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 8143964 Table: 1 of 1

...continued from previous page

Study Citation:	Almaguer, D., Klein, M. (1991). HETA 89-170-2100 February 1991 Northwest Vocational School , Cincinnati, Ohio.
HERO ID:	8143964
Conditions of Use:	Chemical Substances in Treatment/Care Products - Personal care products

		EVALUATION		
Domain	Metric	Rating	Comments	
	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method 3500
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (Classroom exposure) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1989 prior to PEL (1992) and more than 20 years ago.
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH method 3500.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, and sample durations, and exposure frequency, but lacks additional metadata, such as exposure durations, and/or worker activities.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between locations and days. Uncertainty was not discussed but assumed that it was addressed in NIOSH method 3500.

Overall Quality Determination**High**

Study Citation:	Almaguer, D., Klein, M., Klinecicz, S. (1990). Health Hazard Evaluation Report No. HETA-87-387-2050, Ithaca College, Ithaca, New York. :87-387.			
HERO ID:	4440693			
Conditions of Use:	Chemical substances in products not described by other codes.: laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Worker activity description:	cleaning primate cadavers and dissection.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Dec 8, 1987Anatomy Instructor 0.097 ppm*Graduate Assistant 0.12 ppm*Value between the LOD and the LOQ			
Area sampling data:	Dec 7, 1987S-1/anatomy lab NDS-1/anatomy lab 0.032 ppm*S-6/refrigeration NDS-6/refrigeration 0.031 ppm*S-1 Hallway ND S-1 Hallway ND1st floor/outside Physics Office 0.016 ppm*1st floor/outside Lecture Auditorium 0.017 ppm*S -6B/Twincubator room 0.013 ppm*Dec 8, 1987S-1/anatomy lab 0.022 ppm*S-1/anatomy lab 0.06 ppmS-1 hallway 0.035 ppm*S-6/refrigeration 0.017 ppm*S -6B/Twincubator room 0.015 ppm*1st floor 0.021 ppm*2nd floor/outside Lecture Auditorium 0.016 ppm*Room 208/back NDRoom 208/front ND2nd floor, outside auditorium ND3rd floor, hanging from railing ND*Value between the LOD and the LOQ			
Dermal exposure data:	nan			
Number of workers:	62 students and 43 faculty and staff members working in the science building			
Personal protective equipment:	Wearing of protective gloves			
Engineering control:	Local exhaust ventilation should be used during dissection of formaldehyde-preserved specimens. If not feasible, a displacement ventilation system is another method of controlling airborne contaminants.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	1987 - Prior to PEL (1992) more than 20 years old.
	Metric 5:	Sample Size	Medium	Results from individual sampling events were provided which could be used to develop statistics, though they only had two values that were greater than the LOQ. Uncertainty was not discussed but assumed that it was addressed in NIOSH method 3500.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include most metadata, such as sample type and exposure type, sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 4440693 Table: 1 of 1

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Study Citation:		Almaguer, D., Klein, M., Klincewicz, S. (1990). Health Hazard Evaluation Report No. HETA-87-387-2050, Ithaca College, Ithaca, New York. :87-387.		
HERO ID:		4440693		
Conditions of Use:		Chemical substances in products not described by other codes.: laboratory Chemicals		
		EVALUATION		
Domain	Metric	Rating	Comments	
	Metric 7: Metadata Completeness	Medium	Results from individual sampling events were provided which could be used to evaluate variability between locations/jobs, though there was only one area source value greater than the LOQ and one breathing zone sample greater than the LOQ. As this is a NIOSH study, it is assumed that uncertainty was considered in Method 3500.	
Overall Quality Determination		Medium		

Study Citation:	Almeida, S. M., Almeida-Silva, M., Dias, A., Faria, T. (2016). Indoor air quality in urban office buildings. International Journal of Environmental Technology and Management 19(3-4):236.				
HERO ID:	6034242				
Conditions of Use:	Paints and coatings; adhesives and sealants; building and construction materials (overall office work data)				
EXTRACTION					
Parameter	Data				
Worker activity description:	H2CO is often associated with paints, adhesives, insulations, cabinetry, workstations, ceiling tile, wallboard and furniture (pg 13)				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	3 of 7 samples buildings exceeded concentration allowed by Portugese law (two at 0.11, the other 0.15 mg/m3) (pg 12) Table 4 (pg 14) presents average and ranges for this work and others in literature				
Number of workers:	88, 55, n/a, 22, 195, n/a, 136 for the 7 buildings sampled (Table 2, pg 21)				
Comments:	Uncertain measurement type/duration: 8-hr (Table 4, pg 14); "In each sampling point measurements were performed during 15 minutes." (pg 7). Location: at least 1 m away from walls in the room, and about 1 m above the floor, since this is the approximate height of the average breathing zone (pg 7). Measure via portable monitor – PPM, formaldemeter htV model (range: 0–10 ppm; resolution: 0.001 ppm; accuracy: 10% at 2ppm) (pg 7)				
EVALUATION					
Domain		Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Portugal, an OECD country.	
	Metric 3:	Applicability	High	Data are multiple in-scope occupational scenario.	
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.	
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (average, range) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing such as exposure frequency.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.	
Overall Quality Determination			High		

Formaldehyde

Occupational Exposure

HERO ID: 5899315 Table: 1 of 1

Study Citation:	American Cyanamid, (1991). Letter from American Cyanamid Co to US EPA submitting information on formaldehyde mortality study with attachments.			
HERO ID:	5899315			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Personal sampling data:	For all jobs that included potential contact with formaldehyde, average exposure level was 0.143 ppm. (37/107)			
Exposure frequency:	Data is included for mean duration of employment for each cause of death in the cohort. (24/107)			
Number of workers:	7359 in the cohort, 4979 exposed to formaldehyde (15/107)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data from more than 20 years ago.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Analytics, (2017). [Redacted] Formaldehyde monitoring results - Spring 2017 (memo dated 08/23/2017).				
HERO ID:	10602475				
Conditions of Use:	processing				
EXTRACTION					
Parameter	Data				
Worker activity description:	operation and maintenance				
Personal sampling data:	8 breathing zone samples were collected. Results were as follows: Assist. Operator - 0.023 ppm; Assist. Operator - 0.022 ppm; Field Process Operator - 0.174ppm; Assist. Operator - 0.073 ppm; Operator - 0.064 ppm; Power House Op. - 0.019 ppm; E/1 Technician - 0.038 ppm; Mechanic - 0.029 ppm (pg 1 of 8)				
Exposure duration:	8 hr/day (pg 1 of 8)				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling methodology is described and analytical method is NIOSH method	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States	
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	High	The monitoring data were collected no more than 10 years old	
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability. Uncertainty canbe determined from the sampling and analytical method.	
Overall Quality Determination			High		

Study Citation:	Analytics, (2018). [Redacted] Formaldehyde monitoring results - Spring 2018 (memo dated 06/15/18).				
HERO ID:	10602476				
Conditions of Use:	processing				
EXTRACTION					
Parameter	Data				
Personal sampling data:	Employees wore the formaldehyde monitoring badge during their work shift. Position _____ Department _____ Result Operator _____ _____ TMP _____ 0.051 ppm Assist. Operator _____ TMP _____ 0.022 ppm Field Process Operator _____ FA _____ 0.132 ppm Assist. Operator _____ Penta _____ 0.046 ppm Assist. Operator _____ Penta _____ 0.017 ppm Power House Op. _____ Penta _____ 0.020 ppm Mechanic _____ Maint _____ 0.014ppm Mechanic _____ _____ Maint _____ 0.025 ppm Lab Tech. _____ Quality _____ 0.013 ppm · (pg 1 of 14)				
Exposure duration:	8 hrs (pg 7 of 14)				
Number of workers:	9 (pg 1 of 14)				
EVALUATION					
Domain	Metric	Rating		Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling method is well described and analytical method is an approved NIOSH method.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States	
	Metric 3:	Applicability	Medium	The data does not describe the process but based on company information, it is expected to be for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	High	Data no more than 10 years old	
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability. Uncertainty can be determined from the sampling and analytical method.	
Overall Quality Determination			High		

Study Citation:	Analytics, (2019). [Redacted] Formaldehyde monitoring results - Spring 2019 (memo dated 06/20/19).		
HERO ID:	10602478		
Conditions of Use:	processing		
EXTRACTION			
Parameter	Data		
Personal sampling data:	Employees wore the formaldehyde monitoring badge during their work shift. Position _____ Department _____ Result Operator _____ _____ TMP _____ -0.037 ppm Field Process Operator _____ FA _____ -0.109 ppm Field Process Operator _____ FA _____ -0.234 ppm Assist. Operator _____ Penta _____ -0.040 ppm Operator _____ Penta _____ -0.073 ppm Power House Op. _____ Penta _____ -0.031 ppm Mechanic _____ Maint _____ -0.029 ppm Mechanic _____ _____ Maint _____ -0.031 ppm Assist. Operator _____ TMP _____ -0.023 ppm · (pg 1 of 15)		
Exposure duration:	8 hrs (pg 8 of 15)		
Number of workers:	9 (pg 1 of 15)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling method is well described and analytical method is an approved NIOSH method.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Data no more than 10 years old
	Metric 5: Sample Size	High	Full distribution of samples provided.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		High	

Study Citation:	Analytics, (2020). [Redacted] Formaldehyde monitoring results - Spring 2020 (memo dated 06/26/20).			
HERO ID:	10602480			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Personal sampling data:	[TWA calculated] Field Process Operator: 0.080 ppm, 0.076 ppm; Mechanic and Insulator in Maintenance: 0.027ppm, 0.018ppm; Unknown: 0.095 ppm also reported on pg 6			
Exposure duration:	260 - 450 min sampling time (pg 3-4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	OSHA Method 1007M	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	Data are for Perstorp Polyols, which may be FA MFG but it is not stated explicitly	
	Metric 4: Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability is not addressed. Uncertainty canbe determined from the sampling and analytical method.	
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 10602481 Table: 1 of 1

Study Citation:	Analytics, (2016). [Redacted] Formaldehyde monitoring results - Spring 2016 (memo dated 05/27/16).		
HERO ID:	10602481		
Conditions of Use:	processing		
EXTRACTION			
Parameter	Data		
Personal sampling data:	Employees wore the formaldehyde monitoring badge during their work shift. Position_____Department_____Result Assist. operator _____TMP _____-0.090 ppm Operator _____TMP _____-3.39 ppm Field Process Operator _____FA _____0.084 ppm Assist. Operator _____Penta _____-0.056 ppm Operator _____Penta _____-0.160 ppm Power House Op. _____Penta _____-0.035 ppm Mechanic _____Maint _____-0.094 ppm(pg 1 of 6)		
Exposure duration:	8 hours		
Exposure frequency:	7 (pg 1 of 6)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling method is well described and analytical method is an approved NIOSH method.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Data no more than 10 years old
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		High	

Study Citation:	Analytics, (2018). [Redacted] Formaldehyde monitoring results - Fall 2018 (memo dated 11/06/18).			
HERO ID:	10602482			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Personal sampling data:	Pg 1: TWA: ranges from 0.013 (lab tech) to 0.069 ppm (operator)Pg 3-4: 0.033 (0.0405) - 6.14 ppm (7.54 mg/m3)Pg 9 -10: 0.013 (0.016) - 0.053 ppm (0.0651 mg/m3)			
Exposure duration:	467 - 496 min sampling times (pg 3-4)332 - 474 min sampling times (pg 9-10)			
Comments:	NIOSH Method 2016M			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for Perstorp Polyols, which may be FA MFG but it is not explicitly stated
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability is not addressed. Uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Study Citation:	Analytics, (2019). [Redacted] Formaldehyde monitoring results - Fall 2019 (memo dated 11/11/19).			
HERO ID:	10602484			
Conditions of Use:	Manufacturing/Processing as a Reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Personal sampling data:	Employees wore formaldehyde monitoring badge. Operator and assistant operator in TMP department - 0.057 and 0.033 ppm; Field process operators in FA department - 0.123 and 0.242 ppm; Assistant operator, operator, and powerhouse operator in penta department - 0.061, 0.170, and 0.048 ppm; mechanic and insulator in maintenance department - 0.031 and 0.044 ppm. (pg 1 of 12)			
Exposure duration:	approximately 8 hrs/day (pg 6 of 12)			
Number of workers:	9 (pg 1 of 12)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling and analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data is not fully clear on OES but other information (company name) suggest an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data are no more than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability. Uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Analytics, (2017). [Redacted] Formaldehyde monitoring results - Fall 2017 (memo dated 11/13/17).		
HERO ID:	10602486		
Conditions of Use:	Manufacture-Unknown		
EXTRACTION			
Parameter	Data		
Personal sampling data:	Employees wore the formaldehyde monitoring badge during their work shift. Below extracted values are the calculated 8-hr TWA assuming 0 for time not sampled. Values taken from pg. 1 Position _____ Department _____ Result Field Process Operator _____ FA _____ 0.138 ppm Warehouse _____ Supply _____ 0.015 ppm Operator _____ Penta _____ 0.047 ppm Assist. Operator _____ Penta _____ 0.020 ppm Operator _____ TMP _____ 0.059 ppm Assist. Operator _____ TMP _____ 0.041 ppm Mechanic _____ Maint _____ 0.025 ppm Power House Op. _____ Penta _____ 0.010 ppm E/I Technician _____ Maint _____ 0.041 ppm Important Notes: On pg 1., indicates field process operator loaded 0 trucks during sampling; On pg. 7, there are 2 8-hr TWAs not accounted for in summary: A253240 for 0.7 ppm and A253261 for 0.024 ppm Pages 4-5&12-13 for raw data Pages 7-8&15-16 is calculation of the 8-hr TWA		
Exposure duration:	8 hours		
Number of workers:	9 (pg 1 of 18)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling method is well described and analytical method is an approved NIOSH method (NIOSH 2016M)
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Data no more than 10 years old
	Metric 5: Sample Size	Medium	Includes discrete samples, missing clarity on 2 samples shown.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type but lacks other metadata such as additional process details, worker descriptions, and 2 samples were not fully explained.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty can be determined from the sampling and analytical method but variability is not addressed.
Overall Quality Determination		High	

Study Citation:	Analytics, (2016). [Redacted] Formaldehyde monitoring results - Fall 2016 (memo dated 11/17/16).
HERO ID:	10602487
Conditions of Use:	processing

EXTRACTION

Parameter	Data
Personal sampling data:	Employees wore the formaldehyde monitoring badge during their work shift. Position_____Department_____Result Assist. Operator_____ _____TMP_____0.043 ppm Operator_____TMP_____0.043 ppm Field Process Operator _____FA _____ _____0.256 ppm Assist. Operator _____Penta _____0.047 ppm Operator _____Penta _____0.114 ppm Power House Op. _____Penta _____0.015 ppm Mechanic _____Maint _____0.062 ppm E/I_____ _____Maint _____0.066 ppm Lab Technician _____Quality _____0.017 ppm (pg 1 of 11)
Exposure duration:	7 to 8 hours (pg 10 & 11 of 11)
Number of workers:	9 (pg 1 of 11)
Personal protective equipment:	The Field Process Operator- FA wore a full face respirator while loading 2 trucks during the sampling period. (pg 1 of 11)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling method is well described and analytical method is an approved NIOSH method.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Data no more than 10 years old
	Metric 5: Sample Size	High	Sample distribution provided.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination**High**

Study Citation:	Analytics, (2020). [Redacted] Formaldehyde monitoring results - Fall 2020 (memo dated 10/30/20).			
HERO ID:	10602488			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Field process operator, central control operator, powerhouse operator, mechanic, and process operator (pg 1 of 6)			
Personal sampling data:	Employees wore formaldehyde monitoring badge. Field process operator in FA department - 0.157 ppm; Central control operation in production department - 0.031 ppm; Powerhouse operation in production department - 0.078 ppm; Mechanic in maintenance department - 0.086 ppm; Assistant process operator in penta area - 0.175 ppm. (pg 1 of 6)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling and analytical methodology is an approved OSHA method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario within the scope of the risk evaluation but specific condition of use is unclear.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	High	Sample distribution is known
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 10602494 Table: 1 of 1

Study Citation:	Analytics, (2021). [Redacted] Formaldehyde monitoring results - Spring 2021 (memo dated 5/28/2021).			
HERO ID:	10602494			
Conditions of Use:	FA MFG (Perstorp Polyols)			
EXTRACTION				
Parameter	Data			
Personal sampling data:	0.0307 - 0.107 mg/m3 (4 samples; pg 2)			
Exposure duration:	Sampling time ranged from 396 min to 575 min.			
Comments:	OSHA Method 1007M (pg 2)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	OSHA method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for Perstorp Polyols, which conducts FA MFG according to google search, however this is not explicitly stated
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Anas, E., Engstrom, B., Henriks-Eckerman, M.L. (1990). Exposure to paint degradation products when welding, flame cutting, or straightening painted steel. American Industrial Hygiene Association Journal 51(10):561-565.			
HERO ID:	6011113			
Conditions of Use:	Paints and coatings (specifically paint degradation products during welding and flame cutting coated steel)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Exposure to paint degradation products when welding, flame cutting, or straightening painted steel			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Max: 0.1 mg/m3 during welding of polyvinylbutyral coated steel (pg 3)			
Exposure duration:	Type of measurement: 30-60 minute sampling (per Tables 2-3 on pg 4 which are for other chemicals, assumed same for FA)Duration: 1 hr during "specially efficient work"			
Number of workers:	Number of samples: 46 for hull construction, 43 for outfitting, 5 for ship repairing, 7 for ship breaking (pg 2).			
Comments:	Method: liquid chromatography (Table 1, pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for paint and coatings, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple shipyards, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Andersen, M.E., Gentry, P.R., Swenberg, J.A., Mundt, K.A., White, K.W., Thompson, C., Bus, J., Sherman, J.H., Greim, H., Bolt, H., Marsh, G.M., Checkoway, H., Coggon, D., Clewell, H.J. (2019). Considerations for refining the risk assessment process for formaldehyde: Results from an interdisciplinary workshop. Regulatory Toxicology and Pharmacology 106:210-223.			
HERO ID:	6198249			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation (1/14)			
Personal sampling data:	In a study, across 10 plants, the median average intensity of formaldehyde exposure based on exposed jobs ranged from 0.080 ppm (Plant 7) to 2.799 ppm (Plant 2).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Report is from 2019 but monitoring data is from more than 20 years ago.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 6010233 Table: 1 of 2

Study Citation:	Andersson, K., Levin, J. O., Lindahl, R. (1987). Field evaluation of a diffusive sampler for formaldehyde in air using chemisorption of 2,4-dinitrophenylhydrazine-coated glass fiber filters. :407-410.			
HERO ID:	6010233			
Conditions of Use:	Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.02-0.03 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data are for finishing agents in textiles, apparel, and leather manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL. (1987)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing PPE, engineering control, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 6010233 Table: 2 of 2

Study Citation:	Andersson, K., Levin, J. O., Lindahl, R. (1987). Field evaluation of a diffusive sampler for formaldehyde in air using chemisorption of 2,4-dinitrophenylhydrazine-coated glass fiber filters. :407-410.			
HERO ID:	6010233			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Medical students dissecting human organs which had been embalmed with formalin			
Personal sampling data:	0.1-0.5 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL. (1987)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing PPE, engineering control, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	Andjelkovich, D.A., Janszen, D.B., Brown, M.H., Richardson, R.B., Miller, F.J. (1995). Mortality of iron foundry workers: IV. Analysis of a subcohort exposed to formaldehyde. Journal of Occupational and Environmental Medicine 37(7):826-837.			
HERO ID:	192405			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	breathing zone concentrations 2.6 ppm (through July 1978), 1.8 ppm (August 1978 to 1983), and 1.2 ppm from 1984 on (pg. 2, column 2)			
Area sampling data:	<0.02 - 18.3 ppm (pg. 2, column 1)			
Number of workers:	3929 from a cohort of 8147 exposed to formaldehyde			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after the PEL- Published 1995
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing: sampling/analysis methods, sampling locations, number of samples, number of sites, worker activities, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	some information was provided to determine variance of the area sampling but nothing was provided for uncertainty
Overall Quality Determination		Medium		

Study Citation:	Andjelkovich, D.A., Levine, R.J., Mathew, R.M., Tan, W.Y., Yu, R.C. (1990). A deterministic mathematical model for quantitative estimation of historical exposure. American Industrial Hygiene Association Journal 51(4):194-201.			
HERO ID:	6011088			
Conditions of Use:	Commercial Use: Metal Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Hot box core-making			
Personal sampling data:	Mean exposure 1.2 ppm (1986) to 3.2 ppm (1976)			
Exposure duration:	Provided for each set of samples			
Engineering control:	Use of local and general exhaust ventilation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for use in metal product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided in the appendix).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by multiple visits to the same site for temporal change, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Andrea T, M., Douwes, J., Glass, B., Hinz, R., Mclean, D., Pearce, N. (2019). O1D.3 Fumigant and chemical residue 8-hour exposures in workers handling cargo from shipping containers and export logs in new zealand.			
HERO ID:	6152627			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers handling cargo from shipping containers or export logs that were fumigated prior to loading			
Exposure route:	Inhalation			
Personal sampling data:	Formaldehyde concentrations (median and geometric mean values) exceeded the TLV set by the ACGIH (0.1 ppm ST; 0.3 ppm) in 48 (26.2%) samples.			
Number of workers:	193			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Ankica, K., Ruzica, B. L., Natasa, K. (2003). Research of formaldehyde concentration in indoor air surrounding woodworking places. Wood Research 48(4):25-32.			
HERO ID:	5953495			
Conditions of Use:	Building and construction materials (woodworking)			
EXTRACTION				
Parameter	Data			
Number of sites:	Sampling was carried out in the carpentry and three rooms of the furniture factory machining room, assembling room and furniture shop			
Worker activity description:	board material (with FA based resins) storage, assembling rooms, furniture, machining (pg 1)			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Figure 2 presents graphical data of FA exposure in machining room, assembling, and furniture shop; highest value recorded was 0.0772 mg/m3 (pg 4) Figure 5 presntes graphical data of FA exposure in carpentry woodworking places (pg 6)			
Comments:	Figures present multiple data points, unsure if they correlate directly to number of samples. Analytic method: "spektrophotometric method" (Leithe, 1981) (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Croatia, a non-OECD country.
	Metric 3:	Applicability	High	Data are for building/consturction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively (graphically), only one value (maximum) provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency, duration.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple areas in facility, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Anonymous (1982). Preliminary Plant Visit Industrial Hygiene Report, Georgia-Pacific Corporation, Chemical Division, Taylorsville, Mississippi, Report No. CT-114-17a. Monsanto Research Corporation(CT-114-17a):114-117.			
HERO ID:	1167758			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	1 QC lab supervisor1 QC chemist1 Lead maintenance technician3 maintenance workers11 Truckers5 management and clerical staff			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	ranged from 0.9 to 2.4 ppm			
Area sampling data:	Chemical resin plant: range from 0.10 to 0.95 ppm			
Exposure duration:	8 hour shifts 4 hours in the control room away from sources.			
Number of workers:	38			
Personal protective equipment:	hard hats and safety glassesFull face organic vapor respiratorRubber glovesFull protective suit, boots and air-supplied respirator for storage tank entry.			
Engineering control:	emergency eye wash			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH sponsored study so it was assumed that the consultant would use NIOSH methods (though the specific method is not mentioned)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (formaldehyde manufacture) is within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Site visit was in 1981 prior to the PEL (1992)
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by a range of values for personal sampling. The results from the 6 sampling events were provided for each event. No discussion of uncertainty was included
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study provides individual sampling results for area sampling and range data for personal sampling, both of these can use used to appreciate the variance in the data. Because this is a NIOSH study and it is assumed that NIOSH methods were used, it is assumed that uncertainty is addressed in the methodology.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1167758 Table: 1 of 1

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Study Citation:	Anonymous (1982). Preliminary Plant Visit Industrial Hygiene Report, Georgia-Pacific Corporation, Chemical Division, Taylorsville, Mississippi, Report No. CT-114-17a. Monsanto Research Corporation(CT-114-17a):114-117.		
HERO ID:	1167758		
Conditions of Use:	Manufacture		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Anonymous (1982). Preliminary Plant Visit, Industrial Hygiene Report, Formaldehyde Production Facilities, Tenneco Chemicals, Inc., Fords, New Jersey, Report No. CT-114-21a. Dayton(CT-114-21a):114-121.			
HERO ID:	1316695			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	operator responsibilities include controlling the process, reporting maintenance problems, and transferring formaldehyde to storage. Operators may also be used to change catalyst beds. The loading operators are responsible for loading the tank trucks used to ship the formaldehyde, sampling the blended solution and general maintenance. Drivers are responsible for uploading Methanol. The plant also have maintenance workers (40) but report states that none are directly assigned to the formaldehyde units.Report highlights that workers in the silver catalyst process near the bottom of the absorber where a sample point is located and also near the interior storage tanks experience signs of exposure.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Area sampling was done by company IH in formaldehyde loading area, truck loading area, operator control room, the areas above and below the loading platform, the truck hatch area during loading, and the silver catalyst unit control area. Individuals results are not provided though it is noted that no sample was above 1 ppm TWA.			
Exposure duration:	4 shifts per day over 24 hour period, sample analysis is conducted once every two hours.			
Exposure frequency:	Plant operates 24 hours per day/7 days per week; Sampling is done once every two hours			
Number of workers:	15 - one operator per shift per production unit supervised by a foreman for each shift. Additionally there are two truck loading operator and one maintenance operator.			
Personal protective equipment:	- splash proof goggles and rubber gloves for sampling.- disposable tyvec suit, supplied air respirators and gloves for catalyst replacement.-full-face gas mask, rubber coat and gloves for tank cleaning - splash proof goggles for tank truck loading			
Engineering control:	scrubbers are used to control storage tank emissions of formaldehyde.Operator monitors the process from a control board that records operating conditions and alerts the operator to problems. For the formox control area, is in a separate adjacent building. For the silver catalyst unit, the control area is between the methanol vaporizer and the absorption and distillation columns.Product samples are analyzed in a lab hood that is vented to the roof (measured inward facing velocity of 150-200 ft/min)During truck loading, to protect the the truck loading operator, a flexible vacuum tube is also placed just inside the hatch to draw formaldehyde vapors out of the tank and vent them through the roof. As an added precaution, a pedestal fan is also provided.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Although a joint EPA and NIOSH study, the cited monitoring data was reported to be done by the plant manager using an unspecified sampling/analytical methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the US
	Metric 3:	Applicability	High	The data are for an occupational scenario (formaldehyde manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Plant was visited in 1981 prior to PEL (1992)
	Metric 5:	Sample Size	Low	Approximate value is provided but characterized by no statistics.
Domain 3: Accessibility/ Clarity				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1316695 Table: 1 of 1

...continued from previous page

Study Citation:		Anonymous (1982). Preliminary Plant Visit, Industrial Hygiene Report, Formaldehyde Production Facilities, Tenneco Chemicals, Inc., Fords, New Jersey, Report No. CT-114-21a. Dayton(CT-114-21a):114-121.		
HERO ID:		1316695		
Conditions of Use:		Manufacture		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	Medium	Monitoring data include sample type but not the results for each area sampled. However, information on general worker activities, engineering controls, PPE were clearly provided in detail.
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	Low	Only one approximate high end value was provided - variance in exposure estimates were not discussed or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Anonymous (1996). Formaldehyde exposure not associated with respiratory cancer. Journal of Environmental Health 58(6):37.			
HERO ID:	1319496			
Conditions of Use:	Use of metal products			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	probably area sampling-2.6 ppm high mean			
Number of workers:	3,929 men			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for foundry workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1996, but based on data from 1960, prior to the most recent PEL (1992) and is more than 20 years old.
	Metric 5:	Sample Size	Medium	only a mean high value was provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include most critical metadata, such as and exposure type, but lacks additional metadata, such as sample type, sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Anonymous (1996). Formaldehyde exposure in the funeral industry: R. E. Korczynski, Appl. Occup. Environ. Hyg. 9(8), 575. Journal of Safety Research 27(3):198.				
HERO ID:	6186296				
Conditions of Use:	Laboratory chemicals				
EXTRACTION					
Parameter	Data				
Worker activity description:	Embalmers in the funeral industry (1/1)				
Exposure route:	inhalation (1/1)				
Physical form:	vapors (1/1)				
Personal sampling data:	Personal formaldehyde exposures of embalmers during an intact body preparation ranged from 0.12 to 5.64 mg/m3 [arithmetic mean (AM) = 0.78, standard deviation (SD) = 1.06, number (N)=24] During an autopsy preparation (~2 hours), exposures ranged from 0.11 to 4.13 mg/m3 (AM = 0.80, SD = 0.96, N = 24). (1/1)				
Area sampling data:	Concentration for area samples ranged from 0.05 to 8.37 mg/m3 (AM = 0.61, SD = 1.24, N = 72). (1/1)				
Exposure duration:	1 hour for intact body preparations, 2 hours for autopsy preparations(1/1)				
Number of workers:	24 (1/1)				
EVALUATION					
Domain	Metric	Rating		Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Canada, an OECD country.	
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4:	Temporal Representativeness	Low	Data more than 20 years old.	
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations, ranges) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates. Variability addressed by sampling at 18 sites.	
Overall Quality Determination			Low		

Formaldehyde

Occupational Exposure

HERO ID: 1316509 Table: 1 of 1

Study Citation:	Anonymous, (1983). Formaldehyde exposures in dialysis units. Dialysis & Transplantation 12(1):43-44.				
HERO ID:	1316509				
Conditions of Use:	Laboratory Use				
EXTRACTION					
Parameter	Data				
Area sampling data: San Francisco hospital: 0.9 (ppm); Denver Colorado dialysis unit: 1.9 (mg/m^3)					
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4:	Temporal Representativeness	Low	Information from 1980s.	
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling done at two facilities where formaldehyde is used in the medical field but uncertainty is not addressed.	
Overall Quality Determination			Low		

Formaldehyde

Occupational Exposure

HERO ID: 1986672 Table: 1 of 1

Study Citation:	Anonymous, (1986). Leads from the MMWR. Occupational exposure to formaldehyde in dialysis units. JAMA: Journal of the American Medical Association 256(6):698, 703.			
HERO ID:	1986672			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Using formaldehyde as a disinfectant for hollowfiber dialyzers.			
Exposure route:	Inhalation			
Area sampling data:	0.5-1.6 (ppm)			
Engineering control:	Air-tight hoses connecting free-standing modular components of hemodialysis systems to drain lines			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at multiple locations but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5956338 Table: 1 of 1

Study Citation: Anonymous, (1985). Benzene, formaldehyde - workplace exposure limits proposed. Chemical & Engineering News 63(49):4.
HERO ID: 5956338
Conditions of Use: All

EXTRACTION

Parameter	Data
Area sampling data:	fewer than half of workers are exposed to levels above 0.5 ppm and even fewer to levels above 1.0 ppm
Number of workers:	1.3 million

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Monitoring data do not include any needed metadata to understand what the data represent and are not usable in the risk evaluation.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination **Uninformative**

Study Citation:	Anthony, T.R., Joggerst, P., James, L., Burgess, J.L., Leonard, S.S., Shogren, E.S. (2007). Method development study for APR cartridge evaluation in fire overhaul exposures. Annals of Occupational Hygiene 51(8):703-716.			
HERO ID:	1313639			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	This study is to test the performance of respirator cartridges to do this they used field data for overhaul operations to ensure their chamber data were appropriate 0.25 ppm mean, 1.18 ppm max			
Personal protective equipment:	study is to test the performance of respirator cartridges			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology for the field data is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for firefighting which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The study was published in 2007 after the most recent PEL (1992) but more than 10 and less than 20 years old.
	Metric 5:	Sample Size	Medium	Field data include mean and peak data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata are provided for the field data
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Anttila, A., Sallmen, M., Hemminki, K. (1993). Carcinogenic chemicals in the occupational environment. Pharmacology & Toxicology 72(SUPPL. 1):S69-76.			
HERO ID:	1380892			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	likely area sampling Plywood manufacture, particle board production, and laquering 500ug/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Finland - an OECD member	
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The data were published in 1980-85, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Low	one value was provided for a wide range of applications	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No meta data were provided for formaldehyde	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	Apol, A. (1973). Health hazard evaluation/toxicity determination: Western Foundry Company, Tigard, Oregon.			
HERO ID:	6033389			
Conditions of Use:	Chemical substances in metal products			
EXTRACTION				
Parameter	Data			
Personal sampling data:	The formaldehyde concentrations measured were 0.07 ppm during normal conditions over a complete core production cycle; 0.08 ppm during a complete cycle when the sand was warm and 0.33 ppm during the core preparation only when the sand was hot.			
Exposure duration:	0.07 ppm - 50 minutes, 0.08 ppm - 15 minutes, 0.33 ppm - 15 minutes			
Personal protective equipment:	Due to the possible skin and eye contact with the liquid substances used in the process, it is strongly recommended that protective clothing (non-permeable aprons and gloves) and safety glasses be used by the workers.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	methodology well described	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	data are from the United States	
	Metric 3: Applicability	High	data are for an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	more than 20 years old	
	Metric 5: Sample Size	Low	characterized by no statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Apol, A. (1985). Health hazard evaluation report: HETA-85-052-1623 - Alaska Native Hospital, Anchorage, Alaska.		
HERO ID:	8633819		
Conditions of Use:	Laboratory chemical		
EXTRACTION			
Parameter	Data		
Worker activity description:	Using a formalin solution to preserve wildlife samples.		
Exposure route:	Dermal and inhalation.		
Physical form:	Vapor		
Area sampling data:	Second level; On top of file cabinet next to secretary’s desk: 0.02 ppmFirst level; Biologists office next to cabinet where specimens are kept: 0.03 ppmFirst level; open office on filing cabinet; I & R section: 0.01 ppmSecond level; project leaders desk: none detectedSecond level; project leaders office: 0.01 ppmSecond level; biologists office: 0.02 ppmSecond level; library: 0.01 ppm		
Exposure duration:	8 hours/day		
Exposure frequency:	5 days/week		
Number of workers:	16		
Engineering control:	NIOSH recommends the formalin solution be used under fume hoods and that the preserved specimens be stored in a ventilated cabinet.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	Report is from more than 20 years back.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability is addressed by sampling at different locations but uncertainty is not addressed.
Overall Quality Determination		High	

Study Citation:	Apol, A. G., Okawa, M. (1977). Health Hazard Evaluation Determination, Report No. HHE-76-55-443, Certain-Teed Products, Inc., Tacoma, Washington.			
HERO ID:	1317283			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Worker activity description:	There are nine to eleven employees working in this area per shift, for the first and second shifts. Each operation has a man assigned to it and his exposure will be mainly to the materials that are added at that point. In addition, the felt ribbon may sustain a break which requires rethreading of the felt through the saturator and removal of the broken felt. In order to accomplish this, the doors of the saturator are opened and one or more employees enter the saturator to do the rethreading. This may result in an exposure to higher concentrations of asphalt fume inside the saturator. In addition to the operations described, there are two employees that are involved in handling the slate granules. Also, talc and sand are hand dumped from bags into a ventilated hopper. In addition to the standard shingle manufacture, there is a "Hallmark" operation, where small strips of cut shingle are glued to the top of the standard shingle with hot asphalt. Visible fumes arise from the point where the asphalt is dripped on the shingle. The eight employees in this operation rotate through the jobs on a regular basis throughout the day, so the exposure to the asphalt is not continuous.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	During Splice 5 ppm			
Area sampling data:	on platform where fiberglass rolls are spliced and unrolled 0.11 ppmNorth end of accumulator loops 7 ft.above floor 0.09 ppmAbove the area where the slate is added just after the coater 0.01 ppm6" above splice - total time of splice is approximately 15 seconds - 3 ppmchange rolls every 6 - 10 minutes-2.5 ppmIn coater enclosure 4 ppmIn coater enclosure 3 ppmIn coater during repair of break 10 minutes into shutdown < 0. 5 ppmInside of fiberglass roll 4 ppm			
Number of workers:	20 (9-11 employees per shift for the area; 2 shifts); In addition to the operations described, there are two employees that are involved in handling the slate granules. Also, talc and sand arehand dumped from bags into a ventilated hopper.			
Personal protective equipment:	respiratory protection			
Engineering control:	increase intake air Seal Saturator and Coater doorsReplace gas forklift with electric			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is provided but does not cite an approved NIOSH method. However, it does provide the methodology which appears similar to NIOSH 3500 and 2016.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (asphalt roof manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1976-77: Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, and worker activities, but lacks additional metadata, such as exposure durations, and exposure frequency,
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1317283 Table: 1 of 1

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Study Citation:	Apol, A. G., Okawa, M. (1977). Health Hazard Evaluation Determination, Report No. HHE-76-55-443, Certain-Teed Products, Inc., Tacoma, Washington.		
HERO ID:	1317283		
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product		
Domain	Metric	EVALUATION Rating	Comments
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination		Medium	

Study Citation:	Apol, A., Thoburn, T. W. (1986). Health Hazard Evaluation Report HETA-1985-462-1748 Boise Cascade, Vancouver, Washington.			
HERO ID:	8684545			
Conditions of Use:	Paper manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Cleaning the heat exchanger, formulating and preparing coating materials, dumping collected dust.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Back tender #2 paper machine: <0.07 (ppm)Winder man #2 paper machine: <0.04 (ppm)Back tender #2 Paper Machine: <0.06 (ppm)Wilder Man #2 paper machine: <0.06 (ppm)			
Area sampling data:	#2 Paper machine - coating CF - inside hood by can dryers: <0.07 (ppm)CF run room by open tank CF material: <0.05 (ppm)#2 Paper machine coating CF inside hood can dryers: <0.07 (ppm)#2 Paper machine - by CF coater: <0.06 (ppm)CB Coating area - on exhaust fan from can dryers: <0.08 (ppm)			
Exposure duration:	8 hours per day (3 shifts per day)			
Number of workers:	crew size on any particular machine varies from 3 to 5.			
Personal protective equipment:	Workers wear respirators during dust dumping.			
Engineering control:	Exhaust fans are used for the two coating dryers.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling is don by ORBO 22 tubes and analytical method is an approved NIOSH Method P&CAM 354
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3:	Applicability	High	The data are for an occupational scenario (Processing Incorporation into articles-paper) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment
	Metric 5:	Sample Size	High	All sample measurements are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sam-pled site by sampling different workers and areas. The uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		High		

Study Citation:	Apostoli, P., Lucchini, R., Alessio, L. (1996). Health risks due to chemical substances exposure in biomedical laboratories. Nato Science Partnership Subseries: 2 11:231-237.			
HERO ID:	664284			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Area sampling data:	0.1-0.5 (ppm); see Table 4			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country, other than the U.S. (Europe)
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., area) but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 2859370 Table: 1 of 1

Study Citation:	ARCO, (1989). Air monitoring for organic compounds during processing of arco report on ethyl benzene, maleic anhydride and toluene with attachments and cover letter dated 022389 (sanitized).			
HERO ID:	2859370			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Reactant: polystyrenic products			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Take-off operator <0.14 - <0.18 ppm; Sonic welder <0.14 - <0.20; *** Results were below the LDL (lower detection limits)			
Area sampling data:	all area monitoring results were <0.13 ppm*** Results were below the LDL (lower detection limits)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	OSHA method 52 were used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for chemical plant worker which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data used in this study were published in 1988, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	results from individual sampling events provided, summarized by operation
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as source of formaldehyde emissions, process descriptions, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The study provided individual test results that can be used to evaluate variability. Method TO5 includes and assessment of uncertainty.
Overall Quality Determination		High		

Study Citation:	Armstrong, R.W., Rood, M.J., Sani, S., Mohamed, M., Rashid, M., Jab, A.T., Landsberger, S. (2001). Aerosol particle and organic vapor concentrations at industrial work sites in Malaysia. Asia-Pacific Journal of Public Health 13(1):24-29.			
HERO ID:	1614018			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	adhesive manufacturing, foundry, latex processing, metalworking, plywood manufacturing, ricemills, rubbertire manufacturing, sawmill, shoemaking, textile manufacturing			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Mean 8 h concentrations of formaldehyde ranged from 0.16 mg/m3 in metalworking to 0.53 mg/m3 in adhesive manufacturing. 42 sites in 10 industrial sectors were studied. 465 measurements were collected. Percent of measurements below detection limit ranged from 8 (adhesive manufacturing) to 70 (ricemill). Mean concentration for all the industrial sectors combined was 0.25 mg/m3. Formaldehyde levels exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV-Ceiling) of 0.37 mg/m3 in only the adhesives industry but all others had mean 8 h concentrations between 0.16 and 0.35 mg/m3.			
Exposure duration:	8hr/day			
Number of workers:	There were 42 sites and at each site, during one normal working day, six workers each wore one monitor close to their breathing zone.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling method well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	non-OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	the data are more than 10 years but generally, no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	does not address uncertainty in the exposure estimates
Overall Quality Determination		Medium		

Study Citation:	Arthur D. Little Inc, (1987). Evaluation of chemical air emissions from the Bristol plant production facilities Rohm and Haas Delaware Valley, Inc (final report) with attachments and cover letter dated 08/10/89.			
HERO ID:	1481094			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Area sampling data:	ND-1,871 (ppb)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1986)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure duration, exposure frequency, engineering controls, PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by multiple site visits on different dates.
Overall Quality Determination			High	

Study Citation:	Ashland Chemical, (1986). Letter from Ashland Chemical Company to USEPA regarding information on the December 6, 1985 meeting concerning Ashland’s formaldehyde-free adhesive.			
HERO ID:	5901024			
Conditions of Use:	Use- Adhesive and Sealants			
EXTRACTION				
Parameter	Data			
Area sampling data:	FA emission tests with birch plywood: 0.03 ppm and 0.06 ppm; Desiccator test 0.10-0.11 ppm; Plywood with Japanese made emulsion polymer isocyanate adhesives			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Does not contain any other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address uncertainty or variability
Overall Quality Determination			Low	

Study Citation:	ATSDR, (1999). Toxicological profile for formaldehyde.			
HERO ID:	93087			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Boston: car 5.1 ug/m3; subway 4.5 ug/m3; walking biking 6.3 ug/m3. NY/NJ: car 0.3 ug/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for exposure while operating a car, using the subway or biking which are occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1999, but the data are from an earlier study published in 1991 for Boston and 1995 for NYNJ), the Boston study was before the most recent PEL (1992) but both were more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertain
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 93087 Table: 2 of 8

Study Citation:		ATSDR, (1999). Toxicological profile for formaldehyde.			
HERO ID:		93087			
Conditions of Use:		Construction Manufacturing			
EXTRACTION					
Parameter		Data			
Exposure route:		inhalation			
Physical form:		vapor			
Area sampling data:		49-516 ug/m3			
EVALUATION					
Domain		Metric		Rating	Comments
Domain 1: Reliability		Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness		Metric 2:	Geographic Scope	High	US
		Metric 3:	Applicability	High	The data are for fiberglass insulation manufacturing which are occupational scenarios within the scope of the risk evaluation.
		Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1999, but the data are from an earlier study published in 1996, after the most recent PEL (1992) but more than 20 years old.
		Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Low	no metadata provided.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertain
Overall Quality Determination			Low		

Formaldehyde

Occupational Exposure

HERO ID: 93087 Table: 3 of 8

Study Citation:		ATSDR, (1999). Toxicological profile for formaldehyde.			
HERO ID:		93087			
Conditions of Use:		Multiple			
EXTRACTION					
Parameter		Data			
Exposure route:		inhalation			
Physical form:		vapor			
Area sampling data:		About 1.9 million were exposed to levels of formaldehyde between 0.1 ppm and 0.5 ppm (mainly in apparel, furniture, paper mills, and plastic molding); approximately 123,000 were exposed to levels of formaldehyde between 0.5 and 0.75 ppm (mainly in apparel, textile finishing, furniture, laboratories, and foundries); and about 84,000 were exposed to between 0.75 and 1 ppm (mainly in apparel, furniture, and foundries)			
EVALUATION					
Domain		Metric		Rating	Comments
Domain 1: Reliability		Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness		Metric 2:	Geographic Scope	High	US
		Metric 3:	Applicability	High	The data are for apparel, furniture, papermills, plastic molding, textile, laboratories, and foundries which are occupational scenarios within the scope of the risk evaluation.
		Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1999, but the data are from an earlier study published in 1996, after the most recent PEL (1992) but more than 20 years old.
		Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Low	no metadata provided.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertain
Overall Quality Determination				Low	

Formaldehyde

Occupational Exposure

HERO ID: 93087 Table: 4 of 8

Study Citation:	ATSDR, (1999). Toxicological profile for formaldehyde.			
HERO ID:	93087			
Conditions of Use:	Use of Cleaning and Furniture Care Products			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	An inisewing plant using fabrics with a postcure resin found TWA exposure levels: 1.2 ppm, with a mean of 0.9 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The data are for textile workers which is a scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1999, but the data are from an earlier study published in 1990, prior to the most recent PEL (1992) but more than 20 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no metadata provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertain	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 93087 Table: 5 of 8

Study Citation:	ATSDR, (1999). Toxicological profile for formaldehyde.			
HERO ID:	93087			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Area concentrations of formaldehyde in a plywood company ranged from 0.28 to 3.48 ppm; the average personal exposure was 1.13 ppm formaldehyde. Airborne formaldehyde concentrations ranging from 0.187 to 0.783 ppm have been measured during particle-board-sanding operations.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for plywood manufacture and particle board sanding which are scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1999, but the data are from an earlier study published in 1990 (plywood) and 1986 (sanding), prior to the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertain
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 93087 Table: 6 of 8

Study Citation: ATSDR, (1999). Toxicological profile for formaldehyde.	
HERO ID: 93087	
Conditions of Use: Leather Finishing	
EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	Formaldehyde concentrations of 0.5–7 ppm have been measured in leather tanning facilities (
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Sampling and Analytical Methodology
Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
High	US
Metric 3:	Applicability
High	The data are for leather tanning which is a scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness
Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1999, but the data are from an earlier study published in 1987, prior to the most recent PEL (1992) and more than 20 years old.
Metric 5:	Sample Size
Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
Low	no metadata provided.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
Low	The monitoring study does not address variability or uncertain
Overall Quality Determination	
Low	

Formaldehyde

Occupational Exposure

HERO ID: 93087 Table: 7 of 8

Study Citation:	ATSDR, (1999). Toxicological profile for formaldehyde.			
HERO ID:	93087			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Fire fightconcentrations as high as 8 ppm during knockdown and 0.4 ppm during overhaul. levels of 0.3 ppm were measured inside a fire fighter’s self-contained breathing apparatus			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for fire fighting which is a scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1999, but the data are from an earlier study published in 1991, prior to the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertain
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 93087 Table: 8 of 8

Study Citation: ATSDR, (1999). Toxicological profile for formaldehyde.	
HERO ID: 93087	
Conditions of Use: Embalming	
EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	An average airborne formaldehyde level of 0.36±0.19 ppm was measured during 22 embalming procedures
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Sampling and Analytical Methodology
Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
High	US
Metric 3:	Applicability
Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
Metric 4:	Temporal Representativeness
Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1999, but the data are from an earlier study published in 1989, prior to the most recent PEL (1992) and more than 20 years old.
Metric 5:	Sample Size
Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
Low	no metadata provided.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
Low	The monitoring study does not address variability or uncertain
Overall Quality Determination	
Low	

Study Citation:	Aydın, S., Canpınar, H., Undeğer, U., Güç, D., Colakoğlu, M., Kars, A., Başaran, N. (2013). Assessment of immunotoxicity and genotoxicity in workers exposed to low concentrations of formaldehyde. Archives of Toxicology 87(1):145-153.		
HERO ID:	1313374		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	personal and area sampling was implemented but the results were aggregated, so it is not possible to differentiate.		
Area sampling data:	Overall MDF production: Momentary 0.21+/-0.07 ppm (range 0.09-0.35); TWA 0.20+/-0.06 ppm (range 0.10-0.33) separate concentrations are provided to 13 different operations at two MDF facilities.		
Number of workers:	46		
Personal protective equipment:	It was noted which operations used PPE in the detailed concentration tables.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method 3500.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Turkey - OECD member
	Metric 3: Applicability	High	The data are for medium density fiberboard production plants, an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The report was published in 2012 after the PEL (1992) and less than 10 years old. Meta-data on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5: Sample Size	High	Mean concentration and TWA values are provided for combined data as well as 13 different operations at two plants.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, sample durations, and worker activities, but lacks additional metadata, such as exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the two sites and 13 different operations. NIOSH method 3500 considers uncertainty in the methodology.
Overall Quality Determination		High	

Study Citation:	Azari, M.R., Asadi, P., Jafari, M.J., Soori, H., Hosseini, V. (2012). Occupational exposure of a medical school staff to formaldehyde in tehran. Tanaffos 11(3):36-41.		
HERO ID:	2993436		
Conditions of Use:	Laboratory Use		
EXTRACTION			
Parameter	Data		
Worker activity description:	Instructors, students, and lab technicians in a gross anatomy lab with cadavers preserved with formaldehyde.		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	Instructors, exhaust and supply ventilation: 329+-80 ppb Students, exhaust and supply ventilation: 317+-35 ppb Technicians, exhaust and supply ventilation: 220+-21 ppb; Instructors, supply ventilation only: 334+-60 ppb Students, supply ventilation only: 329+-33 ppb Technicians, supply ventilation only: 236+-8 ppb Instructors, no ventilation: 754+-65 ppb Students, no ventilation: 723+-38 ppb Technicians, no ventilation: 493+-8 ppb		
Area sampling data:	Indoor Laboratory, exhaust and supply ventilation: 256 ppb Indoor Lab, supply ventilation only: 270 ppb Indoor Lab, no ventilation: 572 ppb; Corridor, exhaust and supply ventilation: 221 ppb Corridor, supply ventilation only: 241 ppb Corridor, no ventilation: 443 ppb; Moulage, exhaust and supply ventilation: 232 ppb Moulage, supply ventilation only: 253 ppb Moulage, no ventilation: 463 ppb; Classroom, exhaust and supply ventilation: 206 ppb Classroom, supply ventilation only: 228 ppb Classroom, no ventilation: 315 ppb;		
Number of workers:	20		
Engineering control:	Six ceiling diffusers arranged in two rows are attached to the central air conditioning system and four exhausts provide general ventilation for the laboratory. Cadavers are wrapped in cotton cloth and kept in a vinyl bag while not in use. In addition, alternative compounds such as Shellac (32), glutaraldehyde, fixing solutions with low concentrations of formaldehyde and formaldehyde to water ratio 1:3 (33), ammonium carbonate(34) and salt-containing solutions can also be used (35)		
Comments:	Khanzadeh et al. reported the range of concentration of formaldehyde in gross anatomy laboratory of a Medical College in Ohio,United States as 70-2940ppb (15). Kurose et al. reported formaldehyde concentrations in the range of 250-550ppb in a gross anatomy laboratory (16). In addition, the range of formaldehyde concentration in the indoor air of adissection room in Australia was 59-219 ppb (17).		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method (NIOSH no. 2016).
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from Iran, a non-OECD country.
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	High	Monitoring data are no more than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 2993436 Table: 1 of 1

...continued from previous page

Study Citation:		Azari, M.R., Asadi, P., Jafari, M.J., Soori, H., Hosseini, V. (2012). Occupational exposure of a medical school staff to formaldehyde in tehran. Tanaffos 11(3):36-41.		
HERO ID:		2993436		
Conditions of Use:		Laboratory Use		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	Uncertainty is addressed by comparing with other published studies. Variability is addressed by sampling 3 times during the year during different conditions.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 4165387 Table: 1 of 1

Study Citation:	Azuma, K., Ikeda, K., Kagi, N., Yanagi, U., Osawa, H. (2017). Physicochemical risk factors for building-related symptoms in air-conditioned office buildings: Ambient particles and combined exposure to indoor air pollutants. Science of the Total Environment 616-617:1649-1655.			
HERO ID:	4165387			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	The study investigated 11 offices during winter and 13 offices during summer in 17 buildings with air-conditioning systems in Tokyo, Osaka, and Fukuoka. Indoor air concentrations of formaldehyde did not exceed the values set by IAQGs in all the offices during both winter and summer. Measured indoor formaldehyde concentrations (ug/m3) were 3.4 (minimum), 21.2 (maximum), and 9.6 (mean) during winter. Measured indoor formaldehyde concentrations (ug/m3) were 12.1 (minimum), 45.2 (maximum), and 25.7 (mean) during summer. Indoor air quality guidelines (IAQGs) for formaldehyde is 100 ug/m3.			
Number of workers:	107 office workers during winter and 207 office workers during summer			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology is well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S
	Metric 3:	Applicability	Medium	data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4:	Temporal Representativeness	High	data no more than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	monitoring data include only the most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	monitoring study does address variability but not uncertainty
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 1548641 Table: 1 of 1

Study Citation:	Babich, H. (1985). Reproductive and carcinogenic health risks to hospital personnel from chemical exposure—a literature review. Journal of Environmental Health 48(2):52-56.				
HERO ID:	1548641				
Conditions of Use:	Laboratory Use				
EXTRACTION					
Parameter	Data				
Area sampling data:	Levels greater than 2.5 ppm formaldehyde have beendetected in anatomy laboratories in hospitals. Also, article talks about a male being exposed to 0.2-1.2 ppm in unknown occupation.				
EVALUATION					
Domain	Metric	Rating		Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu- ated.	
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	Article is more than 20 years old.	
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta- data.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination			Low		

Formaldehyde

Occupational Exposure

HERO ID: 6950643 Table: 1 of 1

Study Citation:	Baek, K. M., Kim, M. J., Seo, Y. K., Kang, B. W., Kim, J. H., Baek, S. O. (2020). Spatiotemporal variations and health implications of hazardous air pollutants in Ulsan, a multi-industrial city in Korea. Atmosphere 11(5):547.			
HERO ID:	6950643			
Conditions of Use:	disposal			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	Formaldehyde concentrations (ppb) in air at 3 industrial sites are as follows: Site A - 2.63 +/- 1.22; Site B - 4.49 +/- 3.10; Site C - 3.32 +/- 2.49. Compared to this formaldehyde concentrations (ppb) in air at 2 residential locations are as follows: Site D - 3.66 +/- 3.25; Site E - 3.37 +/- 3.35. No statistically significant differences were found for formaldehyde between industrial and residential areas: for industrial areas – mean – 3.56 ppb and median – 2.90 ppb; for residential areas – mean – 3.45 ppb and median – 2.56 ppb.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country. other than the U.S.
	Metric 3:	Applicability	Low	data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainty
Overall Quality Determination		Medium		

Study Citation:	Bahauddin, A., Prihatmanti, R. (2014). Indoor air quality in adaptively reused heritage buildings at a UNESCO world heritage site, Penang, Malaysia. 19(1):69.			
HERO ID:	6031964			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Area sampling data:	Air concentrations (ppm) of formaldehyde at the following locations: City Hall – 0, JHEAIPP – 0, Fire Brigade and Rescue – 0.01, Penang Immigration Department – 0.06, GTWHI – 0.01This chemical is widely used in indoor environments and is a common irritant of the eyes, nose, throat and sinuses at a low concentration of only 0.03 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method, but EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data less than 10 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Bainova, A., Tashkov, V., Vassileva, R., Bonchev, I. (1990). Biological monitoring in processing of phenol-formaldehyde resins. Comptes Rendus de l'Académie Bulgare des Sciences 43(7):123-126.			
HERO ID:	1994546			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	Automatic, semi-automatic presses, syringe machines, finishing machines, drilling machines, cleaning machine operators.			
Exposure route:	Inhalation			
Physical form:	Vapor-Gas aerosols			
Personal sampling data:	Semi-automatic presses: 0.38 (NA-1.20); Syringe machines: 0.57 (0.12-1.05); All other personal samples were below detection limit.			
Exposure duration:	6 hour working shift			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	High quality data as the source is peer reviewed.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is from Bulgaria, a non-OECD country.
	Metric 3:	Applicability	High	Data is applicable to processing of phenol formaldehyde resins.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1990)
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes worker activities, exposure route, and physical form.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by sampling different areas of the plant. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Baj, Z., Majewska, E., Zeman, K., Pokoca, L., Dworniak, D., Paradowski, M., Tchórzewski, H. (1994). The effect of chronic exposure to formaldehyde, phenol and organic chlorohydrocarbons on peripheral blood cells and the immune system in humans. Journal of Investigational Allergology and Clinical Immunology 4(4):186-191.			
HERO ID:	76790			
Conditions of Use:	Use of Floor coverings			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.8 mg/m3			
Number of workers:	22 were examine for health effects			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Poland OECD member
	Metric 3:	Applicability	Medium	not sure what work place data match to US regulatory environment
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after the PEL- -Published in 1994
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Missing: number of samples, number of sites, measurement methods, sampling location, exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed
Overall Quality Determination		Low		

Study Citation:	Bajaj, P. (2002). Finishing of textile materials. Journal of Applied Polymer Science 83(3):631-659.			
HERO ID:	5972253			
Conditions of Use:	Textile finishing			
EXTRACTION				
Parameter	Data			
Area sampling data:	Maximum workplace concentration values well below 0.5 ppm at the curing machine and in the mixing department have been obtained using crosslinkers that are stable to hydrolysis			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Monitoring data do not include any needed metadatato understand what the data represent and are not usable in the risk evaluation.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Uninformative		

Study Citation:	Bakke, B., Ulvestad, B., Stewart, P., Lund, M.B., Eduard, W. (2001). Effects of blasting fumes on exposure and short-term lung function changes in tunnel construction workers. Scandinavian Journal of Work, Environment and Health 27(4):250-257.			
HERO ID:	1313955			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Blasting agent: ammonium nitrate fuel oil (ANFO): 0.02 ppm Mean, 0.015 ppm geometric mean, GSD 1.9			
Exposure frequency:	workers work 2 weeks consecutively and are then off the 3rd week			
Number of workers:	48			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified, though it was noted that formaldehyde was collected on a filter impregnated with 2,4-dinitrophenylhydrazine in a polypropylene housing. Formaldehyde was analyzed by high-performance liquid chromatography with an ultraviolet detector.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Norway - and OECD member
	Metric 3:	Applicability	High	The data are for tunnel construction workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was based on data from 1996-1997. prior to the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Arithmetic and geometric means were provided along with GSD.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, exposure frequency, but lacks additional metadata, such as sample durations, exposure durations, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided geometric standard deviation data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 3307 Table: 1 of 1

Study Citation:	Ballarin, C., Sarto, F., Giacomelli, L., Bartolucci, G.B., Clonfero, E. (1992). Micronucleated cells in nasal mucosa of formaldehyde-exposed workers. Mutation Research: Genetic Toxicology 280(1):1-7.			
HERO ID:	3307			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	exposed to urea-formaldehyde glue,			
Area sampling data:	sawmill: mean 0.1 mg/m3 (standard dev. 0.02), shearing press: mean 0.39 mg/m3 (standard dev. 0.20)			
Number of workers:	A group of 15 non-smokers working in a plywood factory			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3:	Applicability	High	Data are for plywood factory, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL (1992). Published 1991.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (e.g., mean, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing [exposure durations, exposure frequency].
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by samples collected at multiple sites, but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Ballarin, C., Sarto, F., Nardini, B., Maso, S., Bartolucci, G.B., Clonfero, E. (1992). Frequency of micronucleated cells in nasal mucosa of workers exposed to formaldehyde. Mutation Research Letters 271(2):187-187.			
HERO ID:	1318489			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers of plywood factory			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Sawing and gluing: 0.10+/- 0.02 mg/m3 (range 0.08-0.14 mg/m3); Warehouse: 0.39+/- 0.2 mg/m3 (range 0.21-0.60 mg/m3)			
Number of workers:	13			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Italy - an OECD member
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1992, so the sampling was implemented prior to the latest PEL (1992) and is over 20 years old
	Metric 5:	Sample Size	Medium	Mean values and standard error are provided to two different operations (i.e., sawing and gluing & warehouse)
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data for two different plywood operations that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Barsan, M. E. (1994). Health hazard evaluation report No. HETA-92-0117-2388, Rubbermaid, Inc., Reynolds, Indiana. :92-0117.			
HERO ID:	1628108			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers involved in the manufacturing of thermoset microwave cookware and other molded plastic products			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Formaldehyde concentrations for nine press operators in the Press Department ranged from 0.52 to 1.75 parts per million (ppm) with a mean of 1.10 ppm.			
Area sampling data:	Area airborne formaldehyde samples collected at 15 locations inthe Press Department ranged from 0.23 to 1.98 ppm with a mean of 1.15 ppm. Two area samples collected in the Bipel booth yielded airborne formaldehyde concentrations of 0.08 and 0.32 ppm.			
Number of workers:	175 people are employed, of whom 150 work in production areas.			
Personal protective equipment:	respiratory protection till engineering controls are installed			
Engineering control:	NIOSH recommends that engineering controls, including local exhaust ventilation systems should be installed at all of the presses and pre-heat ovens in the Press Department to removeairborne formaldehyde at the source, and minimize worker exposures.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is approved by NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata but lacks additional metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1787506 Table: 1 of 1

Study Citation: Barsan, M. E., Kinnes, G. M., Blade, L. (1994). Heta 90-261-2124 June 1991 Rubbermaid, Inc, Reynolds, Indiana.
HERO ID: 1787506
Conditions of Use: Plastic Manufacturing

EXTRACTION

Parameter	Data
Worker activity description:	workers involved in manufacturing thermoset (irreversibly hardened) plastic cookware products
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	Formaldehyde levels in the Compounding room were 0.2 (personal sample) ppm.
Area sampling data:	Seven area samples collected in the Pressroom for formaldehyde ranged from 0.5 to 1.0 ppm, and averaged 0.6 ppm. Formaldehyde levels in the Compounding room were 0.1 (area sample) ppm.
Number of workers:	The office area (adjacent to production) is used by about 25 employees for administrative and research purposes. 150 work in production areas, manufacturing thermoset (irreversibly hardened) plastic cookware products.
Personal protective equipment:	A protective suit and respirator were provided for this press operator.
Engineering control:	NIOSH recommended that existing local exhaust systems at the presses and pre-heat ovens should be evaluated by a ventilation contractor experienced with these types of systems for proper design and operation. In the Compounding Department, the batch mixer should be covered when it is not in operation.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Methodology is approved by NIOSH
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Uninformative	The report is for an occupational scenario, however formaldehyde is formed from melamine tablets when heated, not a COU of the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include include most critical metadata but lacks additional metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site. The uncertainty can be determined from the sampling and analytical method.

Overall Quality Determination **Uninformative**

Study Citation:	Bassig, B.A., Zhang, L., Vermeulen, R., Tang, X., Li, G., Hu, W., Guo, W., Purdue, M.P., Yin, S., Rappaport, S.M., Shen, M., Ji, Z., Qiu, C., Ge, Y., Hosgood, H.D., Reiss, B., Wu, B., Xie, Y., Li, L., Yue, F., Freeman, L.E., Blair, A., Hayes, R.B., Huang, H., Smith, M.T., Rothman, N., Lan, Q. (2016). Comparison of hematological alterations and markers of B-cell activation in workers exposed to benzene, formaldehyde and trichloroethylene. Carcinogenesis 37(7):692-700.			
HERO ID:	3420801			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	The formaldehyde exposure study was conducted in Guangdong, China, and included 43 exposed workers in two factories that used or manufactured melamine.			
Exposure route:	Inhalation			
Personal sampling data:	The median (10th, 90th percentiles) air exposure levels of formaldehyde in exposed workers were 1.3 ppm (0.6, 2.5).			
Exposure frequency:	For a full work shift for about three workdays over a 3-week period.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is from a non-OECD country.
	Metric 3:	Applicability	High	Data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study provides only limited discussion of the variability in the determinants of exposure and no discussion on uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1239471 Table: 1 of 3

Study Citation:	Bauchinger, M., Schmid, E. (1985). Cytogenetic effects in lymphocytes of formaldehyde workers of a paper factory. Mutation Research: Genetic Toxicology 158(3):195-199.			
HERO ID:	1239471			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Supervisors and operators			
Exposure route:	Inhalation			
Area sampling data:	20-50 (ppm)			
Exposure duration:	1-5 min			
Number of workers:	20			
Personal protective equipment:	Breathing masks and protective clothes			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1239471 Table: 2 of 3

Study Citation:	Bauchinger, M., Schmid, E. (1985). Cytogenetic effects in lymphocytes of formaldehyde workers of a paper factory. Mutation Research: Genetic Toxicology 158(3):195-199.		
HERO ID:	1239471		
Conditions of Use:	Paper Manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	Take samples, change the paper type, tear off paper, workers had to enter the machine		
Exposure route:	Inhalation		
Area sampling data:	3 ppm		
Exposure duration:	45-90 min/day		
Number of workers:	20		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country. other than the U.S.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data more than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1239471 Table: 3 of 3

Study Citation:	Bauchinger, M., Schmid, E. (1985). Cytogenetic effects in lymphocytes of formaldehyde workers of a paper factory. Mutation Research: Genetic Toxicology 158(3):195-199.		
HERO ID:	1239471		
Conditions of Use:	Paper Manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	Supervisors and operators		
Exposure route:	Inhalation		
Area sampling data:	FA exposure outside the papermachine did not exceed 20% of the current maximum workplace concentration (MAC value) of 1 ppm = 1.2 mg/m3, valid in the Federal Republic of Germany.		
Exposure duration:	8hr/day		
Number of workers:	20		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country. other than the U.S.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data more than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 5946972 Table: 1 of 1

Study Citation: Baumann, H. (1990). Facts on formaldehyde in relation to foamed aminoplastics. Cellular Polymers 9(1):36-45.
HERO ID: 5946972
Conditions of Use: lab chemical (medical)

EXTRACTION

Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	uncertain if area/personal: up to 10 ppm (pg 5)
Area sampling data:	uncertain if area/personal: up to 10 ppm (pg 5)
Exposure duration:	8 hours

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3: Applicability	High	Data are for lab chemical, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Sample type and exposure type not provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination **Uninformative**

Study Citation:	Baur, X., Poschadel, B., Budnik, L.T. (2010). High frequency of fumigants and other toxic gases in imported freight containers—an underestimated occupational and community health risk. Occupational and Environmental Medicine 67(3):207-212.			
HERO ID:	4141092			
Conditions of Use:	Distribution in Commerce			
EXTRACTION				
Parameter	Data			
Worker activity description:	Shipping containers: clothes/textiles (28.4%), furniture/household (18.1%) and manufactured goods (16%), followed by natural products (10.6%), foodstuffs (9.6%), electrical appliances (8.4%) and, lastly, shoes (7.5%), with only 29 (1.4%) containers unclassified according to those categories (pg 2)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	59.3% of containers exceeding chronic REL (2.44 ppb) and 30.9% exceeding acute REL (76 ppb) (pg 5) (RELs established by Germany’s Office of Environmental Health Hazard Assessment, pg 3)			
Comments:	2113 containers sampled (pg 1-2); 3 minute samples (pg 2). Analyzed via GC/MS (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	Data are for distribution in commerce, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively (specifies how many containers had concentrations exceeding threshold values and graphical data in Figure 3) .
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as number of workers, exposure duration/frequency, et..
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Bayless Kilgore, (2021). [Redacted] Follow-up sampling to prior elevated results at Holston Army Ammunitions Plant.
HERO ID:	10605382
Conditions of Use:	Explosives Manufacturing (Impurity)

EXTRACTION

Parameter	Data
Worker activity description:	Pg 2:The work performed by BAE operators in B151 involves several discrete tasks working with Hexamine in super sacks. The tasks include 1) using a forklift to unload super sacks from the delivery truck and move them to the storage area, 2) conditioning the super sacks – use of a machine to loosen up the Hexamine particulate within the super sacks, and 3) transporting the super sacks to the 2nd floor and emptying the contents into the dissolver – i.e., charging. These three tasks typically take from 2 – 3 hours of the 12-hour shift. The operators perform other various tasks the remainder of the shift that do not include working with Hexamine (i.e., not thought to have potential exposure to formaldehyde).The personal sampling using ORBO tubes conducted during this sampling event only included the task of unloading super sacks from the delivery truck and moving them to the storage area. This task took approximately 37 minutes to perform.
Exposure route:	inhalation
Personal sampling data:	The ToxiRAE data log calculated TWA results for the Production and Forklift Operators indicated exposures of 0.06 ppm and 0.04 ppm, respectively. (pg 2)The timeframe that the ToxiRAE monitors were worn included the same time that the ORBO tube task sample of “unloading the truck” was collected, which was 9:16 a.m. to 9:53 a.m. The ToxiRAE minute-by-minute download data corresponding to this 37-minute period indicated significantly higher results from the ToxiRAE compared to the ORBO tube sample results. Specifically, the Forklift Operator’s ToxiRAE calculated “average” for the 37-minute period was 0.088 ppm compared to the ORBO tube result of 0.023 ppm. The Production Operator’s calculated ToxiRAE result for the 37-minute period was 0.081 ppm. Because the laboratory damaged the Production Operator’s ORBO tube, his ToxiRAE result could not be compared directly to the his personal ORBO tube result. However, his ToxiRAE calculated average during the same 37-minute period of 0.081 ppm was significantly higher than the Forklift Operator’s ORBO tube result of 0.023 ppm (pg 3)Based on the minute-by-minute chart, it appears that the Production Operator’s highest exposure was near the end of the super sack charging task, while the Forklift Operator’s highest exposure was during the task of unloading super sacks from the truck. (pg 4, table 3)The highest STEL for the Production and Forklift Operators were 0.23 ppm and 0.22 ppm (pg 4)Pg 8-22 restate same dataPg 23-end display minute-by-minute data from ToxiRAE
Area sampling data:	One area task sample using an ORBO tube was also collected during the truck unloading task. The sample was collected on the loading dock while super sacks were unloaded from the tractor trailer. The pump and media were positioned on the dock at the opening to back of trailer containing supersacks. The result of 0.005 ppm was well below the ACGIH STEL of 0.3 ppm. (pg 3)A second area sample using an ORBO tube was collected inside the control room. The sample was positioned approximately 3-4 feet above the floor and started prior to the truck unloading task and concluded after the super sacks had been charged into the dissolver. The sample duration was 175 minutes. This area sample result of 0.084 ppm exceeded the 12-hour adjusted ACGIH TLV of 0.05 ppm. (pg 3)Pg 8-22 restate same data
Exposure duration:	Pg 2:These three tasks typically take from 2 – 3 hours of the 12-hour shift. The operators perform other various tasks the remainder of the shift that do not include working with Hexamine (i.e., not thought to have potential exposure to formaldehyde).The personal sampling using ORBO tubes conducted during this sampling event only included the task of unloading super sacks from the delivery truck and moving them to the storage area. This task took approximately 37 minutes to perform.Pg 4 (Table 3): The ToxiRAE sample durations were only approximately 230 minutes.Pg 5 (Table 4): The control room area sample duration wasapproximately 175 minutes.
Number of workers:	2 operators sampled
Personal protective equipment:	Full face respirator, coveralls/hat, gloves, safety toe shoes, safety glasses (pg 8)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Medium	Data are for hexamine handling, which may relate to an in-scope COU.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 10605382 Table: 1 of 1

...continued from previous page

Study Citation:	Bayless Kilgore, (2021). [Redacted] Follow-up sampling to prior elevated results at Holston Army Ammunitions Plant.			
HERO ID:	10605382			
Conditions of Use:	Explosives Manufacturing (Impurity)			
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 10605390 Table: 1 of 1

Study Citation:	Bayless Kilgore, (2020). [Redacted] Routine periodic evaluation for air contaminants at Holston Army Ammunitions Plant.			
HERO ID:	10605390			
Conditions of Use:	Manufacture/Processing as a Reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	handling hexamine - operating a fork truck to unload and load trucks of hexamine and working near the dissolver during the hexamine charging, loading bags into the dissolver while also periodically checking valves. (pg 6 of 67)			
Exposure route:	inhalation (pg 2 of 67)			
Personal sampling data:	Results from personal TWA formaldehyde samples indicated exposures of 0.47 ppm and 0.60 ppm which exceeded the ACGIH TLV of 0.1 ppm (adjusted to 0.5 ppm for the employee that worked a 12-hour shift). The results were also above the ACGIH Short Term Exposure Limit (STEL) for formaldehyde of 0.3 ppm. The results were below the OSHA PEL of 0.75 ppm. However, the result of 0.60 ppm exceeded the OSHA Action Level of 0.5 ppm.			
Area sampling data:	none collected (pg 1 of 67)			
Exposure duration:	8 hr/day			
Personal protective equipment:	Safety Glasses, Coveralls , Gloves, Safety Shoes (pg 10 of 67)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling methodology is well described and analytical methodology is an approved OSHA method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data collected is no more than 10 years old
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Belanger, P. L. (1985). Health Hazard Evaluation Report No. HETA-85-020-1587, Department Of The Interior, San Francisco Bay National Wildlife Refuge, Newark, California. NIOSH(HETA-85-020-1587):85-020.		
HERO ID:	1316936		
Conditions of Use:	Office Environment		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	San Francisco Nay National Wildlife Refuge Visitor Center: 0 -0.03 ppm		
Exposure duration:	8 hrs		
Exposure frequency:	5 days/week		
Number of workers:	16		
Engineering control:	It is recommended that the formalin solution used by the biologists for preserving the wildlife samples be well controlled to prevent vapors from penetrating the general office areas. If the solution is to be used frequently, than -consideration should be given to using the chemical under a laboratory hood. Also the formalin solution along with other chemicals used in the laboratory should be stored in a proper storage cabinet to contain chemical odors. Consideration might be given to storing the preserved specimens in a ventilated cabinet to control the formaldehyde vapors.		
Comments:	Emission sources being considered include off-gassing from the plastic furniture, wood paneling, and synthetic carpet, these may be subject to other regulations. But the study suggested that the most significant source is likely to be the biologist use Formalin on site to preserve wildlife samples.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High
			NIOSH study - Area air samples were collected using a sampling train {calibrated vacuum pump} and a one percent sodium bisulfite impinger solution through which a known volume of air was passed. A second method was used in an attempt to characterize the long term formaldehyde air concentrations. This method utilized a passive dosimeter (filter)! which was hung a specified height from the ceiling and exposed to the ambient air for seven days. It should be noted that the second method is not a valid NIOSH sampling method due to sampling efficiency of the filter when the filter becomes -dry, thus this data should be carefully scrutinized. The impinger solution and filters were each analyzed by NIOSH Physical and Chemical Analytical method (P&CAM) number 125 (1).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High
	Metric 3:	Applicability	High
	Metric 4:	Temporal Representativeness	Low
	Metric 5:	Sample Size	High
			Results for 7 samples were provided for different locations: Secretary’s desk, biologist’s office, Open office, project leaders office, and library.
Domain 3: Accessibility/ Clarity			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 1316936 Table: 1 of 1

...continued from previous page

Study Citation:	Belanger, P. L. (1985). Health Hazard Evaluation Report No. HETA-85-020-1587, Department Of The Interior, San Francisco Bay National Wildlife Refuge, Newark, California. NIOSH(HETA-85-020-1587):85-020.			
HERO ID:	1316936			
Conditions of Use:	Office Environment			
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, exposure durations, and exposure frequency, but lacks additional metadata on worker activities.
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	High	The study provided individual results for different locations that can be used to evaluate variability. The NIOSH methods include assessment of uncertainty.
Overall Quality Determination			High	

Study Citation:	Belanger, P. L., Coye, M. J. (1981). Health hazard evaluation report no. HHE 80-185-842, Department of Munipal Railway Woods Division, San Francisco, California.			
HERO ID:	3970531			
Conditions of Use:	commercial and industrial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Storekeepers and mechanics working at the Department of Municipal Railway (Woods Division), which operates a maintenance and servicing terminal.			
Exposure route:	inhalation			
Physical form:	gas			
Area sampling data:	No formaldehyde was detected on any of the detector tubes.			
Exposure duration:	8-hour day and 40-hour work week			
Number of workers:	11 in the storekeeping area			
Engineering control:	It is recommended that the use of respirators needs to be started for workers changing wheels for drum grinding. A local exhaust duct which is compatible to the three types of bus exhaust ducts should be designed and utilized when buses are operated indoors. Steps should be taken to assure that air exhausted on the third floor is not permitted to cross contaminate the make-up air units located nearby. Buses which are serviced with fuel should be returned to the parking lot immediately as opposed to idling the buses outside of the light maintenance area to prevent diesel-fume contamination of the horizontal make-up air ducts.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu- ated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	High	Distribution of samples or sample size are characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study addresses some variability in the determinants of exposure for the samplesite or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Study Citation:	Belanger, P. L., Lockey, J. E. (1984). Health hazard evaluation report: HETA-81-227-1408, Manville Corporation, Corona, California.		
HERO ID:	1316906		
Conditions of Use:	Processing as a reactant		
EXTRACTION			
Parameter	Data		
Worker activity description:	Maintenance: Chief maintenance electrician, chief maintenance mechanic, maintenance electrician I, maintenance mechanic I, maintenance electrician II, maintenance mechanic II, pot and burner mechanics, and painter.Hot End: machine chief, operator, binder-marble operator, fabrication "B", fabrication "C".Cold End: forkltruck driver, machine attendant, production laborer, jacketing servicer, jacketer.Control: truck and tractor driver, receiving and stores clerk, quality control inspector, warehouse, forkltruck driver, material handler.		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	12/7Line 61 Middle of Platform 0.13 ppmLine 61 Middle of Platform 0.01 ppmLine 61 Upper Deck, U-Chute Box 0.12 ppmLine 61 Upper Deck, U-Chute Box 0.02 ppmLine 65 Middle of Platform 0.14 ppmLine 65 Middle of Platform 0.02 ppmLine 65 Upper Deck, U-Chute Box 0.55 ppmLine 65 Upper Deck, U-Chute Box 0.17 ppmLine 65 Middle of Platform 0.08 ppmLine 61 Middle of Platform 0.10 ppmLine 65 Lower Level, U-Chute Box 0.14 ppmLine 65 Lower Level, U-Chute Box 0.04 ppm12/8Line 60 Middle of Platform 0.2 ppmLine 60 Middle of Platform 0.06 ppmLine 60 Upper Deck, U-Chute Box 0.2 ppmLine 60 Upper Deck, U-Chute Box 0.08 ppmLine 61 Middle of Platform 0.14 ppmLine 61 Upper Deck, U-Chute Box 0.3 ppmLine 61 Upper Deck, U-Chute Box 0.01 ppmLine 60 U-Chute Box 0.09 ppmLine 60 U-Chute Box 0.19 ppmLine 60 U-Chute Box 0.09 ppmLine 60 U-Chute Box 0.20 ppm12/9Line 61 Middle of Platform 0.13 ppmLine 66 Searing Roll 12/7/82sample 201 249 ug/m3 sample 202 228 ug/m3 sample 203 229 ug/m3 sample 301 231 ug/m3 sample 302 239 ug/m3 sample 303 249 ug/m3 Mean 237.5SD 9.7RSD 0.04Line 60 Searing Roll 12/8/82sample 207 156 ug/m3 sample 208 154 ug/m3 sample 209 159 ug/m3 sample 307 162 ug/m3 sample 307 125 ug/m3 sample 307 163 ug/m3 Mean 153.2SD 14.2RSD 0.09		
Number of workers:	170 of 220 involved in fibrous glass production		
Personal protective equipment:	Respirator, recommended gloves, goggles, apron		
Engineering control:	Exhaust fans		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The data are for an occupational scenario) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1981-1982: prior to PEL (1992) and more than 20 years old
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations, exposure frequency.
Domain 4: Variability and Uncertainty			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 1316906 Table: 1 of 1

...continued from previous page

Study Citation:		Belanger, P. L., Lockey, J. E. (1984). Health hazard evaluation report: HETA-81-227-1408, Manville Corporation, Corona, California.		
HERO ID:		1316906		
Conditions of Use:		Processing as a reactant		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	Medium	Data from individual sampling runs were provided which can be used to assess variability between sampling days, locations and equipment. Uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Bellisario, V., Mengozzi, G., Grignani, E., Bugiani, M., Sapino, A., Bussolati, G., Bono, R. (2016). Towards a formalin-free hospital. Levels of 15-F2t-isoprostane and malondialdehyde to monitor exposure to formaldehyde in nurses from operating theatres. Toxicology Research 5(4):1122-1129.
HERO ID:	3420612
Conditions of Use:	Laboratory Use

EXTRACTION	
Parameter	Data
Worker activity description:	preserving surgical samples/biopsies (pg 2-3)
Exposure route:	inhalation
Physical form:	vapor (volatilized from formalin)
Personal sampling data:	”20.7 +/- 23.3 $\mu\text{g}/\text{m}^3$ (entire population); 33.7 +/- 37.9 $\mu\text{g}/\text{m}^3$ (using FA); 14.6 +/- 4.6 $\mu\text{g}/\text{m}^3$ (not using FA) (pg 5) Additional breakdown (UVS vs. no UVS, prefilled vs liquid FA etc.) provided ”
Exposure duration:	8 hr/day
Number of workers:	94 female nurses in Piedmont region of Italy involved in study (pg 2); 30 reported using FA on sampling day, 12 using prefilled FA vials and 18 handling liquid FA (pg 4)
Engineering control:	Under-Vacuum Sealing - alternative preserving method to use of formalin
Comments:	94 total samples, 64 using FA during sampling day, 30 not (pg 4). 8 hr sampling (assumed TWA) (pg 3).

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3:	Applicability	High	Data are for lab chemical (medical samples), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, SD) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling workers using/not using differing amounts/forms of formaldehyde, but uncertainty is not addressed.

Overall Quality Determination

High

Study Citation:	Belloc-Santaliestra, M., Haar, v.d., R., Molinero-Ruiz, E. (2015). Occupational exposure assessment of highway toll station workers to vehicle engine exhaust. Journal of Occupational and Environmental Hygiene 12(1):51-61.			
HERO ID:	2533686			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Worker activity description:	Toll station workers for two highway toll stations in semi-urban areas			
Exposure route:	Inhalation			
Personal sampling data:	For Tollway Station A, formaldehyde concentrations (ug/m3) for 8 attendants over 2 days ranged from 4.68 for Attendant #7 (automatic truck lane attendant) on Day 1 to 19.33 for Attendant #2 on Day 1. For Tollway Station B, formaldehyde concentrations (ug/m3) for 7 attendants ranged from 0.06 for Attendant #3 (manual car lane attendant) to 16.21 for Attendant #1 (manual truck lane attendant).See Table VI (pg. 9/12)			
Area sampling data:	For Tollway Station A, ambient background formaldehyde concentration was 1.64 ug/m3. For Tollway Station B, ambient background formaldehyde concentration was 1.19 ug/m3.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data is from Spain, an OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data presented is less than 10 years old
	Metric 5:	Sample Size	Low	No statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Bendix Corp, (1979). BCME formation and detection in selected work environments.			
HERO ID:	8727394			
Conditions of Use:	Reactant - resin manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	Plant A Dye Auxiliaries (resin) Productionthe manual addition step where dicyanamide and ammonium chloride were added to the previously charged formaldehyde solution. The reaction vessel hatch was opened and the materials were added in a sequence of 100 pounds of dicyanamide and 50 pounds of ammonium chloride, until 1,500 pounds of dicyanamide were added, resulting in the use of 750 pounds of ammonium chloride. The hatch was then closed and bolted shut. Additional, the final product was manually packed. This was the longest period where the system could be considered open.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Plant B DyestuffsFirst tub mixing572/17/19765.8 ppmFirst tub mixing592/17/19760.7 ppmFirst tub mixing592/17/19762.2 ppmSecond aniline addition602/17/1976< 0.1 ppmSecond aniline addition612/17/19760.3 ppmSecond aniline addition622/17/19760.3 ppmSecond HCL addition632/18/1976< 0.1 ppmSecond HCL addition642/18/1976< 0.1 ppmSecond HCL addition652/18/1976< 0.1 ppmFilter press702/19/1976< 0.1 ppmFilter press712/19/1976< 0.1 ppmFilter press722/19/1976< 0.1 ppmFilter press732/19/1976< 0.1 ppmSecond tub diazotization742/20/1976< 0.1 ppmSecond tub diazotization752/20/1976< 0.1 ppmSecond tub diazotization762/20/1976< 0.1 ppmPlant A dyestuffs Auxiliary (resin) Mixing tub772/24/19761.9 ppmMixing tub782/24/19761.0 ppmMixing tub792/24/19761.1 ppmMixing tub842/25/19760.8 ppmMixing tub852/25/19761.9 ppmScrubber exit802/24/1976< 0.1 ppmScrubber exit862/25/1976< 0.1 ppmScrubber exit872/25/1976< 0.1 ppmPack out Barreling812/25/1976< 0.1 ppmPack out Barreling822/25/1976< 0.1 ppmPack out Barreling832/25/19760.2 ppmPack out Barreling882/26/19760.3 ppmPack out Barreling892/26/1976< 0.1 ppmPack out Barreling902/26/1976< 0.1 ppm			
Exposure duration:	Plant B Dye ManufactureOperations were conducted during three shifts per day, 5 days perweek.			
Number of workers:	Plant A Dye Auxiliaries (resin) Production20 people.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (dye resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Sampling performed in 1976 - prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 8727394 Table: 1 of 5

...continued from previous page

Study Citation:		Bendix Corp, (1979). BCME formation and detection in selected work environments.		
HERO ID:		8727394		
Conditions of Use:		Reactant - resin manufacture		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between processes and dates. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination			High	

Study Citation:	Bendix Corp, (1979). BCME formation and detection in selected work environments.		
HERO ID:	8727394		
Conditions of Use:	Reactant - fertilizer manufacture		
EXTRACTION			
Parameter	Data		
Worker activity description:	Plant C Fertilizer productionA total of three employees were needed to conduct the process. A crane operator was needed for moving dry materials into the mixing containers and removing finished products to bulk storage. Another operator was responsible for the proper mixing of tile dr~’ ingredients in the dry area. A third operator worked near the ammoniator to control liquid material flows, reaction temperature, dryer temperature, and product sizing operations. Occasionally, others were needed, particularly during initial startup operations. Also, laboratory technicians were present to take samples of the mixture for quality control purposes.		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	Plant C FertilizerAmoniator entrance482/5/19760.2 ppmAmoniator entrance502/5/19760.7 ppmAmoniator exit462/5/19760.2 ppmAmoniator exit512/5/19761.1 ppmAmoniator exit522/5/19760.4 ppmAmoniator exit532/5/19761.9 ppmControl room472/5/19760.3 ppmDryer entrance542/5/19760.5 ppmCooler exit492/5/19761.0 ppmCooler exit552/5/19761.8 ppmCooler exit562/5/19760.9 ppm		
Exposure duration:	Plant C Fertilizer productionthree-shifts-per-day, 5-day work week.		
Number of workers:	Plant C Fertilizer productionA total of about 50 production people worked at this plant		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3: Applicability	High	The data are for an occupational scenario (fertilizer production) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Sampling performed in 1976 - prior to PEL (1992) and more than 20 years old
	Metric 5: Sample Size	High	Results from individual sampling events were provided which could be used to de-velop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between processes and dates. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination		High	
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 8727394 Table: 2 of 5

...continued from previous page			
Study Citation:	Bendix Corp, (1979). BCME formation and detection in selected work environments.		
HERO ID:	8727394		
Conditions of Use:	Reactant - fertilizer manufacture		
		EVALUATION	
Domain	Metric	Rating	Comments

Study Citation:	Bendix Corp, (1979). BCME formation and detection in selected work environments.			
HERO ID:	8727394			
Conditions of Use:	incorporation into and article - Finishing agent in textiles			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Plant D Textile finishingMixing area211/27/19760.5 ppmMixing area221/27/19760.5 ppmMixing area291/28/19760.4 ppmMixing area321/29/19760.2 ppmMixing area331/29/19760.2 ppmPad Box181/27/19760.7 ppmPad Box231/27/19760.9 ppmPad Box261/28/19760.3 ppmPad Box341/29/1976<0.1 ppmPad Box351/29/1976<0.1 ppmPad Box361/29/19760.8 ppmPad Box371/29/1976<0.1 ppmPre dryer entrance exit201/27/19760.2 ppmPre dryer entrance exit241/27/19760.9 ppmPre dryer entrance exit421/30/19760.6 ppmPre dryer entrance exit431/30/19761.3 ppmPre dryer entrance exit441/30/19761.3 ppmPre dryer entrance exit451/30/19760.5 ppmDryer (frame) entrance191/27/19760.8 ppmDryer (frame) entrance251/27/19760.8 ppmDryer (frame) entrance281/28/19760.9 ppmDryer (frame) entrance381/30/19760.3 ppmDryer (frame) entrance391/30/19760.8 ppmDryer (frame) entrance401/30/19760.3 ppmDryer (frame) entrance411/30/19760.6 ppmDryer (frame) eit281/28/19760.5 ppmCure oven entrance311/29/19760.2 ppmCure oven exit301/29/1976<0.1 ppmPlant E TextileMixing area141/22/19760.3 ppmMixing area171/22/19761.4 ppmPad Box11/19/19760.3 ppmPad Box41/20/19760.1 ppmPad Box51/20/19760.7 ppmPad Box121/22/19760.4 ppm Pad Box151/22/19760.4 ppm Pad Box161/22/19760.5 ppmPre dryer exit61/2019760.6 ppmDryer (Frame) Entrance21/19/19760.8 ppmDryer (Frame) Entrance131/22/19760.8 ppmDryer (Frame) Entrance111/21/1976<0.1 ppmPre Calendar31/19/1976<0.1 ppmCure oven loop dryer entrance91/21/19760.2 ppmCure oven loop dryer exit101/21/1976<0.1 ppm			
Exposure duration:	Plant D, Textile Finishing Operations were usually conducted at the plant three shifts per day, 5 days per week. Since production had been curtailed somewhat, only the resin-finishing operation was then operating on the 5-day-per-week schedule.Plant E Textile FinishingThe textile finishing area has three-shift-per-day, 5-day-per-week.			
Number of workers:	Plant E Textile FinishingThe area of interest for this project was the finishing area. A total of about 28 employees were present in this area			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (textile work) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Sampling performed in 1976 - prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 8727394 Table: 3 of 5

...continued from previous page

Study Citation:		Bendix Corp, (1979). BCME formation and detection in selected work environments.		
HERO ID:		8727394		
Conditions of Use:		incorporation into and article - Finishing agent in textiles		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between processes and dates. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination			High	

Study Citation:	Bendix Corp, (1979). BCME formation and detection in selected work environments.				
HERO ID:	8727394				
Conditions of Use:	Reactant - adhesive use				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	Plant G Foundry ResinsHotbox Coremaking CR-158 C15801015/4/19760.8 ppmHotbox Coremaking CR-158 C15801025/4/19760.9 ppmHotbox Coremaking cooling CR-158 C15801035/4/19760.8 ppmHotbox Coremaking CR-105 C10501045/4/19761.5 ppmHotbox Coremaking CR-105 C10501055/4/19760.4 ppmHotbox Coremaking cooling CR-105 C10501065/4/19760.7 ppmPouring CR158 C1580 stack1075/5/19760.5 ppmPouring CR158 C1580 nonstack1085/5/1976<0.1 ppmPouring CR105 C1050 nonstack1095/5/1976<0.1 ppmPouring CR105 C1050 stack1105/5/19760.7 ppmPlant H Foundry ResinsShell baking1118/4/1976 < 1 ppm Shell baking1128/4/1976 < 1 ppm Shell baking1138/4/1976 < 1 ppm Shell baking1148/4/1976 < 1 ppm Pouring area1158/4/19764.5 ppmPouring area1168/4/1976 < 1 ppm Pouring area1178/4/1976 < 1 ppm Pouring area1188/5/1976 5.5 ppmPouring area1198/5/19764.5 ppmPouring area1208/5/1976 < 1 ppm				
Exposure duration:	Plant H. Foundry Products - Full scale.Mold production and pouring were conducted in two daily shifts during a 5-day work week.				
Number of workers:	Plant H. Foundry Products - Full scale.Mold production and pouring were conducted in two daily shifts during a 5-day work week.Plant H. Foundry Products - Full scale.During full production, a total of about 150 people were employed in production areas, with another 40 to 50 working in other plant areas				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	High	The data are for an occupational scenario (foundry) within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	Sampling performed in 1976 - prior to PEL (1992) and more than 20 years old	
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between processes and dates. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.	
Overall Quality Determination			High		

Study Citation:	Bendix Corp, (1979). BCME formation and detection in selected work environments.				
HERO ID:	8727394				
Conditions of Use:	Incorporation into and Article - Other chemical product manufacture				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation				
Physical form:	vapor				
Personal sampling data:	Plant F Hospital Burn CenterPersonal Sample1004/6/1976<1.0 ppm				
Area sampling data:	Plant F Hospital Burn CenterFormaldehyde addition hood914/5/1976<1.0 ppmFormaldehyde addition hood964/6/1976<1.0 ppmOven resin curing924/5/1976<1.0 ppmOven resin curing934/5/1976<1.0 ppmOven resin curing974/6/1976<1.0 ppmOven resin curing984/6/1976<1.0 ppmOven resin curing994/6/1976<1.0 ppmGel treatment hood944/5/1976<1.0 ppmGel treatment hood954/5/1976<1.0 ppm				
Number of workers:	Plant F Hospital burn centerAbout 10 people were employed in the laboratory area. Severalothers were employed in the building but were located in separate sections of the facility.				
EVALUATION					
Domain		Metric	Rating		Comments
Domain 1: Reliability		Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study
Domain 2: Representativeness		Metric 2:	Geographic Scope	High	US
		Metric 3:	Applicability	High	The data are for an occupational scenario (development of hospital treatments) within the scope of the risk evaluation.
		Metric 4:	Temporal Representativeness	Low	Sampling performed in 1976 - prior to PEL (1992) and more than 20 years old
		Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between processes and dates. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination			High		

Formaldehyde

Occupational Exposure

HERO ID: 6113331 Table: 1 of 1

Study Citation:	Berglund, B., Berglund, U., Johansson, I., Lindvall, T. (1984). Sampling of indoor air for sensory analysis in situ. :417-423.		
HERO ID:	6113331		
Conditions of Use:	Closed Pre-school Building		
EXTRACTION			
Parameter	Data		
Area sampling data:	Analyzed values of concentration in exposure hood for formaldehyde in 2 different studies: 573 and 691 ug/m3. The ratio of estimated and empirical values for formaldehyde 0.94.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3: Applicability	Low	Data is for consumer use in pre-school but may be useful for commercial use in Toys, playground, and sporting equipment.
	Metric 4: Temporal Representativeness	Low	Report is more than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low	

Study Citation:	Berke, J.H. (1987). Cytologic examination of the nasal mucosa in formaldehyde-exposed workers. Journal of Occupational and Environmental Medicine 29(8):681-684.			
HERO ID:	3325			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Phenol-formaldehyde impregnating process. Passing a single thickness of paper on a continuous roll through a phenol-formaldehyde bath. The paper then enters a dryer in which it is heated to cure the phenol-formaldehyde resin and evaporate excess water and formaldehyde. The majority of formaldehyde exposure occurs in the bathing and drying steps.			
Exposure route:	Liquid contact, Vapor. Dermal, Inhalation			
Personal sampling data:	0.02 - 1.3 ppm (PBZ at the "former plant"); 0.5 - 2.0 ppm (PBZ at the "latter plant")			
Area sampling data:	15 ppm (short-term at both locations); 9 ppm (excursions near drying ovens when ventilation system disruptions occurred)			
Number of workers:	80 (3 locations)			
Comments:	4 groups 3 with occupational exposure and 1 control. (The extracted area sample measurement maybe a personal sample)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for paper manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data collected before the most recent PEL (1992). PBZ data for groups 1 and 2 plants date back to the mid 1970s. Published in 1987.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low		

Study Citation:	Bernardini, P., Carelli, G., Rimatori, V., Contegiacomo, P. (1983). Health hazard for hospital workers from exposure to formaldehyde. La Medicina del Lavoro 74(2):106-110.			
HERO ID:	6110213			
Conditions of Use:	Use in cleaning products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Cleaning operations in a hospital; bathrooms, service floors, ward floors, corridors, and nurses’ rooms			
Physical form:	Lysoform cleaner mixed in 1:9 ratio with water; lysoform is 6-8% formaldehyde			
Personal sampling data:	samples ranged between 0.180-0.260 mg/m3 (with durations for each sample)			
Area sampling data:	samples ranged between 0.020-0.254 mg/m3 (with durations for each sample)			
Exposure duration:	morning washing operation took from 60-120minutes and afternoon operation took from 30-60minutes			
Exposure frequency:	14 days (once a day) every five weeks based on cleaning shift rotation			
Number of workers:	NIOSH estimated in 1972-1973 that one third of total 1.5million workers exposed to formaldehyde were employed in medical services			
Personal protective equipment:	rubber gloves worn on the job			
Engineering control:	Windows typically opened in rooms to increase airflow			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3:	Applicability	High	Data are for use in cleaning products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by changing conditions of whether window is opened during one sample, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 180103 Table: 1 of 8

Study Citation:	Bernstein, R. S., Stayner, L. T., Elliot, L. J., Kimbrough, R., Falk, H., Blade, L. (1984). Inhalation exposure to formaldehyde: an overview of its toxicology, epidemiology, monitoring, and control. American Industrial Hygiene Association Journal 45(11):778-784.
HERO ID:	180103
Conditions of Use:	"Use in agriculture, forestry, fishing, and hunting"

EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Area sampling data:	Formaldehyde levels in air (ppm) in different occupational sampling locations are as follows: Fertilizer production - 0.2-1.9
Engineering control:	Control measures include: 1. Eliminate the source or substitute an alternative material, product or process with a lower potential health risk. 2. Seal or enclose the source. 3. Use mechanical and externally vented ventilation systems (and appropriate air-cleaning devices, if necessary) to achieve sufficient air exchange with fresh air. 4. Limit access or the total time of exposure to the contaminated environment. 5. Use appropriate personal protective equipment as an interim measure or during renovation, removal or maintenance work. 6. Educate potentially exposed workers and consumers regarding appropriate work or use practices and the above control methods.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	Medium	uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure but no discussion of the uncertainty in the exposure estimates.

Overall Quality Determination	Medium

Study Citation:	Bernstein, R. S., Stayner, L. T., Elliot, L. J., Kimbrough, R., Falk, H., Blade, L. (1984). Inhalation exposure to formaldehyde: an overview of its toxicology, epidemiology, monitoring, and control. American Industrial Hygiene Association Journal 45(11):778-784.			
HERO ID:	180103			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	Formaldehyde levels in air (ppm) in different occupational sampling locations are as follows: Dyestuffs - <0.1-5.8,			
Number of workers:	Neatly a third of the more than 1.5 million workers who are potentially exposed to HCHO are engaged in health-related work.			
Engineering control:	Control measures include: 1. Eliminate the source or substitute an alternative material, product or process with a lower potential health risk. 2. Seal or enclose the source. 3. Use mechanical and externally vented ventilation systems (and appropriate air-cleaning devices, if necessary) to achieve sufficient air exchange with fresh air. 4. Limit access or the total time of exposure to the contaminated environment. 5. Use appropriate personal protective equipment as an interIm measure or during renovation, removal or maintenance work. 6. Educate potentially exposed workers and consumers regarding appropriate work or use practices and the above control methods.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	Medium	uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure but no discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Bernstein, R. S., Stayner, L. T., Elliot, L. J., Kimbrough, R., Falk, H., Blade, L. (1984). Inhalation exposure to formaldehyde: an overview of its toxicology, epidemiology, monitoring, and control. American Industrial Hygiene Association Journal 45(11):778-784.			
HERO ID:	180103			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	Formaldehyde levels in air (ppm) Resins (foundry) - <0.1 - 5.5, Bronze foundry - 0.12 - 0.8, Iron foundry - <0.02 - 18.3,			
Number of workers:	Neatly a third of the more than 1.5 million workers who are potentially exposed to HCHO are engaged in health-related work.			
Engineering control:	Control measures include: 1. Eliminate the source or substitute an alternative material, product or process with a lower potential health risk. 2. Seal or enclose the source. 3. Use mechanical and externally vented ventilation systems (and appropriate air-cleaning devices, if necessary) to achieve sufficient air exchange with fresh air. 4. Limit access or the total time of exposure to the contaminated environment. 5. Use appropriate personal protective equipment as an interIm measure or during renovation, removal or maintenance work. 6. Educate potentially exposed workers and consumers regarding appropriate work or use practices and the above control methods.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	Medium	uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure but no discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 180103 Table: 4 of 8

Study Citation:	Bernstein, R. S., Stayner, L. T., Elliot, L. J., Kimbrough, R., Falk, H., Blade, L. (1984). Inhalation exposure to formaldehyde: an overview of its toxicology, epidemiology, monitoring, and control. American Industrial Hygiene Association Journal 45(11):778-784.			
HERO ID:	180103			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	Formaldehyde levels in air (ppm) in different occupational sampling locations are as follows: Textile manufacture - <0.1 - 1.4.			
Engineering control:	Control measures include: 1. Eliminate the source or substitute an alternative material, product or process with a lower potential health risk. 2. Seal or enclose the source. 3. Use mechanical and externally vented ventilation systems (and appropriate air-cleaning devices, if necessary) to achieve sufficient air exchange with fresh air. 4. Limit access or the total time of exposure to the contaminated environment. 5. Use appropriate personal protective equipment as an interim measure or during renovation, removal or maintenance work. 6. Educate potentially exposed workers and consumers regarding appropriate work or use practices and the above control methods.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	Medium	uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure but no discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 180103 Table: 5 of 8

Study Citation:	Bernstein, R. S., Stayner, L. T., Elliot, L. J., Kimbrough, R., Falk, H., Blade, L. (1984). Inhalation exposure to formaldehyde: an overview of its toxicology, epidemiology, monitoring, and control. American Industrial Hygiene Association Journal 45(11):778-784.			
HERO ID:	180103			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	Formaldehyde levels in air (ppm) in different occupational sampling locations are as follows: Urea-formaldehyde foam applicators - <0.08 - 2.4.			
Engineering control:	Control measures include: 1. Eliminate the source or substitute an alternative material, product or process with a lower potential health risk. 2. Seal or enclose the source. 3. Use mechanical and externally vented ventilation systems (and appropriate air-cleaning devices, if necessary) to achieve sufficient air exchange with fresh air. 4. Limit access or the total time of exposure to the contaminated environment. 5. Use appropriate personal protective equipment as an interIm measure or during renovation, removal or maintenance work. 6. Educate potentially exposed workers and consumers regarding appropriate work or use practices and the above control methods.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	Medium	uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure but no discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Bernstein, R. S., Stayner, L. T., Elliot, L. J., Kimbrough, R., Falk, H., Blade, L. (1984). Inhalation exposure to formaldehyde: an overview of its toxicology, epidemiology, monitoring, and control. American Industrial Hygiene Association Journal 45(11):778-784.			
HERO ID:	180103			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	Formaldehyde levels in air (ppm) in different occupational sampling locations are as follows: Treated paper - 0.14 - 0.99			
Engineering control:	Control measures include: 1. Eliminate the source or substitute an alternative material, product or process with a lower potential health risk. 2. Seal or enclose the source. 3. Use mechanical and externally vented ventilation systems (and appropriate air-cleaning devices, if necessary) to achieve sufficient air exchange with fresh air. 4. Limit access or the total time of exposure to the contaminated environment. 5. Use appropriate personal protective equipment as an interIm measure or during renovation, removal or maintenance work. 6. Educate potentially exposed workers and consumers regarding appropriate work or use practices and the above control methods.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	Medium	uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure but no discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Bernstein, R. S., Stayner, L. T., Elliot, L. J., Kimbrough, R., Falk, H., Blade, L. (1984). Inhalation exposure to formaldehyde: an overview of its toxicology, epidemiology, monitoring, and control. American Industrial Hygiene Association Journal 45(11):778-784.			
HERO ID:	180103			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	Occupational exposure levels have been measured in autopsy rooms from 2.2 to 7.9 ppm while levels in nonmedical jobs ranged from less than 0.02 to 18.3 ppm. Formaldehyde levels in air (ppm) in occupational sampling locations are as follows: Hospital autopsy room - 2.2 - 7.9,			
Number of workers:	Neatly a third of the more than 1.5 million workers who are potentially exposed to HCHO are engaged in health-related work.			
Engineering control:	Control measures include: 1. Eliminate the source or substitute an alternative material, product or process with a lower potential health risk. 2. Seal or enclose the source. 3. Use mechanical and externally vented ventilation systems (and appropriate air-cleaning devices, if necessary) to achieve sufficient air exchange with fresh air. 4. Limit access or the total time of exposure to the contaminated environment. 5. Use appropriate personal protective equipment as an interIm measure or during renovation, removal or maintenance work. 6. Educate potentially exposed workers and consumers regarding appropriate work or use practices and the above control methods.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	Medium	uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determi- nants of exposure but no discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Bernstein, R. S., Stayner, L. T., Elliot, L. J., Kimbrough, R., Falk, H., Blade, L. (1984). Inhalation exposure to formaldehyde: an overview of its toxicology, epidemiology, monitoring, and control. American Industrial Hygiene Association Journal 45(11):778-784.			
HERO ID:	180103			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	Formaldehyde levels in air (ppm) in different occupational sampling locations are as follows: Plywood industry - 1.0 - 2.5,			
Engineering control:	Control measures include: 1. Eliminate the source or substitute an alternative material, product or process with a lower potential health risk. 2. Seal or enclose the source. 3. Use mechanical and externally vented ventilation systems (and appropriate air-cleaning devices, if necessary) to achieve sufficient air exchange with fresh air. 4. Limit access or the total time of exposure to the contaminated environment. 5. Use appropriate personal protective equipment as an interim measure or during renovation, removal or maintenance work. 6. Educate potentially exposed workers and consumers regarding appropriate work or use practices and the above control methods.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	Medium	uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure but no discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Bertrand, J.P., Simon, V., Chau, N. (2007). Associations of symptoms related to isocyanate, ureaformol, and formophenolic exposures with respiratory symptoms and lung function in coal miners. International Journal of Occupational and Environmental Health 13(2):181-187.			
HERO ID:	1313651			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Resin handling			
Personal sampling data:	0.4-0.7 (ppm)			
Area sampling data:	2 (ppm)			
Number of workers:	354			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old. (2007)
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by area and personal breathing zone sampling, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Binding, N., Kraenke, B., Witting, U. (1991). Aldehyde exposure during disinfection of hospital beds. Zentralblatt für Hygiene und Umweltmedizin 192(2):168-169.		
HERO ID:	6016309		
Conditions of Use:	Chemical substances in products not described by other codes: Equipment cleaning		
EXTRACTION			
Parameter	Data		
Worker activity description:	Hospital staff who disinfect beds (1/2)		
Exposure route:	inhalation (1/2)		
Physical form:	vapors from aqueous solutions (1/2)		
Personal sampling data:	Personal breathing zones detected 0.6 mL/m3 of formaldehyde. (2/2)		
Area sampling data:	0.4 mL/m3 of formaldehyde was detected in a central disinfection unit. When cleaning only one bed, levels were 0.05 mL/m3. In a poorly air-conditioned room with multiple beds, levels were 0.8 mL/m3.		
Exposure duration:	one shift		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low	

Study Citation:	Blade, L. M. (1996). James River Corporation, Packaging Business Greensburg, Indiana HETA 93–0670–2557 January 1996.			
HERO ID:	8048989			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Packers, operators, and adjusters in the bag department. Extruder operators and helpers in the extrusion department. Plate makers in the printing department. (30/37)			
Exposure route:	inhalation, dermal (8/37)			
Physical form:	gas (8/37)			
Personal sampling data:	No formaldehyde was detected in personal samples. (10/37)			
Area sampling data:	Area samples near the bag machines ranged from 0.021-0.061 ppm. (35/37)			
Exposure duration:	8-12 hours/day (4/37)			
Number of workers:	Over 10 employees work in the Extrusion Department during each of two 12-hr shifts. Approximately four employees work in the Maintenance Department die shop. Approximately 13 employees work in the Printing Department pre–press area. The Bag Department employs approximately 54 people during each of three 8–hr shifts. (4/37)			
Engineering control:	All four print mold making machines are equipped with local exhaust ventilation. During the initial NIOSH survey, only a few of the bag machines were equipped with local exhaust ventilation. In early 1994, between the initial survey and the first follow–up visit, the remaining machines were equipped with local–exhaust enclosures constructed of transparent plastic plates fastened together. (4/37)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL but greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure frequency and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. The monitoring study addresses variability in the determinants of exposure for the sampled site .
Overall Quality Determination		High		

Study Citation:	Blair, A., Stewart, P.A., Hoover, R.N. (1990). Mortality from lung cancer among workers employed in formaldehyde industries. American Journal of Industrial Medicine 17(6):683-699.			
HERO ID:	32197			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	duration of exposure was estimated for concentration bins of (0 ppm; <0.1 ppm,0.1-<0.5 ppm; 0.5-<2.0 ppm; >2.0 ppm (Table III)			
Exposure duration:	Cumulative exposure durations were estimated for different levels of exposure (Table III); too complicated to represent in a spreadsheet - image provided in supplemental tab , the study also provides a matrix of cumulative exposure (ppm-yr) for each site (Table IV) also included in the supplemental tab			
Number of workers:	Cohort of 26,561-described in detail elsewhere [Blair et al., 1986; Stewart et al., 1986			
Comments:	methods described in detail elsewhere [Blair et al., 1986; Stewart et al., 1986			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	too broad
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Published in 1990
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics-exposure data grouped into concentration bins
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	As this is a cohort study, missing sampling and analysis methods, worker activities, type of sampling sampling location, exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	limited information about variability based on exposure bins used, but nothing on uncertainty
Overall Quality Determination			Low	

Study Citation:	Boiano, J. M., Almaguer, D. (n.d.). Health Hazard Evaluation Report HETA-85-044-1761 American Crystal Sugar Company, Drayton, North Dakota.
HERO ID:	8684546
Conditions of Use:	Sugar manufacturing

EXTRACTION	
Parameter	Data
Worker activity description:	Diffuser operators and diffuser watchmen. (26/43)
Exposure route:	inhalation, dermal (12/43)
Physical form:	vapor, solution, and resins (12/43)
Personal sampling data:	Two diffuser operators had personal breathing concentrations of 0.21 and 0.31 ppm formaldehyde. The diffuser watcher has concentrations of 0.09 ppm. (39/43)
Area sampling data:	General area concentrations of formaldehyde were 0.18 ppm in the top end of the diffuser, 0.33 ppm in the bottom end of the diffuser, and ND in the catwalk above the drum filter and at the knife station. (38/43)
Exposure duration:	8 hours (6/43)
Exposure frequency:	7 days/week from September to March, and 6 days/week in the offseason. (6/43)
Number of workers:	370 workers (5/43)
Personal protective equipment:	Respiratory protection should be used in interim while engineering controls are implemented. (21/43)
Engineering control:	The possibility of substituting formaldehyde with a bactericide that is less toxic should be investigated. (21/43)

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Uninformative	Data are for sugar manufacturing, which isn't in the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.

Overall Quality Determination

Uninformative

Study Citation:	Bolstad-Johnson, D.M., Burgess, J.L., Crutchfield, C.D., Stormont, S., Gerkin, R., Wilson, J.R. (2000). Characterization of firefighter exposures during fire overhaul. American Industrial Hygiene Association Journal 61(5):636-641.			
HERO ID:	16335			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Worker activity description:	Fire overhaul, which is the search by firemen for hidden fires inside attics, ceilings and walls after they suppress fires.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Average sample concentration 0.25 ppm; STD Dev 0.252 ppm; Min 0.016 ppm; Max1.18 ppm			
Area sampling data:	Firefighters were monitored during 25 structure fires (25 houses, 6 apartments, and 5 commercial buildings.			
Exposure duration:	The overhaul phase of a fire lasts an average of 30 min. (PDF pg. 1/6) Sampling times were 20 minutes for each event			
Exposure frequency:	Firefighters from a single station responded to 26 fires from June 13 - Sep. 25 of 1998. (PDF pg. 2/6)			
Number of workers:	The number of firefighters who conduct overhaul during firefighting is not stated. However, an estimate of this number is the number of firefighters who conducted the monitoring during this study which is 4 individuals per fire event			
Personal protective equipment:	Masks tend to be removed during this phase of the fire fighting operation, researchers recommended using SCUBA units, but as they are bulky full face APRs were also suggested			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH sampling and analytical methods used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data pertains to U.S.
	Metric 3:	Applicability	High	Exposure of firefighters is an exposure scenario that is associated with a COU.
	Metric 4:	Temporal Representativeness	Medium	The data are slightly older than 20 years but time probably is not a factor regarding the pertinence of the data.
	Metric 5:	Sample Size	High	Statistical distribution is characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Meta data included.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Monitoring occurred at different types of structures. Method sensitivity is given.
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 3420607 Table: 1 of 1

Study Citation:	Bono, R., Munnia, A., Romanazzi, V., Bellisario, V., Cellai, F., Peluso, M.E. (2016). Formaldehyde-induced toxicity in the nasal epithelia of workers of a plastic laminate plant. Toxicology Research 5(3):752-760.		
HERO ID:	3420607		
Conditions of Use:	Plastic Manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	Plastic laminate plant workers		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	Table 1 shows indoor formaldehyde exposure levels: Controls workers - 35.2 +/- 3.4 ug/m^3; Plastic laminate plant workers - 211.4 +/- 14.8 ug/m^3		
Exposure duration:	working shift (8 hours) with a typical 40 hour work week		
Number of workers:	95 workers studied with 50 being FA workers and 45 office personnel		
Personal protective equipment:	Extractor hoods were regularly active in the plastic laminate plant, whereas personal protective equipment were provided and available as well (e.g. mask), but they were not regularly used by all the workers		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data is for Italy, an OECD country.
	Metric 3: Applicability	High	Data is directly applicable for use of formaldehyde in producing plastic products
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old (2016).
	Metric 5: Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Provides worker activity, exposure route, physical form, personal sampling data, PPE, exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		High	

Study Citation:	Bono, R., Vincenti, M., Schiliro’, T., Scursatone, E., Pignata, C., Gilli, G. (2006). N-Methylenvaline in a group of subjects occupationally exposed to formaldehyde. Toxicology Letters 161(1):10-17.				
HERO ID:	1080204				
Conditions of Use:	Compressed Wood Product Manufacturing				
EXTRACTION					
Parameter	Data				
Worker activity description:	Workers in plywood and laminate factories				
Exposure route:	inhalation				
Physical form:	gas/vapor				
Personal sampling data:	Formaldehyde exposure at Factory 1 = 92 ug/m3 with CI of 25 – 160 ug/m3. Formaldehyde exposure at Factory 2 = 76 ug/m3 with CI of 48 – 105 ug/m3. Formaldehyde exposure for controls = 20 ug/m3.				
Number of workers:	21 subjects employed in a plywood factory and a laminate factory (8 subjects from “factory 1” producing plywood panels, 13 subjects from “factory 2” producing laminates) together with a group of 30 controls				
Personal protective equipment:	no protective mask was worn by anyone during data collection				
EVALUATION					
Domain	Metric	Rating			Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described method	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country. other than the U.S.	
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation	
	Metric 4:	Temporal Representativeness	Medium	data is between 10 and 20 years old	
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainty	
Overall Quality Determination			High		

Study Citation:	Boysen, M., Zadig, E., Digernes, V., Abeler, V., Reith, A. (1990). Nasal mucosa in workers exposed to formaldehyde: a pilot study. Occupational and Environmental Medicine 47(2):116-121.				
HERO ID:	61192				
Conditions of Use:	Processing as a reactant				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	exposure was grouped into two groups: 0.5-2 ppm and >2.0 ppm				
Number of workers:	37				
EVALUATION					
Domain		Metric	Rating		Comments
Domain 1: Reliability		Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness		Metric 2:	Geographic Scope	Medium	Norway - OECD member
		Metric 3:	Applicability	High	The data are for formaldehyde and formaldehyde resin manufacture which is an occupational scenario within the scope of the risk evaluation.
		Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1990, before the most recent PEL (1992) and more than 20 years old.
		Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Low	no metadata were provided.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low		

Formaldehyde

Occupational Exposure

HERO ID: 3481 Table: 1 of 2

Study Citation:	Bracken, M.J., Leasa, D.J., Morgan, W.K. (1985). Exposure to formaldehyde: Relationship to respiratory symptoms and function. Canadian Journal of Public Health 76(5):312-316.			
HERO ID:	3481			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Urea-formaldehyde foam insulation (UFFI) exposure			
Personal sampling data:	Table II (on page 4 of 5) has sample data (mean and range) for 4 lab. locations and houses.			
Number of workers:	54 residents from 22 UFFI homes. 26 control residents from 16 non-UFFI homes			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country (Canada).
	Metric 3:	Applicability	High	The data are for an occupational scenario (lab tech) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data collected before the most recent PEL (1992). Published in 1985. Sample collection before then.
	Metric 5:	Sample Size	Medium	Data characterized by median and range, but full statistical distribution not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata (i.e., sample duration, worker activity)
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 3481 Table: 2 of 2

Study Citation:	Bracken, M.J., Leasa, D.J., Morgan, W.K. (1985). Exposure to formaldehyde: Relationship to respiratory symptoms and function. Canadian Journal of Public Health 76(5):312-316.			
HERO ID:	3481			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	All 6 pathology technicians (4 in surgical pathology and tissue preparation and 2 in the morgue) were exposed to formaldehyde. Four other technicians from the anatomy department of the Medical School were also studied.			
Exposure route:	Liquid contact, Vapor. Dermal, Inhalation			
Personal sampling data:	hospital pathology lab. technician: mean exposure = 0.125 +/-0.016 ppm (range 0.02 - 2.7 ppm)			
Number of workers:	10 lab. technicians. (morgue; surgical pathology; tissue prep.; medical anatomy)			
Comments:	'Dupont Pro-Tek series II, type C-60 formaldehyde badge, which determines the TWA over the work shift. After exposure, the absorbing solution in the badge was analyzed by a method similar to the NIOSH chromotropic acid method.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country (Canada).
	Metric 3:	Applicability	High	Data are for construction, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data collected before the most recent PEL (1992). Published in 1985. Sample collection before then.
	Metric 5:	Sample Size	Medium	Data characterized by median and range, but full statistical distribution not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata (i.e., sample duration, worker activity)
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Brandt-Rauf, P. W., Fallon, L. F., Jr, Tarantini, T., Idema, C., Andrews, L. (1988). Health hazards of fire fighters: Exposure assessment. Occupational and Environmental Medicine 45(9):605-612.			
HERO ID:	64686			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	gas			
Area sampling data:	Colorimetric detector tube sampling results for formaldehyde: ranges between 0.1 and 8.3 ppm (page 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is an approved method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	the measurements were collected in 1986. More than 30 years old.
	Metric 5:	Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1314412 Table: 1 of 1

Study Citation: Brandt-Rauf, P.W., Andrews, L.R., Schwarz-Miller, J. (1991). Sick-hospital syndrome. Journal of Occupational Medicine 33(6):737-739.
HERO ID: 1314412
Conditions of Use: Laboratory Use

EXTRACTION

Parameter	Data
Personal sampling data:	only one sample was "in excess of 0.1 ppm". Pg. 2

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Source states that samples were collected by colorimetric gas detector tubes and analyzed by gas chromatography/mass spectroscopy
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data is from US
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Monitoring data do not include any needed metadatato understand what the data represent and are not usable in the risk evaluation.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination **Uninformative**

Formaldehyde

Occupational Exposure

HERO ID: 1317678 Table: 1 of 1

Study Citation:	Brandwein, M., Pervez, N., Biller, H. (1987). Nasal squamous carcinoma in an undertaker–does formaldehyde play a role?. Rhinology 25(4):279-284.			
HERO ID:	1317678			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.25-1.3 (ppm)			
Exposure duration:	0.5-1 hr			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Article from the 1980s.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Breyse, P. A. (1980). Small plants and their medical problems – the furniture industry: The environmental problems of urea-formaldehyde structures – formaldehyde exposure in mobile homes. NIOSH(NIOSH):56-64.			
HERO ID:	1322359			
Conditions of Use:	Use of Furniture and Furnishings			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Date Sample Location Concentration10-7-75 Kitchen 1.3 ppm Master bedroom 1.3 ppm12-19-75 Living room 0.87 ppm Master bedroom 0.87 ppm7-27-76 Kitchen 0.64 ppm Master bedroom 0.93 ppmSampling countConcentration Kitchen Bedroom Other 1.0 ppm 7 7 20.5 - 0.99 ppm 53 44 150.1 - 0.49 ppm 198 161 48 0.1 ppm 34 36 3			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Uninformative	Non occupational exposure
	Metric 4:	Temporal Representativeness	Low	1979 prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., area) but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Results from individual sampling events were provided which could be used to assess variability. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination		Uninformative		

Study Citation:	Breysse, P. A. (1984). The office environment: How dangerous?.			
HERO ID:	6112851			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Washington state officials in government buildings (4/8)			
Exposure route:	inhalation (3/8)			
Area sampling data:	In 20 surveys of office buildings, concentrations of 0.01-0.30 ppm formaldehyde were detected. (4/8)			
Number of workers:	35 workers at the Washington State Capitol building, 46 workers at the Washington DHHS. (4/8)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for ambient air, which is similar to the in-scope occupational scenario use of furniture and furnishing products
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by explaining factors that could confound survey results. Variability is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 3483 Table: 1 of 1

Study Citation:	Breysse, P., Couser, W.G., Alpers, C.E., Nelson, K., Gaur, L., Johnson, R.J. (1994). Membranous nephropathy and formaldehyde exposure. Annals of Internal Medicine 120(5):396-397.			
HERO ID:	3483			
Conditions of Use:	Consumer Use- Residential Home			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Air-borne formaldehyde			
Area sampling data:	0.49 ppm, 0.49 ppm, 0.10 ppm, 0.17 ppm			
Comments:	Formaldehyde levels were measured in the cottage associated with patients 1 and 2, 16 months after it was built. In the adjoining apartment of patient 2, 16 months after it was built. In the mobile (manufactured) home of patient 4, 5 years after it was bought.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for home occupants, which is similar to the in-scope occupational scenario chemical substances in building/construction materials.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL (1992) and greater than 10 years old. Published in 1994.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Bruno, E., Somma, G., Russo, C., Porozaj, D., Pietroiusti, A., Alessandrini, M., Magrini, A. (2018). Nasal cytology as a screening tool in formaldehyde-exposed workers. Occupational Medicine 68(5):307-313.			
HERO ID:	4471271			
Conditions of Use:	pathology and anatomy laboratories			
EXTRACTION				
Parameter	Data			
Exposure route:	mainly by inhalation because of formaldehyde emission from aqueous solution (embalming fluids)			
Area sampling data:	The mean formaldehyde concentrations ranged from <0.04 to 0.15 parts per million (ppm). The maximum levels of formaldehyde concentrations ranged from 0.2 to 0.67 ppm. Table 2 contains a summary of mean, median, and range of air concentrations during different seasons.			
Engineering control:	The laboratory is equipped with combined general and fume hood exhaust system. The general ventilation system consists of two circular anemostats for primary air intake and two rectangular ceiling extractors. Local exhaust consists of three hoods (one Grosslab Senior and two Grosslab Junior) that use a recirculating exhaust system to filter (using formaldehyde neutralizing filters) and recirculate the air.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country, other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.

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Study Citation:	Bruno, E., Somma, G., Russo, C., Porozaj, D., Pietroiusti, A., Alessandrini, M., Magrini, A. (2018). Nasal cytology as a screening tool in formaldehyde-exposed workers. Occupational Medicine 68(5):307-313.		
HERO ID:	4471271		
Conditions of Use:	pathology and anatomy laboratories		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Bryant C, O’Malley, M., Gormon, R., Boiano, J. (1989). Health hazard evaluation report no. HETA 86-421-1956, Cincinnati Public Schools, Cincinnati, Ohio.			
HERO ID:	3970598			
Conditions of Use:	Unknown- School Building			
EXTRACTION				
Parameter	Data			
Number of sites:	1			
Worker activity description:	Teaching			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Formaldehyde was detected in all the samples and ranged from 0.01-0.02 ppm. Since furnishings, rugs, drapes, and some building construction materials can emit formaldehyde, it is not unusual to find small amounts in buildings. The limit of detection was 0.5 ug/sample, which would correspond to an atmospheric concentration of 0.001 ppm (sample air volume of approximately 330 liters).Classroom - 431 0.02 ppmClassroom - 432 0.01 ppmOffice - 431 0.02 ppmOffice - 430 0.02 ppm			
Number of workers:	20-25 occupants			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Low	The data are for an occupational scenario (public school) within the scope of the risk evaluation; however, the condition of use/source of formaldehyde is not clear
	Metric 4:	Temporal Representativeness	Low	1986 Prior to PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Four samples were taken at different locations.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include critical metadata, such as sample type and exposure type, sample durations and worker activity, but lacks additional metadata, such as exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between different classrooms. Uncertainty was not discussed but assumed that it was addressed in NIOSH Method 3500.
Overall Quality Determination		Medium		

Study Citation:	Buist, H.E., Sandt, J.J., Burgsteden, J.A., Heer, C.d. (2005). Effects of single and repeated exposure to biocidal active substances on the barrier function of the skin in vitro. Regulatory Toxicology and Pharmacology 43(1):76-84.			
HERO ID:	3813346			
Conditions of Use:	Non-TSCA			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers using biocidal products			
Exposure route:	dermal			
Dermal exposure data:	Dermal exposure data			
Number of workers:	The skin originated from 7 female donors, aged 31–57 years (average 39). The assay was performed in static diffusion cells using cryopreserved human abdominal skin.			
Comments:	A total of 3 product types and 23 products were tested. Formaldehyde had a tendency for reducing skin permeability, especially after repeated exposure. However, the effect was only in very few cases statistically significant and did not exhibit a clear dose relationship. Application dose concentrations were 0.2, 5, and 30 mg/L.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	sampling methodology is well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data from an OECD country, other than the U.S.
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	data are more than 10 years but generally, no more than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Burgaz, S., Erdem, O., Cakmak, G., Erdem, N., Karakaya, A., Karakaya, A.E. (2002). Cytogenetic analysis of buccal cells from shoe-workers and pathology and anatomy laboratory workers exposed to n-hexane, toluene, methyl ethyl ketone and formaldehyde. Biomarkers 7(2):151-161.			
HERO ID:	629612			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Pathology lab - <2ppm, Anatomy lab - <4ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Turkey - OECD member	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2002.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (range) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Sample type provided but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 6029821 Table: 1 of 1

Study Citation:	Burgess, J. L., Gerkin, R., Hysong, T. A., Lantz, R., Nanson, C. J., Witten, M. L. (2002). Rapid decline in sputum IL-10 concentration following occupational smoke exposure. Inhalation Toxicology 14(2):133.			
HERO ID:	6029821			
Conditions of Use:	Industrial Use (Non-incorporative activities)			
EXTRACTION				
Parameter	Data			
Worker activity description:	A particular phase of firefighting, called overhaul, follows extinguishment of visible flames and involves searching for and putting out hidden sources of combustion. During this phase, firefighters often do not wear respiratory protection due to the lack of visible smoke, but elevated concentrations of a number of products of combustion may still be present.			
Exposure route:	inhalation			
Personal sampling data:	Mean: 0.25 ± 0.26 ppm			
Exposure duration:	Over-haul was conducted for a minimum of 25 min in all incidents.			
Number of workers:	12 firefighters			
Comments:	Sorbent tube samples were collected for aldehydes (acetalde-hyde, acrolein, benzaldehyde, formaldehyde, glutaraldehyde, isovaleraldehyde), benzene, hydrochloric acid, hydrogen cyanide, and sulfuric acid.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S. Phoenix Fire Department firefighters.
	Metric 3:	Applicability	High	Data are for non-incorporative activities (fires, fuel combustion), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata (only firefighter demographics, lung function, sputum conc.).
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Burgess, J. L., Nanson, C. J., Bolstad-Johnson, D. M., Gerkin, R., Hysong, T. A., Lantz, R. C., Sherrill, D. L., Crutchfield, C. D., Quan, S. F., Bernard, A. M., Witten, M. L. (2001). Adverse respiratory effects following overhaul in firefighters. Journal of Occupational and Environmental Medicine 43(5):467-473.			
HERO ID:	3050028			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Worker activity description:	firefighters; Overhaul- is the stage in which firefighters search for and extinguish possible sources of re-ignition			
Exposure route:	inhalation			
Area sampling data:	Combustion products exposure during overhaul: in Tuscon – 0.109 +/- 0.182 ppm; in Phoenix – 0.257 +/- 0.249 ppm			
Number of workers:	51 firefighters cited in this article			
Personal protective equipment:	cartridge respirators			
Comments:	”It is common practice not to wear respiratory protection during overhaul. ”(p.1) The time interval between cessation of extinguishment and the start of overhaul was similar in Tucson (n=4, mean 20.3 +/- 9.2 minutes) and Phoenix (n=7, mean 21.7 +/- 10.0 minutes).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology is well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	Low	Data notes source as combustion byproduct, which is not a condition of use, however, exposures also could include off-gassing from building products and other products in the vicinity when overhauling.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Provides only limited discussion of the variability in the determinants of exposure but no discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Burkhart, J. E. (1995). Health hazard evaluation report No. HETA-95-0162-2536, RCA Rubber Company, Akron, Ohio. :95-0162.			
HERO ID:	1317129			
Conditions of Use:	Rubber Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers working around the Banbury mixers, related mills, and presses			
Exposure route:	inhalation			
Physical form:	Vapor			
Area sampling data:	Six formaldehyde samples were collected on ORB0-23 sampling tubes near the large roll presses. No formaldehyde was detected on any of the samples collected. The minimum detectable concentration of formaldehyde was 0.001 ppm.			
Number of workers:	200			
Personal protective equipment:	half face piece organic vapor and PM respirators			
Engineering control:	implement ACGIH industrial ventilation recommendations for the exhaust hoods in the mixing areas			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study Method 2541
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1995, after release of PEL but more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Burkhart, J. E., Jennison, E. A. (1994). Health hazard evaluation report no. HETA 92-0297-2396, Exxon Chemical Company, Pottsville Film Plant, Polyethylene Film Department, Mar-Lin, Pennsylvania.			
HERO ID:	3970604			
Conditions of Use:	Incorporation into an article- Plastic and Rubber Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Five are involved in bulk handling of the resin pellets and eight are involved in packaging of the final product. The 36 technicians are the individuals who actually operate the blown film machines. The remaining four employees are team leaders who have a supervisory role. (pg. 5)			
Exposure route:	inhalation			
Physical form:	gas			
Personal sampling data:	0.028 to 0.245 ppm for formaldehyde for monitoring study conducted by site (March 1991) pg.6			
Area sampling data:	within the bubble ranged from 0.28 to 4.58 ppm forformaldehyde (Oct 1990) (pg. 6)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified. Data conducted by site, not NIOSH.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment
	Metric 5:	Sample Size	Medium	characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, butlacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Burkhart, J. E., Jennison, E. A. (1994). Health hazard evaluation report no. HETA 92-0297-2396, Exxon Chemical Company, Pottsville Film Plant, Polyethylene Film Department, Mar-Lin, Pennsylvania.		
HERO ID:	3970604		
Conditions of Use:	Incorporation into an article- Plastic and Rubber Products		
EXTRACTION			
Parameter	Data		
Worker activity description:	Five are involved in bulk handling of the resin pellets and eight are involved in packaging of the final product. The 36 technicians are the individuals who actually operate the blown film machines. The remaining four employees are team leaders who have a supervisory role. (pg. 5)		
Personal sampling data:	In summary, 79% (11/14) samples showed no detectable formaldehyde concentrations. The remaining 21% (3/14) showed trace levels of formaldehyde; with all values falling between the LOD and LOQ for this analytical method. Values falling between the LOD and LOQ limits are considered as a semi-quantitative estimate.A semi-quantitative estimate of formaldehyde exposure from those three personal breathing zone samples were approximately 0.013 to 0.016 ppm. pg.11		
Area sampling data:	In summary, all 10 area impingers samples showed trace amounts of formaldehyde, with all values falling between the LOD and LOQ of the analytical method. A semi-quantitative estimate of formaldehyde exposure from the 10 impingers samples ranged from approximately 0.009 to 0.018 ppm. pg. 11		
Exposure duration:	8-hr shifts (3 within a day)		
Exposure frequency:	operates 7 days a week; an average of 15.5 years of service (pg. 5)		
Number of workers:	53 workers(pg. 5)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling and analytical methodology is an approved NIOSH method according to NIOSH Analytical Methods 2501 and NIOSHAnalytical Method 3500.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The monitoring data were collected after the most recentPEL establishment or update but are more than 20 years old
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site. Uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		High	

Study Citation:	Burr, G. A., Richardson, F. D. (1988). Health Hazard Evaluation Report HETA 87-250-1888, GTE Products Corporation, Williamsport, Pennsylvania, April 1988.			
HERO ID:	1989341			
Conditions of Use:	Use of electrical and electronic products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Greatest potential for generating airborne contaminants: wave soldering, using automatic (belt-fed) vapor degreaser, and numerous manual solder touch-ups; Formaldehyde specifically is expected to be generated as pyrolysis product of soldering. Report also indicated that these exposure measurements may have contributions from wood paneling on the walls of the SEM areas, these were subsequently removed before NIOSH measurements.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Private IH results: Total aldehydes measured 0.17-0.27 mg/m3, which is reported to be near the LOD for the analytical method.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Methodology used a NIOSH method (No. 2502), which has since been withdrawn.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old prior to recent PEL.
	Metric 5:	Sample Size	Medium	Unknown number samples, range is provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data is unclear if sample is personal or area measurement and lacks other metadata (sample durations, exposure durations, and frequency).
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Due to lack of clarity on monitoring study, it is uncertain how variability was addressed. Assumes the monitoring study addresses uncertainty in the exposure estimates can be determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Study Citation:	Burr, G. A., Richardson, F. D. (1988). Health Hazard Evaluation Report HETA 87-250-1888, GTE Products Corporation, Williamsport, Pennsylvania, April 1988.			
HERO ID:	1989341			
Conditions of Use:	Use of electrical and electronic products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Greatest potential for generating airborne contaminants: wave soldering, using automatic (belt-fed) vapor degreaser, and numerous manual solder touch-ups; Formaldehyde specifically is expected to be generated as pyrolysis product of soldering. Measured Workers: wave-solder machine operator, a touch-up solderer, and a quality assurance inspector			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	All formaldehyde samples were below the limit of detection (LOD) of 2 micrograms (ug) per sample.			
Number of workers:	The 23 workers interviewed represented 51% of the 45 persons either presently working in SEM, performing SEM-related activities at work stations that were moved to another area of the plant since November 1986, or were employed in the SEM area as of January 1986 but have transferred to other jobs.			
Personal protective equipment:	NIOSH recommended gloves which offer a higher degree of protection.			
Engineering control:	The SEM areas are supplied by 20 separate air conditioning units mounted on the roof of the plant. These units, several of which supply the front offices and fiber optic areas in the building, have dedicated returns. The units vary in capacity from 4.5 to 25 tons, and steam coils, located in supply ducts, supplement ceiling-mounted space heaters in providing heat. NIOSH recommended 4 flexible exhaust hoses, located at the SEM final inspection area, should be lengthened to permit the exhaust opening to reach within 1 to 2 inches of the point of work. Recirculation of exhaust air from the SEM areas is not recommended considering the agents presently being used; Local ventilation used near wave solder and degreasers machine (estimated flow of 3000 ft3/min).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Methodology used a NIOSH method (No. 2502), which has since been withdrawn.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old prior to recent PEL.
	Metric 5:	Sample Size	Medium	3 samples measured and all below limit of detection.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include sample type, worker activities, but lacks sample durations, exposure durations, and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site by measuring different jobs. Assumes the monitoring study addresses uncertainty in the exposure estimates can be determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Study Citation:	Burr, G. A., Wilcox, T. G., Klein, M. K., Weber, A. M. (1993). Health hazard evaluation report no. HETA 93-011-2309, Tri-county North School, Lewisburg, Ohio.			
HERO ID:	3970553			
Conditions of Use:	Unknown- School			
EXTRACTION				
Parameter	Data			
Worker activity description:	Teachers			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Oct 28-Nov 9,1992 - Formaldehyde concentrations ranged from 0.017 to 0.058 ppm, expressed as time-weighted averages. The highest formaldehyde concentrations were measured in C113, one of the group of first floor/central pod classrooms which had CO2 levels ranging up to 4,000 ppm. For comparison, formaldehyde levels measured outside the school ranged from 0.004 and 0.006 ppm (levels between the minimum detectable and minimum quantifiable concentrations for this sampling and analytical method).During the follow-up survey conducted on February 25, 1993. Formaldehyde concentrations ranged from 0.011 - 0.023 ppm. On average, formaldehyde levels measured in February 1993 wereapproximately 50% lower than those measured at TCN in October 1992.			
Number of workers:	75 teachers and administrators, 10 cafeteria workers, and 8 custodial employees.			
Engineering control:	Increasing the amount of relief ventilation for the school, improving access to ventilation system components, and using more efficient filter media.The height of exhaust vents on the roof should be raised to reduce the chance of recirculation into nearby outside air intakes.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study - Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (public school) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1993 - after the PEL (1992) but more than 20 years old
	Metric 5:	Sample Size	Medium	Concentrations for individual rooms was provided, but distribution of samples is characterized by a range without uncertain statistics. It was assumed that uncertainty was addressed in Method 3500.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include all associated metadata, including sample types, exposure types, and worker activities, but additional meta data were not provided, including sample durations, exposure durations exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability between rooms and sampling days. The monitoring study did not provide a discussion of uncertainty in the exposure estimates. It was assumed that uncertainty was addressed in Method 3500.
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Study Citation:	Burr, G. A., Wilcox, T. G., Klein, M. K., Weber, A. M. (1993). Health hazard evaluation report no. HETA 93-011-2309, Tri-county North School, Lewisburg, Ohio.		
HERO ID:	3970553		
Conditions of Use:	Unknown- School		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 1878249 Table: 1 of 1

Study Citation:	Burroughs, G. E. (1978). Health Hazard Evaluation Determination, Report No. HE 77-32-459, Conalco, Hannibal, Ohio.			
HERO ID:	1878249			
Conditions of Use:	Use of metal products			
EXTRACTION				
Parameter	Data			
Worker activity description:	employees working in the rolling mill area			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	no formaldehyde was detected in the mill area			
Engineering control:	NIOSH recommended that local exhaust ventilation should be supplied in the welding section of the maintenance department.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is approved by NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty
Overall Quality Determination		Medium		

Study Citation:	Burroughs, G. E., Thomasino, J. (1976). Health Hazard Evaluation Report No. 75-145-327, Formica Corporation, Cincinnati, Ohio.			
HERO ID:	1317290			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers count out varying numbers of these filler sheets, pile them on a second pallet, add a cover sheet printed in the graining room with some pattern, possibly add a layer of material to give a special effects then add a separator sheet and repeat the process for successive layers. When a load of material is assembled in this manner, it is placed in a press.			
Exposure route:	inhalation			
Physical form:	Vapor			
Personal sampling data:	Filter Treating 0.05-0.20 mg/m3Filler sorting 0.01-0.13 mg/m3Series B Collating 0.01-0.28 mg/m3Press Build-up 0.02-0.34 mg/m3[range above but discrete values provided in table 2]			
Area sampling data:	Resin Plant 0.06-0.61 mg/m3Filter Treating 0.04-0.09 mg/m3[range above but Discrete values provided in table 2]			
Dermal exposure data:	nan			
Number of workers:	350			
Personal protective equipment:	Gloves and coveralls			
Engineering control:	HVAC system			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	NIOSH study, therefore methodology was approved by NIOSH. The report does not reference any recent method numbers but may pre-date current methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (Formica manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1976 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Medium	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, exposure durations, and worker activities, but lacks additional metadata, such as sample durations and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.

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Formaldehyde

Occupational Exposure

HERO ID: 1317290 Table: 1 of 1

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Study Citation:	Burroughs, G. E., Thomasino, J. (1976). Health Hazard Evaluation Report No. 75-145-327, Formica Corporation, Cincinnati, Ohio.		
HERO ID:	1317290		
Conditions of Use:	Paper Manufacturing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Burton, N. C., Hall, R., Kinnes, G., Todd, W. (1993). Health hazard evaluation report No. HETA-92-090-2296, General Castings Toledo Street Facility, Delaware, Ohio. :92-090.
HERO ID:	1320875
Conditions of Use:	Use of Adhesives and Sealants

EXTRACTION	
Parameter	Data
Worker activity description:	The furnace operators spent the majority of their time in a climate-controlled control booth.For the metal pouring operation, two crane operators worked in open cabs. For some of the large molds, the pourer was required to climb a ladder to assist the crane operator with positioning the ladle before and while pouring. In the small core room, employees made oil-based cores which were baked in a gas-fired oven. In the large coremaking area, cores and molds were made of a phenolic-formaldehyde binder mixed with silica sand in an automatic mixer. Compressed air was used to remove excess sand in the coremaking and molding departments.The metal castings were shaken out of the molds while still hot (referred to as "shakeout") on second and third shifts. For certain castings, workers used compressed air to remove excess sand from internal cavities. Sledge hammers were also used to manually remove sand from the castings. Two Bobcat@ front-end loaders were used to load the sand reclamation system and shake out some of the castings. Brooms were used to clean up excess dry sand throughout the facility.
Exposure route:	Inhalation
Physical form:	vapor
Area sampling data:	There may be an issue with the presented data.The text claims: "The results for the five area air samples in the coremaking, molding, and pouring areas are given in Table 6. The results ranged from 0.012 to 0.026 ppm.Table 6.TWALarge Core making Department 1,170.026 ppmSmall Pouring Line 1,210.012 ppmSmall Molding Line 1,190.013 ppmLarge Molding Area 1,310.012 ppmSmall Pouring Line 1,260.021 ppm_____
Number of workers:	44 production workers on day shift, 3 on the afternoon shift and 8 on the night shift.
Personal protective equipment:	Safety shoes, hard hats, and safety glasses were required throughout the facility. NIOSH/Mine Safety And Health Administration (MSHA) approved half-mask respirators with dust/fume/mist cartridges were available upon request. Hearing protection devices (disposable plugs) were required in the shakeout area. Flame retardant clothing was worn by the pourers. Recommend organic vapor cartridge in conjunction with an air-purifying respirator with a high-efficiency particulate filter.
Engineering control:	General ventilation was supplied by propeller fans: two wall fans and two ceiling fans. At the time of the survey, the two ceiling fans over the large mold pouring area were in operation. Heat was provided by direct-fired gas space heaters. Additional general ventilation was supplied by open doors and windows during the warmer months.Recommended:- The shaker table should be enclosed with movable sides to enable ease of movement for large castings. The enclosure should be ventilated to help contain emissions.- The compressed air hoses should be eliminated and replaced with a central vacuum system. As an interim measure, the existing air lines should be regulated to reduce air to less than 30 pounds per square inch (psi) to lessen dust levels currently being generated.3- Make-up air system should be installed to supply fresh air and heat, therefore, replacing the existing direct-fired gas space heaters.- The molds should be poured on a conveyor that then enters an enclosed and ventilated tunnel. The tunnel could lead to a smokehouse where the molds can off-gas safely until ready for the shakeout operation.

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High NIOSH study - Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High US
	Metric 3:	Applicability	High The data are for an occupational scenario (foundry) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium 1992 - which is the same year the PEL was updated but more than 20 years old

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Study Citation:	Burton, N. C., Hall, R., Kinnes, G., Todd, W. (1993). Health hazard evaluation report No. HETA-92-090-2296, General Castings Toledo Street Facility, Delaware, Ohio. :92-090.			
HERO ID:	1320875			
Conditions of Use:	Use of Adhesives and Sealants			
Domain		Metric	EVALUATION	
			Rating	Comments
		Metric 5: Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH method 3500.Note the summary table does not agree with the text.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Low	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, and worker activities, butlacks additional metadata, such as exposure durations, and exposure frequency. In addition, the report lacks clarity due to discrepancy between appendix tables with discussion text.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between different locations/operations. Uncertainty was not discussed but assumed that it was addressed in NIOSH method 3500.
Overall Quality Determination			High	

Study Citation:	Burton, N. C., McCullough, J. (2002). Health hazard evaluation report 98-0237-2872 Mueller Company Chattanooga, Tennessee April 2002.			
HERO ID:	667639			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	The shell core employees load bags of resin-coated sand into a sand hopper which feeds sand into the machine. When the machine opens, an employee pulls out the core and sets it on a table, checks it for flaws, and applies a water-based graphite core wash. Two employees work with the Pepset process, a hand-controlled crane is used to move molds to an adjacent open pouring area. To produce the core nine employees are needed for the no-bake coremaking/molding process. An employee fills the box with pre-heated resin-coated sand at the beginning of the conveyor system. Another employee applies a white Zircon™ wash. The box is turned over and goes through an infrared (IR) heater. Two employees put Pepset cores into the bottom (drag), then add the top (cope) and close. Excess sand is removed using compressed air. Another employee lines up the molds to be poured.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Eight area air samples were collected for formaldehyde: The five formaldehyde samples concentrations collected in the Pepset and No-Bake areas ranged from 0.02 to 0.08 ppm. Three formaldehyde sample concentrations collected in the green sand and shell core areas ranged from 0.03 to 0.17 ppm.			
Exposure duration:	Assumed up to 10 hours per day and 40 hours per week.			
Number of workers:	475 production workers and 100 management staff			
Personal protective equipment:	Recommended that gloves should be worn.			
Engineering control:	Improve ventilation systems			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study Method 2016
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (coremaking/molding operations) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Sampling was implemented in 1999 which is after the 1992 PEL and more than 22 years ago
	Metric 5:	Sample Size	Medium	Actual data for each sampling event provided (Table 7). Range of values provided. Uncertainty with the sampling and analysis was not discussed.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, sample durations and exposure activities but lacks additional metadata, such as exposure durations, and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Actual results and range data were provided allowing for an analysis of variance, uncertainty was assumed considered in the NIOSH methodology.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 667639 Table: 1 of 1

...continued from previous page			
Study Citation:	Burton, N. C., McCullough, J. (2002). Health hazard evaluation report 98-0237-2872 Mueller Company Chattanooga, Tennessee April 2002.		
HERO ID:	667639		
Conditions of Use:	Use of Adhesives and Sealants		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Burton, N. C., Monestersky, J. (1996). Health hazard evaluation report 96–0135–2612 Eagle Knitting Mills, Inc. Shawano, Wisconsin December 1996.			
HERO ID:	1320760			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Worker activity description:	There are ten employees in the cutting department who use either automatic spreading machines or tables on which the fabric is hand-laid to match stripes, glued, and cut using a band saw or straight knives. The cut pieces are sorted into buckets and transported to the sewing area.The sewing department employs about 50 individuals, who work in teams to make the clothing. The completed garments are taken to the finishing department, which has ten employees. Four employees inspect the garments for things such as stitching, loose threads, matching stripes, spots, and stains. There are two spotting stations, used to remove stains from the garments, located adjacent to the sewing department. A heat press is used for fusible fabric. After inspection, the garments are folded and packed to ship to the customer.The maintenance department is staffed by two persons who do awide variety of activities including machine repair and maintaining the ventilation systems. (Page 11-12 of 32)			
Exposure route:	Inhalation and Dermal: When a garment manufacturing facility receives pre-cured, finished fabric from textile-finishing plants, these treated fabrics contain some residual formaldehyde and off-gassing may occur during the cutting and assembly process. Besides off-gassing of free formaldehyde from the already cured resin-treated fabric, there may be exposure to formaldehyde bound or adsorbed on particulates. Upper airway and pulmonary complaints may arise by the inhalation route, and skin complaints may develop from dermal exposure (Page 13 of 32)			
Physical form:	Vapor (Page 11 of 32)			
Personal sampling data:	See Table 1 on page 22 of 32 for results, also listed below. See page 15 of 32 for discussion. Sewer Trace (0.03 ppm)Sewer/Dodge City Trace (0.03 ppm)Supervisor/Cutting Room Trace (0.04 ppm)Sewer/Musical Chairs Trace (0.04 ppm)Bundler Trace (0.06 ppm)Inspector Trace (0.05 ppm)Sewer/Looney Tunes Trace (0.03 ppm)Cutter Trace (0.05 ppm)Sewer/Looney Tunes Trace (0.04 ppm)			
Area sampling data:	See Table 1 on page 22 of 32 for results, also listed below. See page 15 of 32 for discussion. Sewing - Adjacent to Cleaning Trace (0.04 ppm)For formaldehyde released from fabric See Table 2 on page 23 of 32 for results. See page 15 of 32 for discussion.			
Particle size characterization:	See Table 3 on page 24 of 32 for Formaldehyde content of inhalable particles, results also listed below:Sewer/Musical Chairs 0.17 mg/m3Sewer/Mash 0.1 mg/m3Sewer/Little Haiti 0.06 mg/m3Sewer/Looney Tunes 0.08 mg/m3Sewer 0.19 mg/m3			
Exposure duration:	At the time of the site visit, the facility was operating six days (53 hours) per week. (Page 10 of 32)			
Number of workers:	85 employees including management, all full-time (page 10 of 32)			
Personal protective equipment:	Some employees who work at the heat press use Johnson & Johnson Germ filter masks as protection from organic vapors and dust. (Page 11 of 32)			
Engineering control:	The company is housed in a single-story building and has nine ceiling exhaust fans which are used in the summer. (page 10 of 32)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study - Methods 2541 and 5700
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (Garment fabrication) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1996 - after the PEL (1992) but more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH methods 2541 and 5700.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1320760 Table: 1 of 1

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Study Citation:	Burton, N. C., Monestersky, J. (1996). Health hazard evaluation report 96–0135–2612 Eagle Knitting Mills, Inc. Shawano, Wisconsin December 1996.		
HERO ID:	1320760		
Conditions of Use:	Use of fabric, textile and leather products		
Domain	Metric	EVALUATION Rating	Comments
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in Methods 2541 and 5700.
Overall Quality Determination		High	

Study Citation:	Byliński, H., Gębicki, J., Namieśnik, J. (2019). Evaluation of Health Hazard Due to Emission of Volatile Organic Compounds from Various Processing Units of Wastewater Treatment Plant.			
HERO ID:	6110091			
Conditions of Use:	Disposal			
EXTRACTION				
Parameter	Data			
Worker activity description:	wastewater treatment plant workers			
Exposure route:	inhalation			
Area sampling data:	6 ug/m3			
Exposure duration:	(6 hours/day in this study			
Exposure frequency:	(350 days/year in this study)			
Comments:	Human Health Risk Assessment- (6 hours/day in this study), EF—exposurefrequency (350 days/year in this study)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Poland, an OECD country.
	Metric 3:	Applicability	High	Data are for WWTPs, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by collecting samples over multiple weeks/years at the same location.
Overall Quality Determination		High		

Study Citation:	C-A, Nilsson, Lindahl, R., Norstrom, A. (1987). Occupational exposure to chain saw exhausts in logging operations. American Industrial Hygiene Association Journal 48(2):99-105.			
HERO ID:	2948482			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers are in the logging and wood cutting industry: Felling, limbing, bucking and skidding.			
Exposure route:	inhalation			
Physical form:	vapor, dust			
Personal sampling data:	Table 1 provides exhaust emissions during a simulated run cycle: mean - 120 mg/m^3 with 16% SD. Table 2 provides exhaust composition at various fuel-air ratios for one make of chain saw: Lean - 200 mg/m^3; Fuel-air ratio normal - 120 mg/m^3; Rich - 110 mg/m^3. Table 3 provides exposure to chain saw exhaust during logging under snow-free conditions: TWA - 0.08 mg/m^3; Range - 0.04-0.2 mg/m^3. Table 4 provides exposure to chain saw exhaust during logging in the winter with snow on the ground: TWA - 0.08 mg/m^3; range - 0.02-0.1 mg/m^3. Table 5 is a comparison of exposure to chain saw exhaust for loggers engaged solely in felling and those performing ordinary logging (felling, Limbing, Bucking and manual skidding): Felling: TWA - 0.09; range - 0.07-0.1; Ordinary Logging: TWA - 0.07 mg/m^3; range - 0.03-0.09 mg/m^3.			
Exposure duration:	Exposure during working hours of logging divided into 3 periods during the day, each period ranging from 1.5 hr to 2.5 hr. Total working time varies between 6.5 to 7 hr. Exposure measured from time chain saw started until it is switched off. Chain saw operated 65-90% of the time during a work period.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for Sweden, an OECD country.
	Metric 3:	Applicability	High	Data is for occupational exposure using chainsaws in the wood cutting industry
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1987)
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at different mixes of fuel on chainsaws and sampling multiple days for different weeks of the year. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	California Office of Environmental Health Hazard Assessment (OEHHA) (2014). Appendix D: Individual acute, 8-hour, and chronic reference exposure level summaries.			
HERO ID:	5155603			
Conditions of Use:	Wood processing plant			
EXTRACTION				
Parameter	Data			
Worker activity description:	Wood processing plant employees.			
Exposure route:	inhalation			
Physical form:	gas/vapor			
Area sampling data:	Ambient formaldehyde measurements in these three composite wood processing plants between 1975 and 1983 gave a time-weighted average (TWA) of 0.1-1.1 mg/m3 (0.08-0.89 ppm) with peaks of up to 5 mg/m3 (4 ppm). 1975 study reported that estimated formaldehyde exposures of 0.25-1.39 ppm evoked numerous complaints of upper respiratory tract and eye irritation among seven embalmers at six different funeral homes. Exposure measurements taken from a group of West Virginia embalmers were used as exposure estimates for the embalming process, ranging from 0.3-0.9 ppm (average 1-hour exposure) and 0.4-2.1 ppm (peak 30-minute exposure). 1987 study reported dose-dependent increase in health complaints (eye and throat irritation, and headaches) in 2000 residents living in 397 mobile and 494 conventional homes. Complaints of symptoms of irritation were noted at concentrations of 0.1 ppm formaldehyde or above. dose-dependent increase in health complaints (eye and throat irritation, and headaches) in 2000 residents living in 397 mobile and 494 conventional homes. Complaints of symptoms of irritation were noted at concentrations of 0.1 ppm formaldehyde or above. Occupants of houses insulated with urea-formaldehyde foam insulation (UFFI) (1726 subjects) were compared with control subjects (720 subjects) for subjective measures of irritation, measures of pulmonary function (FVC, FEV1, FEF25-75, FEF50), nasal airway resistance, odor threshold for pyridine, nasal cytology, and hypersensitivity skin-patch testing (Broder et al., 1988). The mean length of time of exposure to UFFI was 4.6 years. The mean concentration of formaldehyde in the UFFI-exposed group was 0.043 ppm, compared with 0.035 ppm for the controls. 1989 study found FA levels in 34 wood workers exposed to FA had levels from 0.4 to 0.5 ppm. sub chronic epidemiological study of 38 anatomy class students who, on average, were exposed to a geometric mean of 0.70 ± 2.13 ppm formaldehyde for two hours per week over fourteen weeks. effects of formaldehyde exposure in plywood workers (93 exposed, 93 controls) exposed for 26.6 years, on average, to 1.13 ppm (range = 0.28 -3.48 ppm). Chemical plant workers (70 subjects) were exposed to a mean of 0.17 ppm (0.26 mg/m3) formaldehyde for an unspecified duration. irritant symptoms and pulmonary function of 47 carpentry workers exposed to a mean concentration of formaldehyde of 0.36 ppm (range = 0.04 -1.25 ppm) with 20 unexposed controls.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Report is from California office of environmental health so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is applicable to multiple COUs, primarily manufacturing, processing, and industrial uses.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Medium	Most data is characterized by statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Does not provide much information about sampling data and information is not formatted in a way that makes it readable/easily presentable
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Formaldehyde

Occupational Exposure

HERO ID: 5155603 Table: 1 of 1

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Study Citation:	California Office of Environmental Health Hazard Assessment (OEHHA) (2014). Appendix D: Individual acute, 8-hour, and chronic reference exposure level summaries.		
HERO ID:	5155603		
Conditions of Use:	Wood processing plant		
Domain		EVALUATION	
Metric		Rating	Comments
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Addresses variability by providing multiple studies that monitored FA levels. Does not address uncertainty.
Overall Quality Determination		Medium	

Study Citation:	Canham, M., Kullman, G., Knutti, E. (1996). Health hazard evaluation report 94–0293–2559 Fanelli Boys and Associates Parkersburg, West Virginia February 1996.			
HERO ID:	1620769			
Conditions of Use:	Other Byproduct			
EXTRACTION				
Parameter	Data			
Worker activity description:	office supply recycling			
Exposure route:	inhalation			
Physical form:	gas			
Area sampling data:	On two separate occasions, short-term indicator tube samples for formaldehyde indicated that 0.4 ppm and 0.5 ppm of formaldehyde were generated in the workers breathing zone during the use of the electric hot wire to burn into a toner cartridge.			
Particle size characterization:	not related to formaldehyde			
Personal protective equipment:	Latex gloves were worn during cleaning, but respiratory protection was not worn.			
Engineering control:	Two local exhaust ventilation systems were operated to control dust exposures in the work bench area.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology was approved by NIOSH, report uses direct reading indicator tubes and colorimetric sample analysis
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The data was collected after the most recent PEL but more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability. Uncertainty is assumed to be addressed in sampling/analytical approach.
Overall Quality Determination		Medium		

Study Citation:	Carton, B. (1995). COLCHIC chemical exposure database: information on lead and formaldehyde. Applied Occupational and Environmental Hygiene 10(4):345-350.			
HERO ID:	6029272			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	”Cast iron foundry, Wood fittings manufacture, Various manufacturing, Nonferrous metals foundry, Manufacture of wood-based panels, Felt manufacture, Buttons manufacture, Packaging manufacture, Foundry: croning molding, Sand preparation, hot box (foundry), Glass, fiber, and plastics molding (composites), Chipboard pasting, Pasting, Plastic materials forming, Agglomeration press, Chemical on biological laboratory, Framework manufacture, wood working, Felt manufacture, Furniture fabrication, Buttons manufacture, Packaging manufacture, Wood sheet and plaster manufacture, Medical analysis laboratories, Tailoring in general, Building industry in general, Wood industry (6/7)”			
Exposure route:	inhalation (5/7)			
Area sampling data:	”Cast iron foundry: 0.290 ug/m3 Wood fittings manufacture: 0.165 ug/m3 Various manufacturing: 0.340 ug/m3 Nonferrous metals foundry: 0.295 ug/m3 Manufacture of wood-based panels: 0.300 ug/m3 Felt manufacture: 0.510 ug/m3 Buttons manufacture: 1.110 ug/m3 Packaging manufacture: 1.930 ug/m3 Foundry: croning molding: 0.290 ug/m3 Sand preparation, hot box (foundry): 0.150 ug/m3 Glass, fiber, and plastics molding (composites): 0.345 ug/m3 Chipboard pasting: 0.170 ug/m3 Pasting: 0.270 ug/m3 Plastic materials forming: 0.230 ug/m3 Agglomeration press: 0.640 ug/m3 Chemical on biological laboratory: 2.240 ug/m3 Framework manufacture: 0.710 ug/m3 Felt manufacture: 0.855 ug/m3 Furniture fabrication: 0.630 ug/m3 Buttons manufacture: 1.320 ug/m3 Packaging manufacture: 1.830 ug/m3 Wood sheet and plaster manufacture: 1.072 ug/m3 Medical analysis laboratories: 1.650 ug/m3 Tailoring in general: 1.250 ug/m3 Building industry in general: 1.205 ug/m3 Wood industry: 0.930 ug/m3 (6/7)”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	High	Data are from numerous different industries and situations, all of which are in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (medians, p-values, number of samples) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at over 2000 factories.
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Formaldehyde

Occupational Exposure

HERO ID: 6029272 Table: 1 of 1

...continued from previous page			
Study Citation:	Carton, B. (1995). COLCHIC chemical exposure database: information on lead and formaldehyde. Applied Occupational and Environmental Hygiene 10(4):345-350.		
HERO ID:	6029272		
Conditions of Use:	Processing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Carvalho, de, A. B., Kato, M., Rezende, M. M., Pereira, d.P., P. A., Andrade, de, J. B. (2013). Exposure to carbonyl compounds in charcoal production plants in Bahia, Brazil. Environmental Science and Pollution Research 20(3):1565-1573.			
HERO ID:	1454536			
Conditions of Use:	Combustion Byproduct			
EXTRACTION				
Parameter	Data			
Worker activity description:	Manually loading wood and removing charcoal from the kilns.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Facility 1- Day 1: 66.2 ug/m3 TWA (range 12.3-139.1 ug/m3); Day 2: 35.1 ug/m3 TWA (range 15.0-65.0 ug/m3). Facility 2 - 23.8 ug/m3 TWA SD 2.1 (range 22.3-26.2 ug/m3 TWA)			
Area sampling data:	Facility 1- Day 1: 59.8 ug/m3 TWA (range 27.4-159.5 ug/m3); Day 2: 63.1 ug/m3 TWA (range 23.6-104.8 ug/m3). Facility 2 - range >61->105 ug/m3; breakthrough 915-831 ug/m3			
Personal protective equipment:	The presence of particulate matter and higher temperatures around these kilns hinder the use and management of adequate respiratory protective devices.			
Comments:	21 personal and stationary air samples were collected			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified, though it was noted that samples were collected using Sep-Pak C18 cartridges coated with a 0.2 % acidic solution of 2,4-dinitrophenylhydrazine. The quantification of the resulting 2,4-dinitrophenylhydrazone derivatives was conducted using a high-performance liquid chromatography system with UV detection.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Brazil - not an OECD member
	Metric 3:	Applicability	Medium	The data are for charcoal production, which is an occupational scenario within the scope of the risk evaluation - but the processes used in rural Brazil may not be similar to the industry in the US.
	Metric 4:	Temporal Representativeness	High	The data were published in 2012, after the most recent PEL (1992) and less than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by TWA and range data for different days for different plants for area and personal sampling.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include critical metadata, such as sample type, exposure type, sample durations, exposure durations, and worker activities.
Domain 4: Variability and Uncertainty				
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Formaldehyde

Occupational Exposure

HERO ID: 1454536 Table: 1 of 1

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Study Citation:		Carvalho, de, A. B., Kato, M., Rezende, M. M., Pereira, d.P., P. A., Andrade, de, J. B. (2013). Exposure to carbonyl compounds in charcoal production plants in Bahia, Brazil. Environmental Science and Pollution Research 20(3):1565-1573.		
HERO ID:		1454536		
Conditions of Use:		Combustion Byproduct		
		EVALUATION		
Domain	Metric		Rating	Comments
	Metric 7:	Metadata Completeness	Medium	The study provided range and standard deviation data for two different plants for different days that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Study Citation:	Cavalcante, R.M., Campelo, C.S., Barbosa, M.J., Silveira, E.R., Carvalho, T.V., Nascimento, R.F. (2006). Determination of carbonyl compounds in air and cancer risk assessment in an academic institute in Fortaleza, Brazil. Atmospheric Environment 40(29):5701-5711.			
HERO ID:	2442874			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Technicians, researchers, employees, teachers, students working in research laboratories, libraries, offices, student laboratories, and classrooms.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Concentrations of formaldehyde at the campus were between 0.9 and 5.1 ug/m3 with an average value of 2.8 ug/m3. Formaldehyde levels were lower than those reported in urban zones, but higher than in rural zones and near highways. Formaldehyde concentrations (ug/m3) in indoor air and indoor: outdoor (I/O) ratio at different locations were as follows: research laboratories – average – 13.46, I/O – 4.86, range – 0.32-81.6; libraries – average – 7.84, I/O – 2.83, range – 6.94-8.36; offices – average – 11.82, I/O – 4.26, range – 4.46-18.37; student laboratories – average – 23.20, I/O – 8.37, range – 3.78-60.75; classrooms – average – 6.22, I/O – 2.24, range – 4.63-8.87.			
Exposure duration:	Average in Brazil 8 hr/day			
Exposure frequency:	Average in Brazil: 5 days/week, 251 days/year			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved method or is well described and found to be equivalent to approved methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	non-OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Contains all associated metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Has discussions on variabilities and uncertainties.
Overall Quality Determination		High		

Study Citation:	Cavalcante, R.M., Seyffert, B.H., D’Oca, M.G., Nascimento, R.F., Campelo, C.S., Pinto, I.S., Anjos, F.B., Costa, A.H. (2005). Exposure assessment for formaldehyde and acetaldehyde in the workplace. Indoor and Built Environment 14(2):165-172.			
HERO ID:	2442974			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	8 work places at a university in Brazil			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	The personal exposure, expressed as the potential dose in indoor air, was calculated to range from 129.8 to 930.4 ug/day (low exposure) and 183.9 to 1318.1 ug/day (medium exposure) for formaldehyde.			
Area sampling data:	Levels of formaldehyde measured ranged from 22.5 to 161.5 ug/m3.			
Exposure duration:	8 hrs			
Exposure frequency:	251 days/yr			
Number of workers:	People in office room - 2, classroom - 40, research lab - 5, class practical lab - 40, central library - 10, and print room - 2			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-oecd country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The data is between 10 and 20 yrs old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability and uncertainty are addressed by sampling multiple locations
Overall Quality Determination		Medium		

Study Citation:	CDC (1986). Epidemiologic notes and reports occupational exposures to formaldehyde in dialysis units. MMWR. Morbidity and Mortality Weekly Report 35(24):399-401.			
HERO ID:	1986656			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Reprocessing dialyzers			
Personal sampling data:	0.5-0.57 (ppm)			
Area sampling data:	0.9-1.6 (ppm)			
Personal protective equipment:	Protective equipment should include rubber gloves, protective aprons, and eye and face protection.			
Engineering control:	Hoses connecting free-standing modular components of hemodialysis systems to drain lines should be air tight to prevent formaldehyde vapors from escaping into treatment rooms.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Report is more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing at multiple facilities but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	CDC, (1983). Formaldehyde exposures in a gross anatomy laboratory–Colorado. MMWR. Morbidity and Mortality Weekly Report 31(52):698-700.			
HERO ID:	6230077			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Medical and dental students dissecting cadavers.			
Exposure route:	inhalation			
Area sampling data:	Results of the environmental sampling showed formaldehyde levels ranging from less than 0.02 ppm to 2.7 ppm.			
Number of workers:	25			
Personal protective equipment:	Persons handling formalin or preparing dilute formalin solutions should wear protective equipment, including rubber gloves, protective aprons, and eye and face protection.			
Engineering control:	Ventilation should provide a minimum of five air changes per hour to help lower formaldehyde concentrations.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Ceballos, D., Boradwater, K. (2015). Evaluation of occupational exposures at a drycleaning shop using SolvonK4.			
HERO ID:	8684521			
Conditions of Use:	Dry cleaning solvent			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers at a dry-cleaning shop using SolvonK4. (5/22)			
Exposure route:	inhalation (10/22)			
Physical form:	solvent vapors (10/22)			
Personal sampling data:	Formaldehyde was not detected in full-shift personal air samples or area samples, and the LOD was 0.007-0.01 ppm. (10/22)			
Area sampling data:	Formaldehyde was not detected in full-shift personal air samples or area samples, and the LOD was 0.007-0.01 ppm. (10/22)			
Exposure duration:	The business operated 7 a.m. to 7 p.m. Monday through Saturday, but dry-cleaning activities usually started earlier, depending on the forecasted temperature and anticipated workload. The pressers worked from 6 a.m. until they completed pressing for the day. Each presser worked at one of the six pressing stations for the entire shift. The tailors worked from 12 p.m. to approximately 6 p.m. (7/22)			
Number of workers:	The shop was staffed by 10 full-time employees and two owners. (7/22)			
Personal protective equipment:	According to the safety data sheet (SDS) for SolvonK4, employees should wear eye protection and polyvinyl chloride or polyethylene gloves when spraying this product. For loading and unloading clothes, the operator wore a latex-free Kimberly-Clark Tecnol Procedure mask that was reused throughout the day. During the day the operator hung the mask on the dry-cleaning machine between loading and unloading tasks. The owner explained that the mask was worn for protection from dust released when unloading clothes. (12/22)			
Engineering control:	Recommendations for engineering controls are to install an emergency eyewash station and to brush the pre-spotting mixture onto the fabric instead of spraying it. (13/22)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved OSHA method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Uninformative	Data are for dry-cleaning solvents, which isn't included in the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling multiple locations and different job operations.
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Formaldehyde

Occupational Exposure

HERO ID: 8684521 Table: 1 of 1

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Study Citation:	Ceballos, D., Boradwater, K. (2015). Evaluation of occupational exposures at a drycleaning shop using SolvonK4.
HERO ID:	8684521
Conditions of Use:	Dry cleaning solvent

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		Uninformative	

Study Citation:	Ceballos, D., Burr, G. A. (2011). Evaluating a persistent nuisance odor in an office building– maryland.			
HERO ID:	8684527			
Conditions of Use:	Adhesives and sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office workers			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	In office: 0.02 (ppm)In adjacent businesses: 0.03 (ppm)			
Exposure duration:	1.5-9 hours per day with an average of 4.2 hours per day.			
Exposure frequency:	2-5 days per week with an average of 4 days per week.			
Number of workers:	Eight employees work out of the office.			
Engineering control:	An HVAC system was used in the office. NIOSH recommended to set the HVAC to run in continuous mode and to ensure that the bathroom and locker room ventilation runs under negative pressure.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The monitoring data were collected after the most recentPEL establishment or update but are generally more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty can be determined from the sampling and analytical method. The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site.
Overall Quality Determination		High		

Study Citation:	Ceballos, D., Roberts, J., Whittaker, S., Lee, E. G., Gong, W. (2015). Evaluation of occupational exposures at drycleaning shops using SolvonK4 and DF 2000.
HERO ID:	8684520
Conditions of Use:	Laundry and dishwashing products

EXTRACTION	
Parameter	Data
Worker activity description:	Pressing fabrics and loading/unloading fabrics from drycleaning machine; pressing shirts; cleaning still.
Exposure route:	Dermal and inhalation.
Physical form:	Liquid. Mist during spray for spot cleaning.
Personal sampling data:	Pressing fabrics and unloading and loading fabrics from drycleaning machine: Day 1 - nondetect; Day 2 - 0.0087+ (ppm) (pg.14) For these samples, the minimum detectable concentration (MDC) was 0.008 ppm of formaldehyde+This concentration was above the MDC but below the minimum quantifiable concentration (MQC). This means that there is more uncertainty associated with this value.
Area sampling data:	Work shift area samplesFront desk: Day 1 - 0.0084+ (ppm); Day 2 - not detectedNext to press machine: Day 1 - not detected; Day 2 - 0.012+ (ppm)Next to drycleaning machine: not detected+This concentration was above the MDC but below the MQC. This means that there is more uncertainty associated with this value.*For these samples, the MDC was 0.008 ppm of formaldehydeShort-term area samples1st unloading, 2nd loading: not detected2nd unloading 3rd loading: not detected3rd unloading, 4th loading: not detectedCleaning still: not detectedLoading, wash cycle, and unloading: 0.043+ (ppm)+This concentration was above the MDC but below the MQC. This means that there is more uncertainty associated with this value*For these air samples, the MDC was in the range of 0.04 to 0.2 ppm of formaldehyde.
Dermal exposure data:	Dermal exposure data
Exposure duration:	12 hours/day
Exposure frequency:	The shop was in operation 6 days/week.
Number of workers:	Two full-time employees and an owner/operator.
Personal protective equipment:	NIOSH recommends to wear gloves and eye protection and to wear a long-sleeve shirt and PVC or polyethylene gloves when using spot cleaners. NIOSH recommends the use of chemical protective gloves and eye protection when cleaning the still bottoms, specifically neoprene or butyl rubber gloves.
Engineering control:	NIOSH recommends installing an eye wash station, using a brush to apply prespotting mix onto fabrics rather than a spray bottle, and improving the mechanical ventilation system used at the building.
Comments:	Dermal sampling performed for Solvon4K measured presence of butylal not specifically formaldehyde but both are contained within the formulation.

		EVALUATION		
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity				

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Study Citation:	Ceballos, D., Roberts, J., Whittaker, S., Lee, E. G., Gong, W. (2015). Evaluation of occupational exposures at drycleaning shops using SolvonK4 and DF 2000.			
HERO ID:	8684520			
Conditions of Use:	Laundry and dishwashing products			
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by taking personal and area samples during multiple worker activities.
Overall Quality Determination			High	

Study Citation:	Ceballos, D.M., Burr, G.A. (2012). Evaluating a persistent nuisance odor in an office building. Journal of Occupational and Environmental Hygiene 9(1):D1-D6.			
HERO ID:	1938017			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	office workers & workers in businesses			
Exposure route:	inhalation			
Area sampling data:	Formaldehyde concentrations inside the office remained consistent over the 2 days of this evaluation at 0.020 ppm, while the concentration outside the office was estimated at 0.00019 ppm. The indoor formaldehyde concentrations in the two nearby businesses had a range of 0.020–0.030 ppm.			
Number of workers:	8			
Engineering control:	HVAC system			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	Low	Article does not specify the type of operations for the businesses and office worker exposure is generally not occupational exposure.	
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Ceballos, D.M., Whittaker, S.G., Lee, E., Roberts, J., Streicher, R., Nourian, F., Gong, W., Broadwater, K. (2016). Occupational exposures to new dry cleaning solvents: High-flashpoint hydrocarbons and butylal. Journal of Occupational and Environmental Hygiene 13(10):759-769.			
HERO ID:	3421340			
Conditions of Use:	Use of laundry and dishwashing products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Loading and unloading of dry cleaning machines and operating equipment for pressed dry cleaned fabrics.			
Exposure route:	inhalation, dermal			
Physical form:	gas			
Personal sampling data:	One sample found conc. of FA at 0.0087 pm all other personal samples were ND			
Area sampling data:	All area samples are below the LOD (0.008 ppm)			
Exposure duration:	Full shift (8-10 hr/day)			
Personal protective equipment:	When operating DF-2000 machine and cleaning: surgical mask, prescription glasses (not safety glasses or splash goggles), and nitrile gloves.			
Engineering control:	Ventilation systems used in two different shops: Natural ventilation (HVAC not operation) and one have Natural and HVAC.			
Comments:	Formaldehyde samples measured using OSHA Method 52. Sample times are provided for each sample in Tables 3, 5, and 7.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Report is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to commercial use of solvents containing FA in dry cleaning.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2016).
	Metric 5:	Sample Size	High	Provides individual sample data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Provides worker activity, process description, engineering controls, PPE, exposure duration/frequency, sampling duration, personal and area sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Addresses variability by looking at different locations in dry cleaning shops and doing both area and personal sampling. Addresses uncertainty in providing sampling method and LOD and LOQ.
Overall Quality Determination			High	

Study Citation: Celanese Chem Co Inc, (1983). Industrial hygiene monitoring data summary-rock hill terminal.
HERO ID: 5914740
Conditions of Use: Exposure in terminal

EXTRACTION

Parameter	Data
Worker activity description:	M.O. operators or loaders employed at Rock Hill Terminal of Celanese Chemical Co. Inc.
Exposure route:	inhalation
Physical form:	gaseous
Personal sampling data:	In general, the individual short-term samples indicate that an exposure problem does not exist for either the M.O. operator or the loaders. It does appear that short term problems can exist during filter cleaning. Many of the high short term levels were associated with the collection and analysis of samples. The 0.68 ppm geometric mean indicates that 50% of the time (shifts) the formaldehyde exposure levels of the M. O. operator were less than 0.68 ppm. The 1.19 ppm tolerance level means that 90% of the time the formaldehyde exposure levels of the M.O. operator was less than 1.19 ppm. These levels indicate that formaldehyde exposure is considerably below the OSHA values and in compliance with the Celanese internal exposure levels. The exposure levels of the loaders appear to be well below 1 ppm.
Personal protective equipment:	Appropriate respirators should be worn during the filter cleaning process and during major upset conditions.
Comments:	Tables I and II are not included with the text. These are the table that have the actual formaldehyde data.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data
	Metric 3: Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	data greater than 20 years old
	Metric 5: Sample Size	Uninformative	The data is not provided in this document
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination

Uninformative

Study Citation:	Celanese Corp, (2022). Comment submitted by Celanese Corporation regarding characterization of occupational exposures during formaldehyde manu- facturing, use as an intermediate, and compounding of formaldehyde-based polymers.			
HERO ID:	10385727			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	Paraformaldehyde Operator: Formaldehyde conversion to paraformaldehyde.Paraformaldehyde Warehouse: Loading, storing, and shipping bags and supersacks of paraformaldehyde.Trioxane operator: Works in a unit that uses formaldehyde to manufacture trioxane and dioxolane.Solution Hydrolysis Operator: Works in a unit that polymerizes trioxane, dioxolane and other inputs into an acetal copolymer branded as Celcon® and Hostaform® POM.Natural Finishing/Advanced Products Operator: Works in unit that compounds various grades of Celcon® and Hostaform® POM.Special Products Operator: Works in unit that compounds specialty grades of Celcon® and Hostaform® POM.ONUsUltra-high molecular weight polyethylene operator: Works in a manufacturing unit producing ultra-high molecular weight polyethylene.Maintenance: Performs site-wide maintenance on as needed basis.Boiler House Operator: Generates and distributes steam, boiler feed water, nitrogen, service water, demineralized water, air, methane, electricity and potable water. Considered as part of the utilities group. WWTP Operator: Manages treatment of site-wide wastewater, including wastewater from the formaldehyde-related units.Administrative: Primarily administrative duties. Work in buildings congruent with or physically separated from manufacturing units. Limited to intermittent entry into formaldehyde manufacturing and use areas. Includes industrial hygienists, environmental and safety personnel who are not directly involved in manufacturing or downstream processing. [PDF Pg. 14]			
Exposure route:	Inhalation and Dermal.			
Personal sampling data:	Formaldehyde as a chemical intermediate [PDF Pg. 13]Mean; 0.054 (ppm)Max: 0.47 (ppm)POM Compounding [PDF Pg. 13]Mean: 0.094 (ppm)Max: 0.34 (ppm)**Individual sample results from IH monitoring are give on PDF Pg. 21-24**			
Exposure duration:	Three 12-hour shifts and one 8-hour shift. [PDF Pg. 5]			
Exposure frequency:	The plant operates 7 days/week. [PDF Pg. 5]			
Number of workers:	55 workers are involved in POM compounding. [PDF Pg. 7]			
Personal protective equipment:	Full-face respirators, manufactured by Scott, with combination organic vapor cartridges for filtering out organic vapors and particulates. [PDF Pg. 4]			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for processing as a reactant, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data are no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
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Formaldehyde

Occupational Exposure

HERO ID: 10385727 Table: 1 of 2

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Study Citation:	Celanese Corp, (2022). Comment submitted by Celanese Corporation regarding characterization of occupational exposures during formaldehyde manufacturing, use as an intermediate, and compounding of formaldehyde-based polymers.		
HERO ID:	10385727		
Conditions of Use:	Processing as a reactant		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 10385727 Table: 2 of 2

Study Citation:	Celanese Corp, (2022). Comment submitted by Celanese Corporation regarding characterization of occupational exposures during formaldehyde manu- facturing, use as an intermediate, and compounding of formaldehyde-based polymers.			
HERO ID:	10385727			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Methanol Oxidation operator: Works in unit converting methanol to formaldehyde; i.e., the formaldehyde manufacturing units.Laboratory workers: Sample analysis to ensure product specifications and operating conditions within defined limits.[PDF Pg. 14]			
Exposure route:	Inhalation and Dermal.			
Personal sampling data:	Mean concentration for manufacturing: 0.054 (ppm) [PDF Pg. 13]Maximum concentration: 0.27 (ppm)**Detailed IH monitoring results are available on PDF Pg. 21-24**			
Exposure duration:	Three 12-hour shifts and one 8-hour shift. [PDF Pg. 5]			
Exposure frequency:	The plant operates 7 days/week. [PDF Pg. 5]			
Number of workers:	145 employees total, 90 involved directly with formaldehyde manufacturing. [PDF Pg. 4]130 ONUs are employed at the facility. [PDF Pg. 7]			
Personal protective equipment:	Full-face respirators, manufactured by Scott, with combination organic vapor cartridges for filtering out organic vapors and particulates. [PDF Pg. 4]Long pants, long sleeve shirts, and gloves. [PDF Pg. 9]			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data are no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data pro- vided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not ad- dressed.
Overall Quality Determination		High		

Study Citation:	Celis, R.D., Feria-Velasco, A., Bravo-Cuellar, A., Hicks-Gómez, J.J., García-Iglesias, T., Preciado-Martínez, V., Muñoz-Islas, L., González-Unzaga, M. (2008). Expression of NK cells activation receptors after occupational exposure to toxics: a preliminary study. Immunology Letters 118(2):125-131.			
HERO ID:	1022725			
Conditions of Use:	Unknown			
EXTRACTION				
Parameter	Data			
Area sampling data:	100-120 (ppm)			
Exposure duration:	8			
Exposure frequency:	Monday to Saturday of every week			
Comments:	Monitoring was conducted at a "chemical reagents factory" The type of factory is not stated.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	analytical method is a NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Mexico, an OECD country.
	Metric 3:	Applicability	Low	The COU is uncertain
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2008)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	The only meta data is sample type.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low		

Study Citation:	Chan, Y.,unJ, Yuan, T.,zuH, Sun, H.,uiChu, Lin, T.,aC (2016). Characterization and Exposure Assessment of Odor Emissions from Laser Cutting of Plastics in the Optical Film Industry. Aerosol and Air Quality Research 16(9):2216-2226.			
HERO ID:	5970859			
Conditions of Use:	Commercial Use as chemical substances in plastic products (Optical film industry)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Laser cutter operator, material worker, product inspector.			
Exposure route:	inhalation			
Physical form:	vapor, gas			
Personal sampling data:	No PPE: 2.74 mg/m^3; N95 valved active carbon respirator: 0.07 mg/m^3; Other masks: 1.88 to 2.2 mg/m^3. Figure 7 provides carbonyl concentrations at different working distance for different type of workers ranging from 0.17 to 9.22 mg/m^3. FA is the 2nd largest composition.			
Area sampling data:	Figure 4 provides total carbonyl concentrations of PC and PET at different laser powers, PC: 80 W - 3.25 mg/m^3; 160 W - 5.12 mg/m^3; 240 W - 8.08 mg/m^3; PET: 80 W - 6.81 mg/m^3; 160 W - 13.82 mg/m^3; 240 W - 20.53 mg/m^3. FA takes up the 2nd largest composition of the carbonyl concentrations. Figure 12 provides total carbonyl concentrations at different ventilation conditions during laser cutting at 6.95 mg/m^3 no ventilation and 0.09 mg/m^3 ventilation during G-phase; 2.29 mg/m^3 at no ventilation and ND with ventilation in P-phase. FA is the 2nd largest composition.			
Engineering control:	Local ventilation could remove as much as 99% of FA			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is from Taiwan, a non-OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation - commercial use in plastic products.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2016)
	Metric 5:	Sample Size	Medium	Range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes worker activity, exposure route, physical form, personal and area sampling, effect of engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at two different operations for the ventilation assessment as well as testing with different face masks/covering to determine FA exposure. Does not address uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 3073168 Table: 1 of 1

Study Citation:	Chang, C.J., Yang, H., Wang, Y., Li, M. (2015). Prevalence of Sick Building Syndrome-Related Symptoms among Hospital Workers in Confined and Open Working Spaces. Aerosol and Air Quality Research 15(6):2378-2384.			
HERO ID:	3073168			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Hospital/health care workers			
Exposure route:	inhalation			
Physical form:	vapor/gas			
Area sampling data:	Formaldehyde air conc. of 1.30 ppb in both open and confined work areas.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is for Taiwan, a non-OECD country.
	Metric 3:	Applicability	Low	Data does not specify any specific COUs but could be applied to any used in the health-care space.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2015)
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Contains worker activity, physical form and exposure route.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Checkoway, H., Lees, P.S., Dell, L.D., Gentry, P.R., Mundt, K.A. (2019). Peak exposures in epidemiologic studies and cancer risks: considerations for regulatory risk assessment. Risk Analysis 39(7):1441-1464.			
HERO ID:	5372911			
Conditions of Use:	Garment industry			
EXTRACTION				
Parameter	Data			
Area sampling data:	Geometric mean concentration of 0.15 ppm measured from the 1980s. Average concentrations of formaldehyde at eight garment factories in 1966 (range of average concentrations 0.3– 2.7 ppm). Concentrations in cutting rooms reported to be as high as 10 ppm in 1968, and subsequently reduced to 2 ppm in 1973.			
Comments:	Not primary source of data			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are mostly from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5372911 Table: 2 of 3

Study Citation:	Checkoway, H., Lees, P.S., Dell, L.D., Gentry, P.R., Mundt, K.A. (2019). Peak exposures in epidemiologic studies and cancer risks: considerations for regulatory risk assessment. Risk Analysis 39(7):1441-1464.			
HERO ID:	5372911			
Conditions of Use:	Formaldehyde users and producers			
EXTRACTION				
Parameter	Data			
Area sampling data:	See Table 2. Includes distribution of workers with exposure 0 to >4 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	Monitoring data include sample type (e.g., personal breathing zone) but unclear if data is assumed and not measured.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Uninformative		

Study Citation: Checkoway, H., Lees, P.S., Dell, L.D., Gentry, P.R., Mundt, K.A. (2019). Peak exposures in epidemiologic studies and cancer risks: considerations for regulatory risk assessment. Risk Analysis 39(7):1441-1464.
HERO ID: 5372911
Conditions of Use: Funeral industry

EXTRACTION

Parameter	Data
Area sampling data:	See Table 2. Includes distribution of workers with exposure 0-9.3 ppm.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Monitoring data include sample type (e.g., personal breathing zone) but its unclear if these are assumed exposure concentrations or measured.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.

Overall Quality Determination **Uninformative**

Formaldehyde

Occupational Exposure

HERO ID: 5952378 Table: 1 of 1

Study Citation:	Chen, W., Mendell, M., Li, N., Kumagai, K. (2018). Formaldehyde emissions from seams and cut edges of laminate flooring: Implications for emission testing protocols and exposure estimation. Building and Environment 143:652-660.			
HERO ID:	5952378			
Conditions of Use:	Commercial Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	gas			
Area sampling data:	Two graphs are provided with air concentrations of flooring with low-emitting and high-emitting cores. The low-emitting flooring has concentrations from 0-12 ug/m3. The high-emitting flooring has concentrations of 0-150 ug/m3.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the commercial use of floor coverings, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviations, ranges, and graphs) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling two types of flooring with different edges and cores.
Overall Quality Determination		High		

Study Citation:	Chen, X., Li, F., Liu, C., Yang, J., Zhang, J., Peng, C. (2017). Monitoring, human health risk assessment and optimized management for typical pollutants in indoor air from random families of university staff, Wuhan City, China.		
HERO ID:	4170930		
Conditions of Use:	Home exposure - consumer use		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor, gas		
Area sampling data:	Table 9 provides formaldehyde concentrations inside the pieces of furniture: for rooms in households and office spaces: 0.28, 0.21, 0.12, 0.47, 0.33, 0.13, 0.22, 0.02, 0.13, and 0.22; Top lockers - 2.6, 0.66, bottom lockers - 1.37, 0.59, central lockers - 0.98, 0.59; Computer table drawers - 0.18; Bookcases - 0.26, 0.32, 0.32; wardrobes - 0.9, bedside cabinets - 1.18; big closets - 0.37; shoeboxes - 0.29; TV cabinets - 0.15; cupboards - 0.16; drawers - 0.31; large cabinets - 0.29; Computer desk cabinets - 0.15; computer desk lower cabinets - 0.44; drawers below windowsills - 0.11; windows under cabinets - 0.06; large wardrobe drawers - 0.29; study drawers - 0.31; study wardrobes - 0.29		
Exposure duration:	daily exposure time:6.38(female workers); 6.57(male workers)		
Number of workers:	31		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium Methodology is described (PGM-6208 Portable Formaldehyde Analyzer), but there is limited description of workplaces sampled and not an approved OSHA or NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low Data is for China, a non-OECD country.
	Metric 3:	Applicability	Low Data is primarily for indoor residential homes but some of the sampling locations may be applicable for occupational exposure.
	Metric 4:	Temporal Representativeness	High Data is less than 10 years old.
	Metric 5:	Sample Size	Low Range of data but no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium Characterized by sampling location, physical form, exposure route.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium Addresses variability by its sampling locations. Does not address uncertainty.
Overall Quality Determination		Low	

Study Citation:	Chen, X., Li, F., Liu, C., Yang, J., Zhang, J., Peng, C. (2017). Monitoring, human health risk assessment and optimized management for typical pollutants in indoor air from random families of university staff, Wuhan City, China.			
HERO ID:	4170930			
Conditions of Use:	Commercial Use- Office			
EXTRACTION				
Parameter	Data			
Worker activity description:	University; 24 classrooms and 16 offices or duty rooms.			
Exposure route:	inhalation			
Physical form:	vapor, gas			
Area sampling data:	Workplace: 0.03 mg-m-3			
Exposure duration:	daily exposure time:6.38(female workers); 6.57(male workers)			
Number of workers:	31			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Methodology is described (PGM-6208 Portable Formaldehyde Analyzer), but there is limited description of workplaces sampled and not an approved OSHA or NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is for China, a non-OECD country.
	Metric 3:	Applicability	High	Data is primarily for exposure in offices, which may be related to use of building products, furnishings, which is within scope.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5:	Sample Size	Low	Range of data but no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Characterized by sampling location, physical form, exposure route. Source of formaldehyde is not clear
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by its sampling locations. Does not address uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 4170930 Table: 3 of 3

Study Citation:	Chen, X., Li, F., Liu, C., Yang, J., Zhang, J., Peng, C. (2017). Monitoring, human health risk assessment and optimized management for typical pollutants in indoor air from random families of university staff, Wuhan City, China.			
HERO ID:	4170930			
Conditions of Use:	Home exposure - consumer use			
EXTRACTION				
Parameter	Data			
Worker activity description:	University; 24 classrooms and 16 offices or duty rooms.			
Exposure route:	inhalation			
Physical form:	vapor, gas			
Area sampling data:	TABLE 2 (p.5) for bedroom, living room, and kitchen			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Methodology is described (PGM-6208 Portable Formaldehyde Analyzer), but there is limited description of workplaces sampled and not an approved OSHA or NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is for China, a non-OECD country.
	Metric 3:	Applicability	Uninformative	Data is for indoor air in homes, which would be covered by consumer exposure.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5:	Sample Size	Low	Range of data but no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Characterized by sampling location, physical form, exposure route. Source of formaldehyde is not clear
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by its sampling locations. Does not address uncertainty.
Overall Quality Determination		Uninformative		

Study Citation:	Cheng, J.H., Lee, Y.S., Chen, K.S. (2016). Carbonyl compounds in dining areas, kitchens and exhaust streams in restaurants with varying cooking methods in Kaohsiung, Taiwan. Journal of Environmental Sciences 41:218-226.			
HERO ID:	3120142			
Conditions of Use:	Combustion Byproduct			
EXTRACTION				
Parameter	Data			
Worker activity description:	Restaurant employees - waiters, cooks, etc.			
Exposure route:	Inhalation			
Area sampling data:	Exposure associated with different recipes Tables 3, 4, and 5 (ppb, Dining area/kitchen/exhaust streams) - Chinese buffet - 0.52/4.67/28.88; Chinese hotpot - 30.12/NA/NA; Japanese barbecue - 11.22/1.41/31.94; Western fast food - 0.89/0.97/4.71; CW mixed style - 1.28/5.35/10.23; Chinese stir frying - 1.09/1.54/23.47; Table 6 provides other literature sources of exhaust (ppb): Korean barbecue - 57.8; Chinese restaurant - 32.3; Western fast food - 38.4			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is for Taiwan, a non-OECD country
	Metric 3:	Applicability	Low	Data is not for in scope use, it is for restaurant exposure to employees and gen pop.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2016) literature sources are from 2006.
	Metric 5:	Sample Size	Medium	Characterized by a range of data depending on the source of the activity.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Contains emission factors/sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by sampling from different locations and different food sources. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Cheng, W., Wu, H. (2019). Assessing Organic Chemical Emissions and Workers’ Risk of Exposure in a Medical Examination Center Using Solid Phase Microextraction Devices. Aerosol and Air Quality Research 19(4):865-870.			
HERO ID:	5967509			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Medical examination center of a teaching hospital. Themain medical departments include Medicine, Surgery, Gynecology, Pediatrics, Emergency, Rehabilitation, Dermatology, Ophthalmology, and Non-clinical. The medical examiners collect samples from clinical patients for medical examination.			
Exposure route:	inhalation			
Physical form:	vapor, gas			
Personal sampling data:	0.05–0.0625 ppm			
Personal protective equipment:	Medical technicians wear face masks and gloves to prevent exposure.			
Engineering control:	Samples in fume hood were taken with draught air speed 10 cm outside the exhaust hood was 2.2-3.0 m/s during the procedures, meeting the operational standard.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is from Taiwan, not an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data is under 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes exposure type, physical form, sample type, PPE and some engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Cheong, K. W. (1996). Ventilation and air quality in an office building. Building Services Engineering Research & Technology: An International Journal 17(4):167-176.			
HERO ID:	6155340			
Conditions of Use:	Building and construction materials (office building)			
EXTRACTION				
Parameter	Data			
Number of sites:	1 office evaluated, which is 40% of a two-story building; other 60% is for workshops, i.e. demonstration areas for spray painting/electro-plating (may impact pollutant concentrations in office) (pg 1)			
Worker activity description:	"This contaminant is emitted mainly from particle board and various insulation materials" (pg 5)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.1 ppm average (pg 4)			
Engineering control:	Mechanical ventilation; AC (details such as air exchange rate on pgs 1-4)			
Comments:	Mechanical ventilation; AC (details such as air exchange rate on pgs 1-4)Method: MIRAN portable ambient air analyser. The accuracy of this analyser is estimated as ± 15%. (pg 4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Singapore, a non-OECD country
	Metric 3:	Applicability	High	Data are for building and construction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (average) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low		

Study Citation:	Chia, S.E., Ong, C.N., Foo, S.C., Lee, H.P. (1992). Medical students’ exposure to formaldehyde in a gross anatomy dissection laboratory. Journal of American College Health 41(3):115-119.			
HERO ID:	1314340			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	medical students exposed to formaldehyde during the dissection of cadavers in a gross anatomy laboratory			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.74 +/- 0.18 ppm mean (range 0.41- 1.20 ppm)			
Area sampling data:	0.50 ppm mean, 0.08 ppm SD (range 0.40-0.60 ppm)			
Exposure duration:	2.5 hours			
Exposure frequency:	2 days per week;			
Number of workers:	150 first year students			
Personal protective equipment:	Recommended use of googles and respirators			
Engineering control:	The use of an effective ventilation system would make it possible to lower the concentration of formaldehyde in the gross anatomy laboratory. Exposure can be reduce by changing the composition of the embalming fluid. IT has been reported that by using an embalming fluid consisting of 86.5% ethanol, 8.1% formalin, 2.7% glycerol, and storing the bodies for at least 3 months in 70% ethanol, it is possible to keep the formaldehyde concentration in his dissection room to below 0.20 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH method was used that require drawing a known volume of air through a midget impinger containing 10 mL of distilled water. Aliquots of 2 mL of the collected sample solutions were treated with chromotropic acid-sulfuric acid to form a purple monoca-tionic chromogen. The concentration of the formaldehyde was measured by colorimetric method, using a Shimadzu UV-visible spectrophotometer at 580 nm. A standard curve was calibrated to determine the unknown samples.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Singapore - not a member of OECD
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The study was published in 1992, around the time of fhe most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized with mean values, standard deviation and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data includes the critical metadata, such as sample type, exposure type, exposure durations, exposure frequency, and worker activities.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1314340 Table: 1 of 1

...continued from previous page

Study Citation:	Chia, S.E., Ong, C.N., Foo, S.C., Lee, H.P. (1992). Medical students’ exposure to formaldehyde in a gross anatomy dissection laboratory. Journal of American College Health 41(3):115-119.		
HERO ID:	1314340		
Conditions of Use:	Laboratory Use		
Domain	Metric	EVALUATION Rating	Comments
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided standard deviation and range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium	

Study Citation:	Chrostek, W. J. (1985). Health hazard evaluation report: HETA-84-392-1597 - Syntex Dental Products, Inc., Audubon, Pennsylvania.			
HERO ID:	1317246			
Conditions of Use:	Use of Paper Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	light manufacturing of dental equipment and supplies and packaging; Formaldehyde was measured in carbonless paper used at site, which is why formaldehyde was measured at the site.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Three air samples were collected for formaldehyde (2 in accounting, 1 in executive office). All samples were less than the lower limit of detection. (2 micrograms per sample)			
Comments:	It states that personal pumps were used for formaldehyde sampling, but presented per location therefore EPA assumes these are area samples.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is a NIOSH Study - Method P&CAM 354(1). Uncertain which current terminology matches with this method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (use of carbonless paper) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1984 - 85 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Low	Discrete values (n=3) provided but all samples were below the lower limit of detection.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (i.e, area) but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Concentrations were below the lower limit of detection and it was assumed that uncertainty was considered in Method P&CAM 354.
Overall Quality Determination		Medium		

Study Citation:	Chrostek, W. J. (1984). Health hazard evaluation report: HETA-83-261-1448. Rolling Hill Hospital, Elkins Park, Pennsylvania. 83-261-1448:1-12.			
HERO ID:	5096596			
Conditions of Use:	Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Worker activity description:	Gross pathology laboratory employees preserve tissue in a formalin solution before visual examination of the samples. (4/12)			
Exposure route:	inhalation, dermal, ingestion (6/12)			
Physical form:	gas (6/12)			
Personal sampling data:	The two personal breathing samples were 0.04 and 0.51 mg/m3. (10/12)			
Area sampling data:	Three area samples were ND, 0.10, and 0.25 mg/m3. (10/12)			
Exposure duration:	8-10 hours (5/12)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and duration provided, but missing exposure frequency, number of workers, engineering controls, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at two different labs in the hospital.
Overall Quality Determination			High	

Study Citation:	Chrostek, W. J. (1985). Health hazard evaluation report: HETA-85-0067-1614 - Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania.			
HERO ID:	8632769			
Conditions of Use:	Plastic and rubber products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Rigid foam mixing, pouring, and grinding operations.			
Exposure route:	Dermal and inhalation.			
Physical form:	Vapor			
Area sampling data:	Two samples collected for formaldehyde were below the laboratory limit of detection, 0.2 ug/sample.			
Personal protective equipment:	NIOSH recommends a Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure mode or with full facepiece, helmet, or mode operated in continuous-flow mode.			
Engineering control:	General and local exhaust ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Report is more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Chung, J., Lee, M., Kang, S., Bolan, N.S. (2014). Concentration distribution of carbonyl compounds in an industrial shipbuilding complex. K S C E Journal of Civil Engineering 18(4):927-932.			
HERO ID:	2433035			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Painting and coating during the ship construction process			
Exposure route:	Inhalation			
Physical form:	Liquid			
Area sampling data:	3.02-3.72 (ppb)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved method or is well described and found to be equivalent to approved methods.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Korea, an OECD country.	
	Metric 3: Applicability	High	Data are for paints and coatings, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2013)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.	
Overall Quality Determination		High		

Study Citation:	Clausz, J.C., MacIntyre, B.A., Malone, E.S., Twelmeyer, J.M. (1984). Atmospheric formaldehyde levels in an academic laboratory. Journal of Chemical Education 61(4):A121-A123.			
HERO ID:	5964008			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Area sampling data:	For formaldehyde-treated specimens, values ranged from 2.48 to 1.33 ppm above background. (2/3)			
Engineering control:	The use of formaldehyde-free dissection specimen and increased laboratory ventilation reduced formaldehyde concentrations to a background level. (3/3)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range (in graph form) with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure concentration provided but missing most other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Clerc, F., Steinhausen, M., Bertrand, N., Vincent, R., Gabriel, S., Gelder, R.V. (2015). Comparison of formaldehyde exposure measurements stored in French and German databases. <i>Gefahrstoffe, Reinhaltung der Luft / Air Quality Control</i> 75(4):119-126.
HERO ID:	5947094
Conditions of Use:	commercial uses

EXTRACTION

Parameter	Data
Worker activity description:	Based on data available in two databases (MEGA from Germany and COLCHIC from France) for the period from 2002 to 2011, the following information is available for worker activities: for France the highest contributing sector is human health activities at 21%, followed by manufacture of wood, furniture and related at 13% and manufacture of rubber and plastic products at 12%; for Germany the highest contributing sector is manufacture of wood, furniture and related at 18.1%, followed by manufacture of basic metals at 15.7% and human health activities at 12.9%. See Table 3 for more info and smaller percentage uses
Exposure route:	inhalation
Personal sampling data:	From Table 4: Based on data available in two databases (MEGA from Germany and COLCHIC from France) for the period from 2002 to 2011, the following information is available for personal samples: for France GM is 0.09 mg/m ³ , median is 0.09 mg/m ³ , 75th percentile is 0.26 mg/m ³ , 90th percentile is 0.55 mg/m ³ , 95th percentile is 0.9 mg/m ³ from 2743 measurements; for Germany GM is 0.06 mg/m ³ , median is 0.06 mg/m ³ , 75th percentile is 0.19 mg/m ³ , 90th percentile is 0.52 mg/m ³ , 95th percentile is 0.8 mg/m ³ from 2796 measurements. These data are for sampling duration ≥ 30 minutes and ≤ 240 minutes. Based on data available in two databases (MEGA from Germany and COLCHIC from France) for the period from 2002 to 2011 for human health activities, the following information is available for personal samples: for France GM is 0.16 mg/m ³ , median is 0.18 mg/m ³ , 75th percentile is 0.41 mg/m ³ , 90th percentile is 1.07 mg/m ³ , 95th percentile is 1.74 mg/m ³ from 583 measurements; for Germany GM is 0.23 mg/m ³ , median is 0.30 mg/m ³ , 75th percentile is 0.56 mg/m ³ , 90th percentile is 0.94 mg/m ³ , 95th percentile is 1.6 mg/m ³ from 254 measurements. Based on data available in two databases (MEGA from Germany and COLCHIC from France) for the period from 2002 to 2011 for manufacture of wood and furniture sector, the following information is available for personal samples: for France GM is 0.12 mg/m ³ , median is 0.13 mg/m ³ , 75th percentile is 0.24 mg/m ³ , 90th percentile is 0.41 mg/m ³ , 95th percentile is 0.50 mg/m ³ from 466 measurements; for Germany GM is 0.07 mg/m ³ , median is 0.07 mg/m ³ , 75th percentile is 0.17 mg/m ³ , 90th percentile is 0.47 mg/m ³ , 95th percentile is 0.7 mg/m ³ from 1063 measurements.
Area sampling data:	Based on data available in two databases (MEGA from Germany and COLCHIC from France) for the period from 2002 to 2011, the following information is available for area samples: for France GM is 0.07 mg/m ³ , median is 0.06 mg/m ³ , 75th percentile is 0.21 mg/m ³ , 90th percentile is 0.62 mg/m ³ , 95th percentile is 1.2 mg/m ³ from 4041 measurements; for Germany GM is 0.03 mg/m ³ , median is 0.02 mg/m ³ , 75th percentile is 0.09 mg/m ³ , 90th percentile is 0.3 mg/m ³ , 95th percentile is 0.58 mg/m ³ from 3663 measurements. These data are for sampling duration ≥ 30 minutes and ≤ 240 minutes. Based on data available in two databases (MEGA from Germany and COLCHIC from France) for the period from 2002 to 2011 for human health activities, the following information is available for area samples: for France GM is 0.07 mg/m ³ , median is 0.08 mg/m ³ , 75th percentile is 0.20 mg/m ³ , 90th percentile is 0.48 mg/m ³ , 95th percentile is 0.87 mg/m ³ from 574 measurements; for Germany GM is 0.09 mg/m ³ , median is 0.12 mg/m ³ , 75th percentile is 0.29 mg/m ³ , 90th percentile is 0.73 mg/m ³ , 95th percentile is 1.2 mg/m ³ from 228 measurements. Based on data available in two databases (MEGA from Germany and COLCHIC from France) for the period from 2002 to 2011 for manufacture of wood and furniture sector, the following information is available for area samples: for France GM is 0.07 mg/m ³ , median is 0.08 mg/m ³ , 75th percentile is 0.20 mg/m ³ , 90th percentile is 0.48 mg/m ³ , 95th percentile is 0.87 mg/m ³ from 574 measurements; for Germany GM is 0.09 mg/m ³ , median is 0.12 mg/m ³ , 75th percentile is 0.29 mg/m ³ , 90th percentile is 0.73 mg/m ³ , 95th percentile is 1.2 mg/m ³ from 228 measurements.
Exposure duration:	Samples are said to be between 30 and 240 minutes
Comments:	Tables 5 - 9 contain info specific to various sectors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	methodology is well described
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	data are from Germany and France, OECD countries.
	Metric 3: Applicability	High	Data are for occupational scenarios within the scope of the risk evaluation

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Formaldehyde

Occupational Exposure

HERO ID: 5947094 Table: 1 of 1

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Study Citation:	Clerc, F., Steinhausen, M., Bertrand, N., Vincent, R., Gabriel, S., Gelder, R.V. (2015). Comparison of formaldehyde exposure measurements stored in French and German databases. Gefahrstoffe, Reinhaltung der Luft / Air Quality Control 75(4):119-126.				
HERO ID:	5947094				
Conditions of Use:	commercial uses				
Domain		Metric	EVALUATION		
			Rating	Comments	
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old	
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.	
Domain 3: Accessibility/ Clarity					
	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata	
Domain 4: Variability and Uncertainty					
	Metric 7:	Metadata Completeness	Medium	does not discuss uncertainties	
Overall Quality Determination			High		

Study Citation:	Cocalis, J. C., Rao, C. Y., Kestenber, K. A., Martin, J. E. (2001). Health Hazard Evaluation Report 2000-0098-2862, Robinson Run Mine, Shinnston, West Virginia, July 2001.		
HERO ID:	8016652		
Conditions of Use:	Other- Byproduct of Biocide in MWF		

EXTRACTION				
Parameter	Data			
Worker activity description:	During a production shift, typical jobs on the longwall include:• stage loader operator (headgate area),• shieldman (positioned along the face, i.e., headgate to tailgate),• shieldman helper (positioned along the face)• two shearer operators (positioned along the face),• two electrician/mechanic (one usually at face),• two timbermen (sometimes relieve shearer operator), and• scoop operator (mainly in the headgate area).			
Exposure route:	inhalation - Concerns were raised that triazine biocide used to control microbial growth in the emulsion would adsorb onto or absorb into the rockdust, become aerosolized with rockdust, and convert to formaldehyde, a known irritant and carcinogen, afterdepositing in the upper respiratory system.dermal			
Area sampling data:	Formaldehyde concentrations ranging up to 0.006 ppm were detected in outdoor air on June 13-14, 2000. Formaldehyde concentrations ranging up to 0.006 ppm were detected in the headgate area on June 13- 14, 2000. Formaldehyde concentrations ranging up to 0.027 ppm were detected in the mid-panline area on June 13-14, 2000. Formaldehyde concentrations ranging up to 0.016 ppm were detected in the tailgate area on June 13-14, 2000. Formaldehyde concentrations in air up to 0.02 ppm were measured at the teardown area. The measured formaldehyde concentrations in air at the setup area ranged to 0.009 ppm.Area sampling for formaldehyde measured concentrations up to 0.027 ppm over the two sampling trips with the highest levels measured at the tailgate.			
Exposure duration:	There are two production shifts per day, seven days per week, with maintenance performed on the swing shift. Any of the 250 miners may be positioned on the longwall during teardowns and setups (longwall moves) which occur over a 3-6 day period 2-3 timesper year.			
Number of workers:	Approximately 250 miners work at the RobinsonRun mine			
Engineering control:	If substitution is not feasible, engineering and administrative controls such as improved maintenance to control leaks and recycling of the emulsion during longwall moves should be implemented.			

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved OSHA or NIOSH method 2016 and 5700.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu- ated.
	Metric 3:	Applicability	Uninformative	The data are for an occupational scenario that is similar to an occupational scenario withthe scope of the risk evaluation, in terms of the type of industry, operations, and work activities. Rated unacceptable because source of the formaldehyde is stated as a biocide, so non-TSCA.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				

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Formaldehyde

Occupational Exposure

HERO ID: 8016652 Table: 1 of 1

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Study Citation:	Cocalis, J. C., Rao, C. Y., Kestenberg, K. A., Martin, J. E. (2001). Health Hazard Evaluation Report 2000-0098-2862, Robinson Run Mine, Shinnston, West Virginia, July 2001.
HERO ID:	8016652
Conditions of Use:	Other- Byproduct of Biocide in MWF

		EVALUATION	
Domain	Metric	Rating	Comments
	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.

Overall Quality Determination **Uninformative**

Study Citation:	Coggon, D., Ntani, G., Harris, E.C., Palmer, K.T. (2014). Upper Airway Cancer, Myeloid Leukemia, and Other Cancers in a Cohort of British Chemical Workers Exposed to Formaldehyde. American Journal of Epidemiology 179(11):1301-1311.				
HERO ID:	2337789				
Conditions of Use:	Multiple				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation				
Personal sampling data:	It was estimated that background exposure corresponded to time-weighted concentrations of <0.1 ppm, low exposure to 0.1–0.5 ppm, moderate exposure to 0.6–2.0 ppm, and high exposure to >2.0 ppm. Table 1 provides number of workers from each study with high exposure.				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country - Britain	
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	Data greater than 20 years old.	
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study addresses variability in different studies but does not address uncertainty.	
Overall Quality Determination			Low		

Study Citation:	Cohen, S., Sparer, J. (1984). Health hazard evaluation report: HETA-82-107-1444 - Torrington Company, Torrington, Connecticut.			
HERO ID:	8637901			
Conditions of Use:	Processing aids, not otherwise listed			
EXTRACTION				
Parameter	Data			
Worker activity description:	There are several discrete work areas for the plant, including cutting and shaping processes, grinding operations, tumbling, and inspection and packaging. (4/29)			
Exposure route:	dermal (3/29)			
Physical form:	fluid (3/29)			
Dermal exposure data:	Dermal exposure data			
Number of workers:	49 workers (4/29)			
Personal protective equipment:	Workers were provided with gloves, sleeves, and aprons, but compliance with the program was minimal. (8/29)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for metalworking fluids, which is similar to the in-scope occupational scenario processing aids not otherwise listed.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure duration, frequency, and engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Coldiron, V. R., Ward, J. B., Trieff, N. M., Janssen, H. E., Smith, J. H. (1983). Occupational exposure to formaldehyde in a medical-center autopsy service. Journal of Occupational and Environmental Medicine 25(7):544-548.			
HERO ID:	1980824			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Cooler cleaning/work, prosecting, tissue sectioning, gross SO/gross conference, changing solutions (19% formaldehyde), general autopsy duties.			
Exposure route:	Inhalation			
Personal sampling data:	0.39-3.28 (ppm) [Table 2,3 and 5]; Table 5 contains TWA by occupation: resident 0.8; pathologist 1.25; and technician 0.82			
Area sampling data:	<0.10-13.57 (ppm) [Table 4]			
Exposure duration:	Exposure duration is tied to activity[hrs/week]: Technicians- cooler cleaning 1-3.5 hrs, -Gross SO/gross conference 1-2 hrs, -changing solutions 1-3.5 hrs, -general autopsy duties 15.5 -30 hrs, -minimal exposure, -nonexposure 7.5-8.5 hrs ; Residents- cooler cleaning/work 0-0.8 hrs, prosecting 3-9.5hrs, tissue sectioning 2.5-10.8 hrs, gross SO/gross conference 2.25-4.5, changing solutions 0-1.5 hrs, general autopsy duties 1-3.5 hrs, minimal exposure 7-27.5 hrs, nonexposure 5.5-16 hrs... [Also includes hours for faculty].			
Number of workers:	>500,000			
Comments:	Study measured both area and personal, authors provide an estimated TWA which appears to use both personal and area sampling with recorded activity logs to generate TWA [Table 1]			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States(TX) and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	Data are for laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL update and are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations per sample, exposure durations, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple areas and job functions but uncertainty is not addressed.
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Formaldehyde

Occupational Exposure

HERO ID: 1980824 Table: 1 of 1

...continued from previous page			
Study Citation:	Coldiron, V. R., Ward, J. B., Trieff, N. M., Janssen, H. E., Smith, J. H. (1983). Occupational exposure to formaldehyde in a medical-center autopsy service. Journal of Occupational and Environmental Medicine 25(7):544-548.		
HERO ID:	1980824		
Conditions of Use:	Laboratory Use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Collett, C. W., Hedge, A., Nie, V., Sterling, D. A., Sterling, E. M., Sterling, T. D. (1989). Indoor air quality and health in two office buildings with different ventilation systems. Environment International 15(1):115.			
HERO ID:	6028096			
Conditions of Use:	Building and construction materials: Office buildings			
EXTRACTION				
Parameter	Data			
Number of sites:	2 adjoining office buildings			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Sampling conducted for two four hour blocks: Air conditioned office: 0.011-0.308 mg/m3; natural ventilation: <0.005 mg/m3; outside: <0.005 mg/m3 (Table 7, pg 8) Maximum for each office: AC: 0.147, 0.221, 0.209, 0.145, 0.258, 0.308 mg/m3; natural ventilation: <0.005 mg/m3 (Table 8, pg 8)			
Engineering control:	studies one building with natural ventilation vs. AC			
Comments:	9 air conditioned building offices and 2 from natural ventilation building sampled via Chromotropic acid method (NIOSH 1977) (pg 3-4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for various in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (minimum, maximum) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample distribution characterized by limited statistics (minimum, maximum) but discrete samples not provided and distribution not fully characterized.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by comparing AC vs naturally ventilated buildings. Uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Collins, J. J., Acquavella, J. F., Esmen, N. A. (1997). An updated meta-analysis of formaldehyde exposure and upper respiratory tract cancers. Journal of Occupational and Environmental Medicine 39(7):639-651.			
HERO ID:	627559			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Garment workers 0.1-1.9 ppm 8 hr TWA (1975-86); Tables included in the report were too small to read and when expanded were blurry			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown	
	Metric 3: Applicability	High	Data are for garment workers are an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Monitoring data are greater than 20 years old but prior to PEL - Article published in 1997 but monitoring data are from 1975-86	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (range) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Sample type and exposure type not provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.	
Overall Quality Determination		Low		

Study Citation:	Collins, J. J., Acquavella, J. F., Esmen, N. A. (1997). An updated meta-analysis of formaldehyde exposure and upper respiratory tract cancers. Journal of Occupational and Environmental Medicine 39(7):639-651.			
HERO ID:	627559			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Foundary Core operators 0.3-2.8 ppm 8 hr TWA (1975-86) Tables included in the report were too small to read and when expanded were blurry			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	Data are for foundry core operators are, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but prior to PEL - Article published in 1997 but monitoring data are from 1975-86
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type and exposure type not provided. Presumably PBZ but not clear
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 627559 Table: 3 of 5

Study Citation:	Collins, J. J., Acquavella, J. F., Esmen, N. A. (1997). An updated meta-analysis of formaldehyde exposure and upper respiratory tract cancers. Journal of Occupational and Environmental Medicine 39(7):639-651.			
HERO ID:	627559			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Pathologist 0.1-1.1 ppm 8 hr TWA (1981-86) Tables included in the report were too small to read and when expanded were blurry			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	Data are for pathology lavatories which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but prior to PEL - Article published in 1997 but monitoring data are from 1981-86
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type and exposure type not provided. Presumably PBZ but not clear
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 627559 Table: 4 of 5

Study Citation:	Collins, J. J., Acquavella, J. F., Esmen, N. A. (1997). An updated meta-analysis of formaldehyde exposure and upper respiratory tract cancers. Journal of Occupational and Environmental Medicine 39(7):639-651.				
HERO ID:	627559				
Conditions of Use:	Use of Floor coverings				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	Carpenters 0.01 -0.1 ppm. Tables included in the report were too small to read and when expanded were blurry				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown	
	Metric 3:	Applicability	High	Data are for carpentry which is an in-scope occupational scenario.	
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after PEL - Article published in 1997	
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type and exposure type not provided. Presumably PBZ but not clear	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.	
Overall Quality Determination			Low		

Study Citation:	Collins, J. J., Acquavella, J. F., Esmen, N. A. (1997). An updated meta-analysis of formaldehyde exposure and upper respiratory tract cancers. Journal of Occupational and Environmental Medicine 39(7):639-651.			
HERO ID:	627559			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Embalmers 0.3-2.6 ppm (1981-86) Tables included in the report were too small to read and when expanded were blurry			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but prior to PEL - Article published in 1997 but monitoring data are from 1981-86
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type and exposure type not provided. Presumably PBZ but not clear
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1222842 Table: 1 of 2

Study Citation:	Collins, J.J., Ness, R., Tyl, R.W., Krivanek, N., Esmen, N.A., Hall, T.A. (2001). A review of adverse pregnancy outcomes and formaldehyde exposure in human and animal studies. Regulatory Toxicology and Pharmacology 34(1):17-34.			
HERO ID:	1222842			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.4-3.5 (ppm)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1222842 Table: 2 of 2

Study Citation:	Collins, J.J., Ness, R., Tyl, R.W., Krivanek, N., Esmen, N.A., Hall, T.A. (2001). A review of adverse pregnancy outcomes and formaldehyde exposure in human and animal studies. Regulatory Toxicology and Pharmacology 34(1):17-34.			
HERO ID:	1222842			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.6-1.3 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 3256955 Table: 1 of 2

Study Citation:	Cometto-Muniz, J.E., Abraham, M.H. (2015). Compilation and analysis of types and concentrations of airborne chemicals measured in various indoor and outdoor human environments. Chemosphere 127:70-86.
HERO ID:	3256955
Conditions of Use:	Consumer Use- Residential Home

Parameter	Data
Area sampling data:	Formaldehyde concentrations (ug/m3)measured in indoor home/school environments are as follows: minimum – 12.7; maximum – 134; range (max/min) – 11; mean – 60.5; median – 53.4; std. deviation – 34.8; variance – 1208.4; std. error – 8.89. Ratio of formaldehyde in home/school environment compared to commercial environments is 3.6.

Domain	Metric	EVALUATION Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	No measuring of concentration was done by authors, only a review of other published studies that performed monitoring studies. No specified sampling or analytical methodology included and also expected to vary.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	data from various countries including US has been used
	Metric 3: Applicability	Uninformative	The data are from an non-occupationalscenario that does not applyto any occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	report is generally no more than 10 years old
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Report address variability in its review of several different studies, but not uncertainty in exposure results.

Overall Quality Determination **Uninformative**

Study Citation:	Cometto-Muniz, J.E., Abraham, M.H. (2015). Compilation and analysis of types and concentrations of airborne chemicals measured in various indoor and outdoor human environments. Chemosphere 127:70-86.			
HERO ID:	3256955			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Area sampling data:	Formaldehyde concentrations (ug/m3)measured in indoor commercial environments are as follows: minimum – 5.6; maximum – 21.3; range (max/min) – 3.8; mean – 15.4; median – 17.1; std. deviation – 5.55; variance – 30.818; std. error – 2.1.			
Comments:	Not primary source, the source of measured air concentration provided in supplemental file which cites other peer-reviewed journal articles.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	No measuring of concentration was done by authors, only a review of other published studies that performed monitoring studies. No specified sampling or analytical methodology included and also expected to vary.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data from various countries including US has been used
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	report is generally no more than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Report address variability in its review of several different studies, but not uncertainty in exposure results.
Overall Quality Determination			High	

Study Citation:	Connor, T.H., Ward, J.B., Legator, M.S. (1985). Absence of mutagenicity in the urine of autopsy service workers exposed to formaldehyde: Factors influencing mutagenicity testing of urine. International Archives of Occupational and Environmental Health 56(3):225-237.			
HERO ID:	1222807			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Hospital autopsy service workers			
Exposure route:	Inhalation			
Personal sampling data:	time weighted average: between 0.61 and 1.32 ppm; range: 0.1 ppm (outside of immediate work area) - 5.8 ppm (specific activity)			
Exposure duration:	nan			
Comments:	The data includes area monitoring data, but it is not clear to what extent so.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1985)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Not clear which of the data is area sampling and which is personal sampling.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability is not discussed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 6201928 Table: 1 of 1

Study Citation:	Cooley, R.L., Stilley, J., Lubow, R.M. (1984). Formaldehyde emitted by chemical vapor sterilizers. Oral Surgery, Oral Medicine, and Oral Pathology 57(1):28-30.
HERO ID:	6201928
Conditions of Use:	Sterilization

EXTRACTION

Parameter	Data
Worker activity description:	Dentists and dental assistants
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	No formaldehyde was detected in air sampling.
Exposure duration:	8 hours
Engineering control:	The manufacturer of the Chemiclave now offers a filtering system to remove the odor of the residual vapors and any residual formaldehyde.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Uninformative	Data are for use as a disinfectant, which is not in-scope or similar to an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by comparing two different sterilization methods.

Overall Quality Determination Uninformative

Study Citation:	Cornwell, R. (1988). Health Hazard Evaluation Report HETA 88-230-1939, Morgan Shirt Company, Morgantown, West Virginia, December 1988.			
HERO ID:	8140526			
Conditions of Use:	Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Pressing, finishing, assembly line workers, collar/cuff making, front making, sleeve/back making, cutting room, and warehouse workers. (13/16)			
Exposure route:	inhalation, dermal (7/16)			
Physical form:	vapors (7/16)			
Personal sampling data:	Personal breathing zones ranged from 0.01-0.21 ppm with a mean of 0.06 ppm. (13/16)			
Area sampling data:	Two area samples were taken in the warehouse, and were both 0.01 ppm. (14/16)			
Engineering control:	The facility is not air-conditioned nor is there any local exhaust ventilation. General mechanical and dilution ventilation are used for conform and exposure control. (5/16)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for finishing agents in textile manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing number of workers, exposure duration, frequency, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different worker activities during different days.
Overall Quality Determination		High		

Study Citation:	Cornwell, R. J. (1990). Hazard Evaluation and Technical Assistance Report No. RDHETA-90-145-2086, MAP International, Fairmont, West Virginia.			
HERO ID:	NIOSH:90-145.1317193			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Fibrous glass making area and molding area			
Area sampling data:	Fibrous glass making deck railing 0.12 ppm (TWA)Fibrous glass making below deck 0.09 ppm (TWA)Fibrous glass making top of room - Deck 0.07 ppm (TWA)Molding Sterling 0.09 ppm (TWA)Molding Bosch 0.09 ppm (TWA)			
Dermal exposure data:	nan			
Exposure duration:	12 hour day shift			
Exposure frequency:	two shifts 7 days per week.			
Number of workers:	50 production workers out of 100 individuals.			
Personal protective equipment:	long sleeve shirts, goggles and gloves			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method, NIOSH Study Method 2541
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (fibrous glass manufacture) within the scope of the risk evaluation. Note: Unlike the personal sampling data, area sampling were in areas where smoking was prohibited pg. 11
	Metric 4:	Temporal Representativeness	Low	1990 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample duration, and exposure durations, but lacks additional metadata, such as exposure frequency, andworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations/jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in Method 2541.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1317193 Table: 2 of 2

Study Citation:	Cornwell, R. J. (1990). Hazard Evaluation and Technical Assistance Report No. RDHETA-90-145-2086, MAP International, Fairmont, West Virginia.			
HERO ID:	NIOSH:90-145.1317193			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers in the fibrous glass making area and the molding area			
Personal sampling data:	Production 0.07 ppm (TWA)Production 0.09 ppm (TWA)Utility 0.09 ppm (TWA)Operator 0.09 ppm (TWA)Relief person 0.07 ppm (TWA)Binder 0.09 ppm (TWA)Maintenance 0.07 ppm (TWA)Trimmer 0.41 ppm (TWA)Molder 0.14 ppm (TWA)Trimmer 0.07 ppm (TWA)			
Exposure duration:	12 hour day shift			
Exposure frequency:	two shifts 7 days per week.			
Number of workers:	50 production workers out of 100 individuals.			
Personal protective equipment:	long sleeve shirts, goggles and gloves			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method, NIOSH Study Method 2541
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Uninformative	The data are for an occupational scenario (fibrous glass manufacture) within the scope of the risk evaluation. However, report states that the workers included smokers who may have smoke during the break. 'It is not possible to differentiate between formaldehyde contributed from the process and from cigarette smoke.' pg. 11
	Metric 4:	Temporal Representativeness	Low	1990 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample duration, and exposure durations, but lacks additional metadata, such as exposure frequency, andworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations/jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in Method 2541.
Overall Quality Determination		Uninformative		

Study Citation:	Costa, S., Brandao, F., Coelho, M., Costa, C., Coelho, P., Silva, S., Porto, B., Teixeira, J.P. (2013). Micronucleus frequencies in lymphocytes and buccal cells in formaldehyde exposed workers. 16:83-94.			
HERO ID:	5422263			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Pathology and anatomy workers: In total, 80 women were involved in the study, 38 working for at least one year in pathology and anatomy laboratories located in Portugal, and 42 non-exposed control females, working in administrative offices in the same area and without occupational exposure history to formaldehyde.			
Exposure route:	Inhalation			
Personal sampling data:	The mean level of worker’s exposure to formaldehyde was 0.35 ± 0.03 ppm (range 0.18–0.69 ppm).			
Number of workers:	80 women were involved in the study, 38 working for at least one year in pathology and anatomy laboratories located in Portugal, and 42 non-exposed control females, working in administrative offices in the same area and without occupational exposure history to formaldehyde.			
Engineering control:	Implementation of security and hygiene measures, such as periodic air sampling, efficient air extraction, temperature control, as well as good practice campaigns, were recommended to decrease formaldehyde exposure in this workplace. Recommendations include development of training programs and medical surveillance programs.			
Comments:	Results found in the present study substantiate an association between DNA damage at chromosomal level and occupational exposure to formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Air sampling and formaldehyde analysis were performed according to the NIOSH method no. 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data from an OECD country other than the U.S
	Metric 3:	Applicability	High	Data is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	Data no more than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most associated metadata, but not sample durations and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Costa, S., Carvalho, S., Costa, C., Coelho, P., Silva, S., Santos, L.S., Gaspar, J.F., Porto, B., Laffon, B., Teixeira, J.P. (2015). Increased levels of chromosomal aberrations and DNA damage in a group of workers exposed to formaldehyde. Mutagenesis 30(4):463-473.			
HERO ID:	2823656			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.38+/-0.03 ppm 8 hr TWA (range 0.08-1.39 ppm); Peak exposure occurred during macroscopic examination of formaldehyde-preserved specimens (range 0.3–3.2 ppm) and disposal of specimens and waste solutions (range 0.3–2.8 ppm).			
Number of workers:	84			
Personal protective equipment:	In most FA-related tasks, workers were only using masks for biological hazard, not appropriate to protect from FA vapors. The primary reason given by workers for not using goggles and appropriate masks (if available) was interference in efficiency of activities performed, namely taking notes and handling material, and communication difficulties.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Used NIOSH Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Portugal - an OECD member
	Metric 3:	Applicability	High	The data are for anatomy pathology laboratory workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The study was published in 2015, after the most recent PEL (1992) and less than 10 years old.
	Metric 5:	Sample Size	High	TWA and standard error provided along with quantification of peak occurrences.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, butlacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The study provided standard error and range data that can be used to evaluate variability. NIOSH method 3500 includes uncertainty analysis.
Overall Quality Determination		High		

Study Citation:	Costa, S., Coelho, P., Costa, C., Silva, S., Mayan, O., Santos, L.S., Gaspar, J., Teixeira, J.P. (2008). Genotoxic damage in pathology anatomy laboratory workers exposed to formaldehyde. Toxicology 252(1-3):40-48.			
HERO ID:	626187			
Conditions of Use:	Laboratory use			
EXTRACTION				
Parameter	Data			
Worker activity description:	examination of FA-preserved specimens and disposal of specimens and waste solutions			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Personal concentrations 0.44 ppm mean (range 0.04-1.58 ppm)			
Area sampling data:	Area concentrations: examinations 1.5 ppm mean and disposal 4.43 ppm mean;			
Exposure duration:	8 hr			
Number of workers:	30			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method no. 3500.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Portugal - OECD member
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2008
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics mean values for area monitoring and mean and range for personal monitoring but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing data distribution data for area monitoring and personal monitoring does not differentiate between examination and disposal also missing: number of samples, and exposure frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range for personal samplers, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Costa, S., Costa, C., Madureira, J., Valdiglesias, V., Teixeira-Gomes, A., Pinho, P.G., Laffon, B., Teixeira, J.P. (2019). Occupational exposure to formaldehyde and early biomarkers of cancer risk, immunotoxicity and susceptibility. Environmental Research 179(Pt A):108740.				
HERO ID:	6129394				
Conditions of Use:	Laboratory Chemical				
EXTRACTION					
Parameter	Data				
Worker activity description:	Workers in hospital anatomy-pathology laboratories				
Exposure route:	Inhalation				
Personal sampling data:	Analysis of the samples allowed the calculation of the 8 h time weighted average (8 h-TWA) level of exposure to formaldehyde for each subject. Air sampling and formaldehyde analysis were performed according to the NIOSH method no. 3500. The mean TWA-level of worker's exposure to formaldehyde was 0.38 +/- 0.03 ppm (range 0.08–1.39 ppm). The peak emission of formaldehyde occurred during macroscopic examination of formaldehyde -preserved specimens (range 0.3–3.2 ppm) and disposal of specimens and waste solutions (range 0.3–2.8 ppm).				
Number of workers:	Eighty-five workers exposed to formaldehyde from 9 hospital anatomy-pathology laboratories, working for at least one year, and 87 non-exposed control employees working in the same area in administrative offices and without occupational exposure history to formaldehyde.				
Engineering control:	Effective ventilation and local (benches) exhaust, control of the room temperature, ventilated sample cabinets or rooms, periodic air sampling and medical surveillance				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from an OECD country other than the U.S.	
	Metric 3:	Applicability	High	Data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.	
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by range and standard deviation.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure frequency.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study addresses variability by comparing data from two worker activities but uncertainty is not addressed.	
Overall Quality Determination			High		

Study Citation:	Costa, S., García-Lestón, J., Coelho, M., Coelho, P., Costa, C., Silva, S., Porto, B., Laffon, B., Teixeira, J.P. (2013). Cytogenetic and immunological effects associated with occupational formaldehyde exposure. Journal of Toxicology and Environmental Health, Part A: Current Issues 76(4-5):217-229.			
HERO ID:	1578367			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances in products not described by other codes: Anatomy lab			
Worker activity description:	Macroscopic examination of FA-preserved specimens, and disposal of specimens and waste solutions.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.36+/- 003 ppm (range 0.23-0.69 ppm)			
Number of workers:	35			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Air sampling and analysis were performed according to NIOSH method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Portugal - an OECD member
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	The study was published in 2013, after the most recent PEL (1992) and less than 10 years old.
	Metric 5:	Sample Size	Medium	Mean value, standard error and range data were provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, and worker activities during peak events. but lacks additional metadata, such as sample durations, exposure durations, and exposure frequency,
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided standard error and range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Cox, J.E. (1986). Formaldehyde study released - exposure in the workplace is the target of the 4-year investigation. ASHRAE Journal 28(7):8.			
HERO ID:	5936913			
Conditions of Use:	Multiple COUs - production of FA, processing/use as resins, molding compounds, photographic film, plywood and plastic products			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	gas, vapor			
Personal sampling data:	Exposure levels in ppm were none (10% exposed) between 0.1 or less (11% exposed), 0.1-0.5 (32% exposed), 0.5-2.0 (37% exposed), over 2.0 (3% exposed) and undetermined (7% exposed)			
Number of workers:	26,500 workers in 10 industrial facilities			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Unclear if source is peer reviewed but likely contains high quality data based on sourcing used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is applicable to multiple COUs.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1986)
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes exposure route, physical form, sampling data, number of workers.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address uncertainty or variability.
Overall Quality Determination		Medium		

Study Citation:	CPChem, (2002). Initial submission: Ltr fr CPChem to USEPA reporting residual production of formaldehyde in a polystyrene production unit, dated 102402.			
HERO ID:	6574134			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in the polystyrene production			
Personal sampling data:	Several breathing zone samples have indicated the presence of formaldehyde in the work environment at levels above detectable but well below OSHA exposure limits. None of the samples collected have indicated formaldehyde levels above OSHA exposure limits.			
Personal protective equipment:	Personal protection equipment (PPE) requirements including the following: 3M Respirators with 3M #60926 Multi-gas filters; full face and half mask respirators (same filter used for both types of respirators); Tyvek to prevent skin contact; Gas proof goggles (if needed) when using half mask respirator to protect eyes; Chemical resistant gloves - Nitrile rubber to protect hands			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data from between 10 and 20 years ago.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	CPSC, (1982). Investigation of exposure to formaldehyde from preserved biological specimens.			
HERO ID:	6574135			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Students and teachers in school laboratories where biological specimens are used			
Personal sampling data:	A previous study reported air levels of formaldehyde in a biology laboratory at New York University where students were dissecting preserved cats. Formaldehyde levels were 14.1 ppm in the students’ breathing zone. Measurements in an anatomy laboratory of a German university showed levels of formaldehyde ranging from 0.4 ppm to 6 ppm. The Field Offices and Laboratories measured formaldehyde vapor levels in 25 high school and college teaching laboratories, where preserved biological specimens were being dissected. Air sampling was conducted in the breathing zones of students. The results showed: levels of formaldehyde in the breathing zone of students dissecting a specimen were significantly higher than the background levels found elsewhere in the school or outdoors; in several classrooms, where formalin-packed specimens were in use, the levels of formaldehyde in the breathing zones of students were well within the levels that can cause adverse health effects.			
Area sampling data:	A previous study reported air levels of formaldehyde in a biology laboratory at New York University where students where students were dissecting preserved cats. Formaldehyde levels were 2.8 ppm in classroom air. Measurements in an anatomy laboratory of a German university showed levels of formaldehyde ranging from 0.4 ppm to 6 ppm. The Field Offices and Laboratories measured formaldehyde vapor levels in 25 high school and college teaching laboratories, where preserved biological specimens were being dissected. Air sampling showed that the levels of formaldehyde in the classroom were significantly higher than the background levels found elsewhere in the school or outdoors; in several classrooms, where formalin-packed specimens were in use, the levels of formaldehyde in the classroom, were well within the levels that can cause adverse health effects.			
Exposure duration:	For seniors in high school in advanced biology and physiology classes, students are exposed for 6-8 months of the 10-month school year.			
Number of workers:	24% of the total junior and senior high school are exposed. 10% of the total college level enrollment was exposed to preserved specimens for dissection.			
Engineering control:	Ventilation, in the form of open windows and other active ventilation can lower formaldehyde concentrations in air			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data more than 20 years old.
	Metric 5:	Sample Size	Low	Characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 6574135 Table: 1 of 1

...continued from previous page			
Study Citation:	CPSC, (1982). Investigation of exposure to formaldehyde from preserved biological specimens.		
HERO ID:	6574135		
Conditions of Use:	Laboratory Chemical		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Low	

Study Citation:	CPSC, (1982). Preliminary economic report on the use of formaldehyde in school laboratories.			
HERO ID:	6574136			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Students and teachers in school laboratories where biological specimens are used			
Exposure route:	Inhalation			
Physical form:	In pure form, formaldehyde is a colorless, flammable gas with a pungent, irritating odor.			
Personal sampling data:	In the school samples, the highest formaldehyde levels were found in the breathing zones of students engaged in dissections. In 4 of the 27 laboratories monitored, the breathing zone levels were between 1 and 1.5 ppm (average was 0.73 ppm). When treated formalin-fixed animal specimens were used, formaldehyde concentration in breathing zone was 0.13 ppm (average).			
Area sampling data:	Room air levels, where formalin-fixed specimens were used, were below 0.5 ppm, and 16 of 27 measurements were below 0.1 ppm (average was 0.22 ppm). When treated formalin-fixed animal specimens were used, formaldehyde concentration in class room air was 0.06 ppm (average).			
Number of workers:	As per the survey presented, number of students exposed to formaldehyde were: elementary schools – 50 out 10,319; junior high school – 328 out of 6,728; senior high school – 4,902 out of 37,148; college – 9,624 out of 100,534. In the same schools, the number of teachers exposed to formaldehyde were: elementary schools – 2; junior high school – 8; senior high school – 62; and college – 126.			
Engineering control:	Increased ventilation of classrooms, using exhaust fans, where specimens are handled may reduce the potential inhalation of formaldehyde gas. It is doubtful, however, that opening laboratory doors and windows would provide sufficient ventilation. Indeed, opening doors may allow fumes to spread elsewhere in the school, increasing the number of students exposed.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data more than 20 years old
	Metric 5:	Sample Size	Medium	samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Crandall, M. S. (1985). Health hazard evaluation report: HETA-84-026-1599 - U.S. Penitentiary, Terre Haute, Indiana.			
HERO ID:	8632280			
Conditions of Use:	Manufacture of Textiles, Apparel, and Leather (including fabric/textile finishing)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Sewing machine operator, sheet folder, sheet cutter, inspector, stenciler, sheet puller.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Mean concentrations given in ppmSewing machine operator: 1.10Sheet folder: 1.03Sheet cutter: 1.15Inspector: 1.04Stenciler: 0.82Sheet Puller: 1.25Overall average: 1.07			
Area sampling data:	Area exposure data in ppm (sorbent tube)North end new addition: 1.12Between cutting tables: 1.24Central old building: 1.33Fabric bolt stack: 1.43Overall average: 1.28Short-term area data in ppm (impinger)East end: 0.56-1.26Central: 0.95-1.22West end: 1.30			
Number of workers:	80			
Engineering control:	Ventilation: Airing of fabrics, prior to used, is recommended. One treatment method would involve aerating the fabric in a ventilated chamber, while at the same time adding heat to drive the formaldehyde out of the cloth. This would mean unrolling the bolt of cloth at one end of the process, and rolling it back at the other end in order to use your current pattern cutting technology. Proper temperature, humidity, and airing time would need to be determined (perhaps in an empirical fashion).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture of Textiles, Apparel, and Leather (including fabric/textile finishing), which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by sampling multiple areas and personal breathing samples of multiple workers.
Overall Quality Determination		High		

Study Citation:	Crandall, M. S., Handke, J. L. (1987). Health Hazard Evaluation Report HETA 84-289-1798, Kirby Manufacturing Company, Inc., McClure, Pennsylvania, May 1987.			
HERO ID:	8141062			
Conditions of Use:	Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	A majority of the workers were sewing machine operators (80 workers). Other jobs were fabric cutting, folding, pressing, and inspection. (4/17)			
Exposure route:	dermal, inhalation (6/17)			
Physical form:	vapor (6/17)			
Personal sampling data:	Personal formaldehyde exposure concentrations ranged from 0.5 to 1.5 ppm, and averaged 1.0 ppm for 14 samples. By job category, exposure concentrations averaged 1.1 ppm for the small parts area sewing machine operators, and 1.2 ppm for the fabric spreaders in the pattern shop. One sewing machine operator in the automatics areawas exposed to 0.9 ppm of formaldehyde. (8/17)			
Area sampling data:	The full-shift area samples from throughout the plant showed formaldehyde concentrations ranging from 0.8 ppm in the assembly and pressing areas to 1.4 ppm in the automatics area. (8/17)			
Number of workers:	The company employed approximately 100 hourly workers at the time of the NIOSH survey. (4/17)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for textile finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling multiple locations and different job operations.
Overall Quality Determination		High		

Study Citation:	Crandall, M. S., Wilcox, T. G. (1988). Health Hazard Evaluation Report HETA 87-181-0000, Graphic Packaging Corporation, Paoli, Pennsylvania.			
HERO ID:	664397			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	gluing microwave popcorn bags			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	duplex roller 0.19 ppm; heated drum 0.03 ppm; heated block 0.04 ppm			
Particle size characterization:	nan			
Number of workers:	51			
Personal protective equipment:	gloves			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH 3500 method note the analysis was performed in a NIOSH lab.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	Data are for a print shop which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years and prior to the PEL- Article published in 1988 and sampling occurred in 1987
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Croteau, G., Dills, R., Beaudreau, M., Davis, M. (2010). Emission factors and exposures from ground-level pyrotechnics. Atmospheric Environment 44(27):3295-3303.				
HERO ID:	851253				
Conditions of Use:	Use of explosives				
EXTRACTION					
Parameter	Data				
Worker activity description:	Performer				
Exposure route:	inhalation				
Physical form:	vapor				
Personal sampling data:	Personal <0.02 mg/m3 & 0.02 mg/m3;				
Area sampling data:	Area <0.02 mg/m3 & 0.02 mg/m3; for entire show 0.003 mg/m3				
Exposure duration:	up to 2 hours				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	High	Data are for fire work displays which are an in-scope occupational scenario.	
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.	
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing [numberof samples and number exposed]	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology and variability was presented for different performances.	
Overall Quality Determination		High			

Formaldehyde

Occupational Exposure

HERO ID: 80252 Table: 1 of 1

Study Citation:	Crump, D.R., Yu, C.W., Squire, R.W., Atkinson, M. (1996). Small chamber methods for characterizing formaldehyde emission from particleboard. :211-224.			
HERO ID:	80252			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Area sampling data:	Daily average emission rate 0.070 mg/m2-hr (day 6) 0.094 mg/m2-hr (day 7;) 0.0071 mg/m2-hr (day 8); 0.069 mg/m2-hr (day 9); 0.076 mg/m2-hr mean.			
Exposure duration:	Sampling period 10 days			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Used European guideline CEC COST 613 for chamber and field site
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	UK OECD member
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after the PEL- Published 1996
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing: number of samples, number of sites, worker activities, Exposure frequency, number of workers
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	variance over time is quantified but not uncertainty
Overall Quality Determination		Medium		

Study Citation:	Currie, J., Caseman, D., Anthony, T.R. (2009). The evaluation of CBRN canisters for use by firefighters during overhaul. Annals of Occupational Hygiene 53(5):523-538.			
HERO ID:	834715			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Worker activity description:	Structural firefighters involved in overhaul operations and wildland firefighters			
Exposure route:	Inhalation			
Personal protective equipment:	This study evaluated the performance of three chemical, biological, radiological, and nuclear (CBRN) canisters (MSA, 3M, and Scott) and one multi-gas canister similar in appearance to CBRN canisters but without CBRN certification. For all tests, the APR canister reduced the overall irritant index to levels below unity, indicating that these canisters would provide protection for firefighters working in overhaul environments. Formaldehyde was present in the challenge air at concentrations that exceeded the occupational exposure limits (OELs) (peak challenge concentration for formaldehyde was 1.6 ppm and more than 5 times the OEL). However, in each test conducted, the CBRN canisters were found to reduce the formaldehyde concentrations to less than 1% of the OEL for formaldehyde. Penetration was calculated at <2% for formaldehyde.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described methodology
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	data between 10 and 20 years old
	Metric 5:	Sample Size	Medium	characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study has very limited discussion on variability and none for uncertainty
Overall Quality Determination		Medium		

Study Citation:	D. Majumdar (née som), Dutta, C., Mukherjee, A.K., Sen, S. (2008). Source apportionment of VOCs at the petrol pumps in Kolkata, India; exposure of workers and assessment of associated health risk. Transportation Research Part D: Transport and Environment 13(8):524-530.			
HERO ID:	1058107			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Area sampling data:	11.6-55.5 (ug/m^3)			
Number of workers:	35			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country (India).
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data is from more than 10 years ago but less than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Daftarian, H. S., Roegner, K. C., Reh, C. M. (2000). Health hazard evaluation report 98-0011-2801 Woodbridge Corporation Brodhead, Wisconsin July 2000.
HERO ID:	1317223
Conditions of Use:	Construction Manufacturing

EXTRACTION

Parameter	Data
Worker activity description:	A robot applies the wax to molds on the B-line. On the A-line wax is applied manually. Workers in the A-line demold station rotate through the wax application booth in 60-minute intervals. The waxdispersion is applied to the bowl of the mold using an air atomization spray gun. Workers in the insert area are responsible for inserting components such as metal frames/wires and velcro patches, into the bowl of the mold before it reaches the pourhead. Typically, fiveemployees work at each of the insert stations. One of the five insert workers is rotated off the line, in turn, into what is termed a supply job, which entails bringing needed materials to theother workers at the insert station. This rotation occurs at 60-minute intervals.The pourhead is the point where the TDI and polyol components come together and the mixture is dispensed by a robot into the bowl of an open mold. Each of the pourheads is fully automated,and a worker is not required to be in the immediate vicinity. Persons in the demold area are responsible for removing the foam cushion from the mold and cleaning the mold in preparation for the next cycle. The demold work station is subdivided into pullers, tossers, and mold cleaners. Pullers loosen the foam cushions from the bowls of molds. The tosser removes the foam cushion from the mold and places it on a conveyor belt. Mold cleaners pull tape and residual foam flash out of the mold. After the foam cushions are removed from the molds, employees in the offline area trim, sort,inspect, and repair the finished foam product. (p.9)
Exposure route:	inhalation
Physical form:	vapor/gas
Personal sampling data:	Typical operationsLine B Demold 0.055 ppmLine A Demold 0.061 ppmLine B Insert 0.057 ppmLine A Demold 0.07 ppmLin A Insert 0.07 ppmCold BlastMold cleaner 0.021 ppmMold Cleaner 0.056 ppmMold Cleaner 0.017 ppmMold Cleaner 0.014 ppm
Area sampling data:	Typical operationsAbove Line B passive exhaust vent 0.065 ppmInside Quality Lab 0.034 ppmStorage Area - North end 0.052 ppmAbove Poly N/E manway 0.05 ppmCold BlastOn table in blasting area 0.012 ppm Above molds entering blasting area 0.017 ppmAbove Poly N/E manway 0.02 ppmAbove passive exhaust vent line B 0.013 ppmStorage Area - North end 0.013 ppm
Number of workers:	At the time of the first site visit in November 1998, the Woodbridge Brodhead plant employed 240 hourly workers, distributed equally across three shifts. Sixty-eight hourly workers per shift work directly on the production line, 34 on each line. Of these 68 employees, 16 work directly on the foam production line (i.e., insert or demold), and the remainder work in the offline area. Other hourly employees work in the warehouse area (where baskets of cushions are stacked), or as tooling or maintenance specialists. (p. 9)
Personal protective equipment:	supplied air hood during ice blasting (p.14)gloves
Comments:	Noted that the source of formaldehyde is within the plant, but actual sources could not be identified.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method (NIOSH Study Method 2016)
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Low	The data are for an occupational scenario but the source of formaldehyde exposure is unknown. "no previous industrial hygiene data or rationale could be cited to indicate thatformaldehyde should be evolving frompolyurethane foam production processes. Thesource of the formaldehyde at the Brodhead plantis unknown at this time."(p. 30) Therefore data cannot be matched with a COU within the scope of the risk evaluation, however it may be suitable for commercial use of building materials

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Formaldehyde

Occupational Exposure

HERO ID: 1317223 Table: 1 of 1

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Study Citation:	Daftarian, H. S., Roegner, K. C., Reh, C. M. (2000). Health hazard evaluation report 98-0011-2801 Woodbridge Corporation Brodhead, Wisconsin July 2000.			
HERO ID:	1317223			
Conditions of Use:	Construction Manufacturing			
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 4:	Temporal Representativeness	Medium	Sampling implemented in 1999, after the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was considered in Method 2016.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations and jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in Method 2016.
Overall Quality Determination			High	

Study Citation:	Dahlgren, J.G., Talbott, P.J. (2018). Asthma from hair straightening treatment containing formaldehyde: Two cases and a review of the literature. Toxicology and Industrial Health 34(4):262-269.			
HERO ID:	4455144			
Conditions of Use:	Commerical Use-Hair Straigthening Products (FDA Use)			
EXTRACTION				
Parameter	Data			
Worker activity description:	The process involves applying the product solution, blow drying, and applying a hot iron. Stylists first apply the solution, blowdry the hair, and then flat iron (heat-treats at about 400F) the hair. A follow-up conditioner, rinse, and blow dry is sometimes used.			
Exposure route:	This process created fumes that caused immediate irritating symptoms in the eyes, nose, and throat.			
Area sampling data:	0.059 to 1.88 ppm during application of hair straightening treatments; 1.3 ppm during application; 0.9 ppm during blow drying; 3.59 ppm during peak exposure in the blow-drying process; environmental formaldehyde levels ranged from 0.09 to 0.16 ppm in four salons that used products versus 0.02 and 0.04 ppm in salons that did not use them; the mean concentration for Zone 1 measured in the immediate area of the stylist was 1.17 ppm and in zone 4, the mean concentration was 0.52 ppm. Combining Zones 2 and 3 gives a concentration of about 0.705 ppm; The air levels during blow-drying operations were air concentration of 3.47 and 1.05 ppm in the area where the hair stylist worked.			
Comments:	Study also includes a summary of studies on formaldehyde-related asthma, with exposures levels that induced a response.; Data provided from multiple studies.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Uninformative	The data are for a FDA use, which is outside the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study did not addresses uncertainty in the exposure estimates.

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Formaldehyde

Occupational Exposure

HERO ID: 4455144 Table: 1 of 1

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Study Citation:	Dahlgren, J.G., Talbott, P.J. (2018). Asthma from hair straightening treatment containing formaldehyde: Two cases and a review of the literature. Toxicology and Industrial Health 34(4):262-269.
HERO ID:	4455144
Conditions of Use:	Commerical Use-Hair Straigthening Products (FDA Use)

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		Uninformative	

Study Citation:	Daniels, W. J. (1989). Health Hazard Evaluation Report HETA 89-007-1983, St. Thomas More Hospital, Canyon City, Colorado, September 1989.			
HERO ID:	1628028			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers dealing with anesthetic gases and vapors in a hospital (primarily morgue); During the preparation of tissues, various organic solvents are used. Approximately once per month, tissuespecimens which are stored in a formaldehyde solution are required to be dumped in the morgue area. No localexhaust ventilation is used during this procedure.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Formaldehyde was found at a TWA concentration of 4.8 ppm in a 63 minute PBZ sample.			
Area sampling data:	A TWA concentration of 1.8 ppm was found in both general area samples collected in the room			
Exposure frequency:	once per month			
Number of workers:	2 employees work in the specific area.			
Engineering control:	Local exhaust ventilation should be installed at the operation where the formaldehyde is dumped to help reduce exposure to this substance to the lowest feasible level. The particular type of ventilation used would depend on the location where the operation is to be placed. However, the system should enclose the process as much as possible and maintain sufficient capture velocity to keep the formaldehyde from entering the work atmosphere.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is approved by NIOSH (1400 and 1501)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old prior to the most recent PEL
	Metric 5:	Sample Size	Medium	Discrete values provided, however, only 2 area samples and 1 personal sample was measured.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include sample type, sample duration, frequency, location and worker activity. It is assumed that sample duration was equivalent to the exposure duration based on the calculation of the 8-hr TWA.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability in exposure determinant (e.g., different location or time). It is assumed that uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Daniels, W., Almaguer, D., Kramkowski, R. (1987). Health Hazard Evaluation Report HETA-86-0343-1822 Sheller-Glose (Allen Industries, Inc.), Herrin, Illinois. :23.
HERO ID:	8197552
Conditions of Use:	Processing-Reactant-Intermediate in-Plastic materials and resin manufacturing

EXTRACTION

Parameter	Data
Worker activity description:	Old Compound Room - resin powder mixing; Airlay Dept - The cotton material is first taken from the bales and placed into feed blend boxes. It is then formed into a continuous sheet material on a conveyor line. Next it is transported to one of the three Airlay lines. At the Airlay lines, one of the two resin materials prepared in the Old Compound Room is dispensed onto the cotton material as it passes along the conveyor system. The material then enters a curing oven (450° - 500° F), and is pressed and cut as it leaves the oven; Hot Oil Department - partially cured blankets from the Airlay department are taken from pallets and placed in the hotoil presses for curing and forming to the desired shape under heat (300° - 450° F) and pressure...One employee works on either side of each press placing new blankets in the press and removing them at the end of the press cycle. A third employee is sometimes present to trim the molded product. In some cases, one group of employees may work two presses.
Exposure route:	inhalation
Personal sampling data:	Hot oil Operator - Press # 1002-1003 - <LOQ, Press # 1009 - <LODOven Operator - Line 3 - <LOQ
Area sampling data:	Exit from Oven - Line 3 - <LOQOn Pump Frame - <LOD
Exposure duration:	8 hr/day
Number of workers:	520 employees, including 2 in the Old Compound Room, up to 15 in the Airlay Department, and the Hot Oil Department, with 114 employees over 3 shifts.
Engineering control:	Hot Oil Dept. has general ventilation and air moving fans.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty			

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 8197552 Table: 1 of 1

...continued from previous page

Study Citation:	Daniels, W., Almaguer, D., Kramkowski, R. (1987). Health Hazard Evaluation Report HETA-86-0343-1822 Sheller-Glose (Allen Industries, Inc.), Herrin, Illinois. :23.				
HERO ID:	8197552				
Conditions of Use:	Processing-Reactant-Intermediate in-Plastic materials and resin manufacturing				
Domain		Metric		EVALUATION	
				Rating	Comments
	Metric 7:	Metadata Completeness		High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination				High	

Study Citation:	Daniels, W., Kramkowski, R. (1986). Health Hazard Evaluation Report HETA 1985-0083-1705 Summit Finishing Company, Inc., Mooresville, Indiana.			
HERO ID:	8684543			
Conditions of Use:	Plating agents and surface treating agents in all other chemical product and preparation manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees are located at the head end of the production line to load the stock, and at the tail end of the lines to check the finished products and ensure proper winding of the material onto spools. The employees also periodically enter the tank area to check the operating conditions of the tanks and maintain the solutions. On occasion, the individual lines are "rebuild" to accomidate new products and plating solutions, a process which often requires the employees to work in the proximity of operational plating lines. Also, employees working at the remaining plating lines are responsible for moving the hangers or racks containing the parts through a series of tanks containing the pretreatment and plating solutions. The nature of these operations brings the operators into close proximity to the plating tanks. Additionally, the reflow operator places batches of plated parts into a container of heated oil, following this the parts were dipped into a tank of perchloroethylene to remove the residual oil. (6/25)			
Exposure route:	inhalation, dermal (24/25)			
Physical form:	vapors (24/25)			
Area sampling data:	Two area samples were less than the LOD of 2 ug/sample. (21/25)			
Number of workers:	67 employees, 26 of them in production operations. (4/25)			
Personal protective equipment:	PPE included safety shoes, safety glasses, and cloth work gloves, with goggles, face shields, aprons, rubber gloves, and boots available for specific activities. Respirators were also available. (6/25)			
Engineering control:	The majority of the metal pretreatment and electroplating tanks are supplied with local exhaust ventilation and covers that could be open or closed. (6/25)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plating agents, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1013846 Table: 1 of 1

Study Citation:	Davis, M.E., Blicharz, A.P., Hart, J.E., Laden, F., Garshick, E., Smith, T.J. (2007). Occupational Exposure to Volatile Organic Compounds and Aldehydes in the U.S. Trucking Industry. Environmental Science and Technology 41(20):7152-7158.			
HERO ID:	1013846			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Worker activity description:	P&D driver; mechanic			
Area sampling data:	Mean values: P&D Driver (nonsmoker): 8.30 (ug/m^3); P&D Driver (smoker): 9.59 (ug/m^3); Loading dock: 25.44 (ug/m^3); Mechanic shop: 13.72 (ug/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (median, mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency, exposure duration, engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple locations at multiple sites, but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Dehghani, M., Hashemi, H., Khodabakhshi, A., Rastgoo, E., Taghizadeh, M. M. (2016). Modelling of formaldehyde dispersion in the industrial park air using GIS. International Journal of Environment and Waste Management 16(4):293-304.			
HERO ID:	6155459			
Conditions of Use:	Processing: Melamine powder production			
EXTRACTION				
Parameter	Data			
Area sampling data:	38.1 ug/m3 near the chemical industry. The source includes additional air monitoring locations in residential areas and near highways, with formaldehyde concentrations ranging from 2.2 to 3.6 ug/m3. Includes measured and modeled values.			
Comments:	Study includes measured and modeled formaldehyde concentrations at an industrial park and residential areas surrounding it.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3:	Applicability	Low	The data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, such as a consumer DIY scenario that is similar to a worker scenario (air concentration was conducted near the chemical industry, not in the occupational areas where workers and ONUs are present).
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
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Formaldehyde

Occupational Exposure

HERO ID: 6155459 Table: 1 of 1

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Study Citation:	Dehghani, M., Hashemi, H., Khodabakhshi, A., Rastgoo, E., Taghizadeh, M. M. (2016). Modelling of formaldehyde dispersion in the industrial park air using GIS. International Journal of Environment and Waste Management 16(4):293-304.		
HERO ID:	6155459		
Conditions of Use:	Processing: Melamine powder production		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Low	

Study Citation:	Dement, J. M., Smith, N. D., Hickey, S., J.L., Williams, T. M. (1984). An evaluation of formaldehyde sources, exposures and possible remedial actions in two office environments. 3:99-104.			
HERO ID:	22861			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	office work			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Modular offices: Unoccupied without any mechanical ventilation 0.33-0.78 ppm averages (peak 0.80); occupied before improvements 0.06-0.23ppm averages (peak 0.29 ppm); occupied after new air conditioning unit <0.05-0.08 ppm (peak 0.08). New Office: Initial 0.15 ppm average (peak 0.34 ppm); Interim 0.10 ppm average (peak 0.40 ppm); Most recent 0.08 ppm average (peak 0.11 ppm).			
Engineering control:	Ammonia fumigation at 1000 ppm for 24 hrs reduced formaldehyde concentrations by 70% and increased dilutin ventilation reduced concentration below 0.1 ppm			
Comments:	Average concentration refers to the range of average values obtained in the 12 units sampled. Unoccupied office temperature was 83 to 93F			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology noted that Impingers/chromotropic acid and pararosaniline procedures were used, but more specifics are not included. No indication of flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - 1984 but the test data are from 1981-1983
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - average and peak values are provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only discussion of the variability due to relative humidity, ventilation, and new vs. older buildings. The monitoring study provides only limited discussion of theuncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Dement, J. M., Zumwalde, R. D., Parnes, W. (1972). Fibrous Glass Dust and Industrial Hygiene Survey at Pittsburgh Plate Glass Industries, Shelbyville, Indiana.			
HERO ID:	1320952			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Formaldehyde concentrations ranged from 0.01 to 0.08 ppm.At Forming Station Superfine #203 0.02 ppmAt Control Panel Superfine #203 0.01 ppmAt Control Panel of Uncured Mat Line 0.02 ppmAt Curing Oven in Molded Pipe 0.08 ppm			
Number of workers:	600			
Personal protective equipment:	Safety glasses and respiratory protection devices were provided.			
Engineering control:	Curing ovens for the superfine and rotary process leak badlyand emit dense smoke into the work areas. Ventilation improvements for these ovens are badly needed. One obvious improvement would be to increase the stack air flow and provide better hooding at the oven entrances.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study - but methods used were not from NIOSH.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (fiberglass manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1972 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the method that NIOSH used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure types, and sample durations, but lacks additional metadata, such as exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between different locations/operations. Uncertainty was not discussed but assumed that it was addressed in the method that NIOSH used.
Overall Quality Determination			High	

Study Citation:	Dharmawardene, L. I. (1991). Finger clubbing in match factory workers in Fiji. Ceylon Medical Journal 36(2):73-76.			
HERO ID:	1514439			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Match factory workers in Fiji - first worker was a chemist and the second worker was a lab technician.			
Exposure route:	Dermal			
Number of workers:	2			
Personal protective equipment:	First worker used dust respirator and goggles when handling chemicals and wore gloves only when handing phosphorus, urea, formalin and antimony. The second worker used a dust respirator and goggles, but never used gloves when handling chemicals in the first 6 years. He started using gloves in the last 3 years.			
Comments:	This article reports two cases of clubbing of fingers.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Not equivalent to an approved OSHA or NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	non-OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data greater than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type, but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty
Overall Quality Determination			Low	

Study Citation:	Diberardinis, L., Edwards, R., Herrick, R., Julien, R. (2001). Strategy to assess exposure of laboratory personnel to select OSHA-regulated chemicals at Massachusetts Institute of Technology. Chemical Health and Safety 8(4):25-29.			
HERO ID:	6278284			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Personnel engaged in research activities at Massachusetts Institute of Technology laboratories that utilized the following five chemicals regulated by OSHA: benzene, formaldehyde, chloroform, methylene chloride, and arsenic compounds. Eight laboratories were selected.			
Exposure route:	inhalation			
Personal sampling data:	Formaldehyde concentrations in personal sample were 0.441 (sample time = 15 min) and 0.083 ppm (sample time = 80 min).			
Area sampling data:	Formaldehyde concentration in area sample was 0.014 ppm (calculated 8-hr TWA).			
Exposure duration:	nan			
Exposure frequency:	nan			
Number of workers:	Eight laboratories were selected.			
Engineering control:	adequate ventilation			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	data is between 10 and 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	monitoring study does not address variability or uncertainty
Overall Quality Determination		Medium		

Study Citation:	Dimenstein, I.B. (2009). A Pragmatic Approach to Formalin Safety in Anatomical Pathology. Laboratory Medicine 40(12):740-746.			
HERO ID:	1986504			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers in histology laboratory			
Personal sampling data:	Personal samples at 2 grossing stations collected on the same day near each other came back with different readings. One was 10 ppm while another showed 0.055 ppm. No one on this day reported any odors that would be consistent with high formaldehyde exposures.			
Personal protective equipment:	Recommended PPE are disposable gown, gloves, and safety glasses. Vented goggles are preferable while cleaning up. Additionally, a wet mask (preferably a Kimberly-Clark Face Shield type) should be worn. The wet mask is ideal because the evaporating formaldehyde goes through the multi layers of a dry mask, but a wet mask partially absorbs formaldehyde due to its high solubility in water. Both types of laboratory gloves, nitrile and latex, used in anatomical pathology laboratories are eventually formalin permeable. Nitrile gloves seem more resistant to mechanical damage. Double gloves are highly recommended.			
Engineering control:	The engineering controls for histology, pathology, and anatomy laboratories are mandated by OSHA at the level of local exhaust ventilation. A histology laboratory uses hoods, for example, at grossing workstations. The optimal choice is a back-vented station. Laboratory hoods have face velocities (the flow rate at the front of the hoods) in the 60–100 fpm range.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	report uses high quality data and/or techniques
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	data is between 10 and 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimate
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1986339 Table: 1 of 1

Study Citation:	Dingle, P., Tapsell, P., Hu, S. (2000). Reducing formaldehyde exposure in office environments using plants. Bulletin of Environmental Contamination and Toxicology 64(2):302-308.			
HERO ID:	1986339			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	office workers			
Area sampling data:	Monitoring was conducted in 18 conventional office buildings and 20 portable buildings used as offices in Perth, Western Australia. Average levels of formaldehyde in office buildings ranged from background levels of 10 ppb to 2110 ppb. Concentrations in the 18 conventional office buildings ranged from 10 ppb in an established office building to 78 ppb in a new four storey office building. Formaldehyde concentrations in 20 portable buildings ranged from 420 ppb to 2110 ppb. The highest levels of formaldehyde found were in newly constructed portable buildings. All these levels exceeded the recommended indoor guideline of 100 ppb and frequently exceeded the occupational standard of 1000 ppb. With plants, no change in formaldehyde concentrations with the addition of 5 or 10 plants in the rooms and only an 11% reduction in formaldehyde concentrations with 20 plants in the room.			
Engineering control:	Different plants were used as air purifiers. Plants include spider plant, fig tree, cast-iron plant, dumb-cane, and arum ivy. Up to 20 plants were used.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is well described and found to be equivalent to approved methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector, and no discussion on uncertainty.
Overall Quality Determination			High	

Study Citation:	Diodiu, R., Galaon, T., Bucur, E., Stefan, D.S., Pascu, L.F. (2016). Aldehydes, acetone, formic and acetic acids in indoor air of an office building. Revista de Chimie 67(12):2396-2399.			
HERO ID:	5950760			
Conditions of Use:	General population - office buildings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Indoor office workers. (1/4)			
Exposure route:	inhalation (1/4)			
Area sampling data:	"Area 1: 38.30 ug/m3 Area 2: 42.00 ug/m3 Area 3: 31.48 ug/m3 Area 4: 41.53 ug/m3 Outdoors: 0.61 ug/m3 (3/4)"			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Romania, a non-OECD country.
	Metric 3:	Applicability	Low	Data are for ambient air in an office, which is similar to the in-scope occupational scenario use of furniture products.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure concentration provided but missing most other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling four locations around the office, and comparing them to an outdoor location.
Overall Quality Determination		Medium		

Study Citation:	Doane, M., Sarenbo, S. (2014). Exposure of farm laborers and dairy cattle to formaldehyde from footbath use at a dairy farm in New York State. Science of the Total Environment 487:65-71.			
HERO ID:	2402019			
Conditions of Use:	Non-TSCA			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers in diary industry tending to dairy cattle			
Exposure route:	inhalation and dermal			
Physical form:	vapor			
Personal sampling data:	no breathing zone samples were collected			
Area sampling data:	Formaldehyde concentrations in ambient air measured at the milking facility on Day 1 ranged between 0.04 and 1.4 ppm, on Day 2 ranged between 0.02 and 1.2 ppm, and on Day 3 ranged between 0.05 and 2.3 ppm. (from graphs on page 4/7)			
Personal protective equipment:	protective clothing, eye wear, gloves and a respiratory mask			
Engineering control:	ventilation			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	only the critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainty
Overall Quality Determination		High		

Study Citation:	Dodson, R.E., Houseman, E.A., Levy, J.I., Spengler, J.D., Shine, J.P., Bennett, D.H. (2007). Measured and modeled personal exposures to and risks from volatile organic compounds. Environmental Science and Technology 41(24):8498-8505.			
HERO ID:	1067092			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Teachers and office workers were sampled. (1/8) Area samples were taken at retail stores, dining establishments, and transportation modes. (2/8)			
Exposure route:	inhalation (1/8)			
Personal sampling data:	Median of personal samples: 18 ug/m3 (Table 2, pg. 6/8)			
Area sampling data:	Median of area samples, not including transportation: 3.62 ug/m3 Median of area samples, including transportation: 3.00 ug/m3(See Table 2 for more info)			
Number of workers:	55 included in study (2/8)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for ambient air in an office/building, which is similar to the in-scope occupational scenario use of furniture products.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (medians, confidence intervals) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability isn't addressed.
Overall Quality Determination		Medium		

Study Citation:	Dow Chemical, (2017). [Redacted] 2016 Exposure monitoring for XXX formaldehyde, XXX at the Michigan Operations Environmental Operations Facility, Midland, MI, USA.			
HERO ID:	10602380			
Conditions of Use:	Chemical substances in treatment products			
EXTRACTION				
Parameter	Data			
Worker activity description:	raking the bar screener at the waste water treatment plant (p. 3)			
Area sampling data:	37 samples collected, 7 short-term during bar screener raking: first one was 1.9ppm FA, next six were 0.009-0.095 ppm, 3 short-term during process area walk-through: ranged from 0.008 to 0.041 ppm (p. 3)			
Exposure duration:	10-60 min (p. 5)			
Personal protective equipment:	respirator with a MPC cartridge (p. 2)			
Engineering control:	local ventilation (p. 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Report uses EPA TO-11/NIOSH 2016 methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or updateor are generally, no more than 10 years old, whichever is shorter.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Uncertainty can be determined from the sampling and analytical method. The monitoring study does not address variability.
Overall Quality Determination			High	

Study Citation:	Dow Chemical, (2017). [Redacted] 2016 Exposure monitoring for XXX at Dow Water Solutions Ion Exchange-Anion/SR Facility, 963 Building, Midland, MI USA.			
HERO ID:	10602381			
Conditions of Use:	Resin MFG (ion exchange)			
EXTRACTION				
Parameter	Data			
Worker activity description:	The following job classes were monitored: Anion Operators, SR Operators, Tech Advisor, and Logistic workers; Anion operators- performed the task of Unhooking Paraformaldehyde Car; performed the task of Sampling T55 overheads and bottoms; task of Line and equipment opening (LEO) on silo, replacing radar on top of silo; removing 2 Pop Valves on blower; Tech Advisor- Star Valve LEO and valve cleanout			
Personal sampling data:	Pg 3:General full shift work (Anion Operator)Two General 8 hour Time Weighted Average (TWA) samples were collected during routine shifts. During the shift, operators performed several tasks including unhooking a Paraformaldehyde car and sampling T55 overheads and bottoms. The results were 0.025 ppm and 0.0085 ppm respectively as an 8 hour Time Weighted Average. LEO on silo, replace radar on top of silo(Anion Operator)- One STEL sample was collected for this task. The results were 0.056 ppm. Removed two Pop Valves on blower (Anion Operator)- One STEL sample was collected for this task. The results were 0.0065 ppm. Star Valve LEO and Valve Cleanout (Anion Operator)- One STEL sample was collected for this task. The results were 3.0 ppm. Operator had supplied air on while conducting this task. Samples will need to continue to be collected for this task.Star Valve LEO and Valve Cleanout (Tech Advisor)- Two STEL samples were collected for this task on different days. The results were 2.9 ppm and 3.1 ppm respectively, for an average of 3.0 ppm. Operator had supplied air on while conducting this task. Samples will need to continue to be collected for this task.			
Exposure duration:	340 min, 350 min, 23 min, 15 min, 26 min, 42 min, and 19 min sampling times			
Personal protective equipment:	supplied air (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for an ion exchange facility, which is in-scope for FA under paint and coating MFG
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, worker activities and exposure type, but lacks additional metadata, such as exposure durations, exposure frequency..
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty can be determined from the sampling and analytical method but variability are not addressed.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 10602381 Table: 1 of 1

...continued from previous page

Study Citation:	Dow Chemical, (2017). [Redacted] 2016 Exposure monitoring for XXX at Dow Water Solutions Ion Exchange-Anion/SR Facility, 963 Building, Midland, MI USA.		
HERO ID:	10602381		
Conditions of Use:	Resin MFG (ion exchange)		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 10602389 Table: 1 of 1

Study Citation:	Dow Chemical, (2018). [Redacted] 2017: Area monitoring for formaldehyde XXX Ion Exchange, Cation, Midland, MI.		
HERO ID:	10602389		
Conditions of Use:	Processing: Incorporation into a product		
EXTRACTION			
Parameter	Data		
Worker activity description:	Formaldehyde was unloaded and handled in solid form in the adjacent Anion plant; Formaldehyde was also a bi-product sent to a THROX unit located just east from the Cation control room and was a decomposition product (p. 3)		
Physical form:	solid (p. 3)		
Area sampling data:	Formaldehyde was detectable on area samples within the Cation control room across the dates sampled. Results ranged from 0.0018 ppm to 0.0048 ppm. (p. 3)		
Engineering control:	Formaldehyde was also a bi-product sent to a THROX unit located just east from the Cation control room (p. 3)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (NIOSH 2016/EPA IP-6) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		High	

Study Citation:	Dow Chemical, (2017). [Redacted] 2017 Personal exposure monitoring for XXX formaldehyde, XXX at the Elk Grove Site, Elk Grove Village, Illinois, USA.		
HERO ID:	10602390		
Conditions of Use:	Chemical MFG (FA MFG or PROC - Reactant)		
EXTRACTION			
Parameter	Data		
Worker activity description:	Job Class: Chemical Operator; Activities: Change filters (Formaldehyde), Drumming Formaldehyde (pg 3)		
Personal sampling data:	Three short term samples were collected on an Operator while drumming finished products. The results were 0.027 ppm, 0.038 ppm and 0.015 ppm. One short term sample was collected on an Operator while changing filters. The result was 0.012 ppm. (pg 4)Pg 7 also lists 0.012 ppm sample which was 33 min sampling duration. Pg 9-10 also lists the drumming results for sampling times of 53 min, 60 min, and 44 min respectively		
Personal protective equipment:	chemical resistant; FRC; goggles; Safety shoes; apron (pg 7; 9-10)		
Engineering control:	noted no ventilation		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method (NISOH 2016/38C-4A1-TSG)
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Medium	Data appear to be for either FA MFG or FA PROC, not clear which but both in scope.
	Metric 4: Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 10602393 Table: 1 of 1

Study Citation:	Dow Chemical, (2018). [Redacted] 2017: Personal monitoring for XXX formaldehyde, XXX 1803 Building, Midland MI.			
HERO ID:	10602393			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Lab employees dispensing from a large container into smaller jars (pg 2)			
Personal sampling data:	0.013 ppm, 0.016 ppm, 0.036 ppm (pg 6)			
Exposure duration:	24, 18, 24 min sampling (pg 6)			
Personal protective equipment:	lab coat, nitrile gloves and safety glasses with side shields (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method (EPA TO-11/NIOSH 2016).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is from the U.S.
	Metric 3:	Applicability	High	Data is for Lab Use, an in-scope OES
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old (2017).
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, sample durations and exposure type, but lacks additional metadata, such as exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			High	

Study Citation:	Dow Chemical, (2019). [Redacted] 2017: Monitoring for formaldehyde, XXX Dow Water Solutions, Ion Exchange - Anion/SR Facility, 963 Building, Midland MI.			
HERO ID:	10602394			
Conditions of Use:	Adhesive MFG; paint and coating MFG (ion exchange)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Anion Operators: filter change 1H3 Filter, changing PVRV and pop valves, line and equipment opening, , general 8h exposureTech Advisor: star valve line and equipment opening and valve cleanoutUnloader: change 1F4 filter, draining para de-mister, unhook and hook up rail car (pg 2)			
Personal sampling data:	One full-shift formaldehyde sample was collected while the Anion Operator performed routine tasks including: unloading paraformaldehyde. The result was 0.0057 ppm,which was below the ACGIH Ceiling and OSHA TWA. This result was consistent with two full shift samples collected in 2016. The Student’s T Best Estimate of the 95thpercentile was 0.099 ppm. This was just under the ACGIH TWA but below the Ceiling and the OSHA TWA.One short term sample was collected while Anion Operators changed pop valves. The result was 0.012 ppm and was below the ACGIH Ceiling and OSHA STEL. Thiswas consistent for pop valve changes from past years which were not event driven.One short term task sample was collected while an Anion Operator changed the PVRV on the Para Silo. The result was 0.048 ppm and was below the ACGIH Ceilingand OSHA STEL. Additional samples will be needed to conduct statistical analysis.Two short term task samples were collected while an Tech Advisor performed a filter change on 1H3. The results were 0.46 ppm and non-detectable (ND) with adetection limit of 0.001 ppm. The first sample was above the ACGIH Ceiling but below the OSHA STEL. Additional samples will be needed to conduct statistical analysis.One short term task sample was collected while Anion Operators performed general line breaks in paraformaldehyde service. The result was 0.17 ppm and was belowthe ACGIH Ceiling and OSHA STEL. The 95th percentile of the distr bution was not in compliance with the ACGIH Ceiling.One short term task sample was collected while Anion Operators unplugged the star valve in the paraformaldehyde service. The result was 0.018 ppm and was belowthe ACGIH Ceiling and OSHA STEL. This was significantly different than past year’s data, which indicated both were exceeded. The difference in exposure potential maybe due to the installation of a de-mister unit in the system. Additional samples should be collected for statistical analysis.Seven short term task samples were collected while Unloaders drained the de-mister. This collection was to get a baseline understanding of exposure potential since thede-mister was installed this year. Results ranged from 3.1 ppm to ND with a detection limit of 0.003 ppm. The 95th percentile of the distribution was not in compliancewith the ACGIH Ceiling or OSHA STEL but was a good reduction in concentrations that resulted from previously having to unplug the star valve. The installation of the demisterwas an effort to eliminate the plugging issues. One result far exceeded the exposure limit at 3.1 ppm, but this instance was event driven and involved additionalline openings.One sample was collected while an Unloader changed filter 1F4. The result was 0.22 ppm and was below the ACGIH Ceiling and OSHA STEL. Additional samples willbe needed to perform statistical analysis.One short term sample was collected while the Unloader unhooked paraformaldehyde railcars. The result was 0.2 ppm which was below the ACGIH Ceiling and OSHASTEEL. (pg 3)			
Personal protective equipment:	supplied air (pg 8)			
Comments:	NIOSH 2016			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH/OSHA method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for paint and coating or adhesive MFG (ion exchange), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
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Formaldehyde

Occupational Exposure

HERO ID: 10602394 Table: 1 of 1

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Study Citation:	Dow Chemical, (2019). [Redacted] 2017: Monitoring for formaldehyde, XXX Dow Water Solutions, Ion Exchange - Anion/SR Facility, 963 Building, Midland MI.		
HERO ID:	10602394		
Conditions of Use:	Adhesive MFG; paint and coating MFG (ion exchange)		
Domain		EVALUATION	
Metric		Rating	Comments
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing [list missing metadata].
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		High	

Study Citation:	Dow Chemical, (2019). [Redacted] 2018: Personal monitoring for formaldehyde, XXX at the Anion/SR Plant in Ion Exchange Midland, MI USA.			
HERO ID:	10602415			
Conditions of Use:	processing into a formulation			
EXTRACTION				
Parameter	Data			
Worker activity description:	The following job classes were monitored: Anion Operators, Special Resins (SR) Operators, and Unloaders. Anion Operators performed line and equipment openings, maintenance activities, changing PVRV and pop valves, and filter changes on 1H3. Unloaders performed draining para de-mister, hookup and unhook railcars and tank trucks, 1F4 filter change (pg 2 of 15)			
Personal sampling data:	One short term sample was collected for Anion Operators during changing of pop valves. The result was 0.15 ppm. This is consistent for pop valve changes from past years when not event driven. The performance of statistical analysis which included previous monitoring concluded that the 95th percentile of the distribution was not in compliance with the ACGIH STEL or the OSHA STEL. All samples were below the OSHA STEL. One short term sample was collected for Unloaders while unhooking the paraformaldehyde railcars. The result was 0.035 ppm. The performance of statistical analysis which included previous monitoring concluded that the 95th percentile of the distribution was not in compliance with the ACGIH STEL. All samples were below the OSHA STEL. One short term sample was collected for Unloaders while hooking up and sampling of paraformaldehyde railcars. The result was 0.079 ppm. Additional samples are needed to perform statistical analysis. This sample was below the OSHA STEL. The above results were all below the ACGIH and OSHA STEL. One short term sample was collected for Anion Operator while performing a filter change on 1H3. The result was 0.32 ppm. This was above the ACGIH STEL but below the OSHA STEL. Additional samples are needed to perform statistical analysis. The following tasks were above both the ACGIH and OSHA STEL: One short term sample was collected for Anion Operators while performing general line breaks in paraformaldehyde service (Star Valve Cleanout). The result was 2.6 ppm. The 95th percentile of the distribution was not in compliance with the ACGIH STEL. One sample was collected while an Unloader changed filter 1F4. The result was 3.7 ppm. Additional samples are needed to perform statistical analysis. Four short term samples were collected while Unloaders drained the de-mister. The results ranged from 0.017 to 2.8 ppm. There is still potential to exceed the OELs but this was a good reduction to the previous concentrations that resulted from unplugging the Star Valve. The installation of the de-mister was an effort to eliminate plugging issues. The sample that resulted in level of 2.8 ppm was event driven and involved additional line openings than normal. The 95th percentile of the distribution is not in compliance with the ACGIH STEL. (pg 3 of 15)			
Exposure duration:	8 hr/day (pg 3 of 15)			
Personal protective equipment:	PPR used is referred as "basic plus"; however, there is no elaboration			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data collected is no more than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability. Uncertainty can be determined from the sampling and analytical method.
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Study Citation:	Dow Chemical, (2019). [Redacted] 2018: Personal monitoring for formaldehyde, XXX at the Anion/SR Plant in Ion Exchange Midland, MI USA.		
HERO ID:	10602415		
Conditions of Use:	processing into a formulation		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Dow Chemical, (2019). [Redacted] 2018: Summary of industrial hygiene monitoring for oxide.			
HERO ID:	10602416			
Conditions of Use:	Chemical MFG (uncertain)			
EXTRACTION				
Parameter	Data			
Personal sampling data:	15 min sample: ND (0.027 ppm) (pg 15)			
Personal protective equipment:	gloves (leather & chemical resistant as req.), FRC, chemical goggles (pg 15)			
Comments:	NIOSH 2016 sampling			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are for the U.S.
	Metric 3:	Applicability	Low	Data are for chemical MFG, however it is unclear what specific COU
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata. Descriptor of worker is unclear to the tasks the workers is performing.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Dow Chemical, (1988). [Redacted] Airborne formaldehyde from aqueous solutions.			
HERO ID:	10602429			
Conditions of Use:	General			
EXTRACTION				
Parameter	Data			
Worker activity description:	routine workroom exposure; material transfers from vessels; container packout or spills.			
Personal sampling data:	[MODELED ESTIMATES] The evolution rate at 60 degC is about 3 times (range 2. 7 to 3.0) higher than the rate at 25 degC for all concentrations. (pg 3 of 13); Modeled estimated 0.1 to 0.5ppm for standard workrooms with ventilation and enclosure, and above 1 ppm for the other scenarios (pg. 3/13)			
Engineering control:	Local exhaust ventilation of the air in the container during filling can virtually eliminate this emission and subsequent exposure. (pg 7 of 13)			
Comments:	Report uses experimentally determined rates of evolution of formaldehyde to then model occupational exposures. Occupational exposures were not monitored.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Experimental methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data collected is more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 10602469 Table: 1 of 1

Study Citation:	Dow Chemical, (2017). [Redacted] Industrial hygiene study: Employee exposure and area air monitoring for formaldehyde during the operation of the twin screw extruder machine in 3113 building, Midland Plant.			
HERO ID:	10602469			
Conditions of Use:	Plastic Converting			
EXTRACTION				
Parameter	Data			
Personal sampling data:	Two personal samples were collected from the personnel processing DuPont Delrin 100P NC010 through the twin screw extruder. The Time Weighted Averages (TWA) of the two personal samples were both < 0.013 ppm, which is less than the current MIOsha Action Level and PEL. The sample results also suggest conformance with the ACGIH ceiling limit. (pg 5 of 7)			
Area sampling data:	An area sample was collected at the head of the extruder. A second area sample was collected at the pelletizer, directly above the bucket of finished product. (pg 5 of 7). The result for the area sample collected at the head of the extruder was < 0.014 ppm, and the result for the area sample collected at the pelletizer was 0.13 ppm. (pg 6 of 7)			
Exposure duration:	8-hour (pg 5 of 7)			
Engineering control:	Local exhaust ventilation (pg 5 of 7)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling and analytical methodology is well described.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The monitoring data were collected no more than 10 years old.
	Metric 5:	Sample Size	High	Full sampling distribution provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		High		

Study Citation:	Dow Chemical, (2017). [Redacted] Industrial hygiene assessment of employee exposures to formaldehyde during manufacturing of Dow Corning® IT MQ-1644H Solid Resin in MOD B 2901 Building Dow Corning Midland Plant, Midland MI.			
HERO ID:	10602471			
Conditions of Use:	Plastics material and resin MFG			
EXTRACTION				
Parameter	Data			
Worker activity description:	Operator enters the production area to change the bag and then makes process rounds spending approximately 10-15 minutes on the floor at one time. Local exhaust ventilation is present at the twin screw and bagging operation. (pg 4)for personal sample: Operated twin screw extruder and bagging station. 7 20kg bags filled with MQ-1644H (pg 4)			
Exposure route:	inhalation			
Personal sampling data:	0.014 ppm (pg 3). 322min sample time (pg 4)			
Personal protective equipment:	hard hat, googles, SilverShield®/4H® gloves with a leather over glove; no respiratory protection (pg 4)			
Engineering control:	LEV (pg 4)			
Comments:	Personal samples were collected using SKC Inc UMEx 100 passive diffusion monitors. (pg 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastics material and resin MFG, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, butlacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study addresses variability in the determinants of exposure for the sampled site. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		High		

Study Citation:	Dow Chemical, (2019). [Redacted] Personal IH monitoring for XXX formaldehyde, XXX at the HT Facility in Deer Park, Texas from April 25, 2016 to September 19, 2018.			
HERO ID:	10602492			
Conditions of Use:	Processing- unknown			
EXTRACTION				
Parameter	Data			
Personal sampling data:	ND (0.002 ppm): Sample was collected while operator performed the task of a filter change on the strainer 273 and 0.013 ppm: Sample was collected while operator performed a filter change on the strainer 272 (pg 9)			
Exposure duration:	27 and 25 min sampling durations (pg 9)			
Personal protective equipment:	full face with dual cartridge (P-100), nitrile gloves, FRC’s or chemical suits, safety glasses, face shield, chemical steel toe boots or steel toe boots, and ear plugs. (pg 2)Full face; P-100; Neoprene; FRC/chemical suit; ear plugs; steel toe (pg 9)			
Comments:	EPA TO-11/NIOSH 2016 method			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH/OSHA method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario within the scope of the risk evaluation but the specific COU is unclear.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is not addressed. Uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Dufresne, A., Infante-Rivard, C., Malo, J.L., Gautrin, D. (2002). Exposure to formaldehyde among animal health students. AIHA Journal 63(5):647-650.			
HERO ID:	6192569			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Students in animal health technology during a weekly biology lab. (2/5)			
Exposure route:	inhalation (2/5)			
Physical form:	vapor (2/5)			
Personal sampling data:	The students in TC 1 were exposed to formaldehyde levels ranging from less than 0.11 to 0.76 mg/m3 with an average at 0.25 mg/m3 during the 3-hour biology laboratory. The students in TC 2 were exposed to higher concentrations of formaldehyde ranging from 0.26 to 1.2 mg/m3 with an average at 0.632 mg/ m3. (2/5)			
Exposure duration:	3 hours			
Number of workers:	36 (2/5)			
Personal protective equipment:	"Appropriate gloves, such as butyl rubber, nitrile rubber, or viton are recommended.(12) An approved respirator for use with formaldehyde, as described in the literature,(13) also would help. Also, anyone who uses a respirator must be fit tested and trained on the use of the respirator." (4/5)			
Engineering control:	"Local exhaust ventilation in the laboratory would be the ideal solution.... An alternative for cat dissection could be the use of videos on cat dissection. training centers could maximize the use of interactive videodiscs or multimedia computer techniques and minimize the number of animals used in labs." (4/5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at two student training centers.
Overall Quality Determination			High	

Study Citation:	Duhayon, S., Hoet, P., Maele-Fabry, G.V., Lison, D. (2008). Carcinogenic potential of formaldehyde in occupational settings: a critical assessment and possible impact on occupational exposure levels. International Archives of Occupational and Environmental Health 81(6):695-710.			
HERO ID:	1578389			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Unknown - assumed area sampling: Pinkerton (2004) TWA 0.15 ppm (range 0.09 -0.20 ppm) - page 10- these measurements are from three garment plants n=11,039)			
Number of workers:	14,014 (page 5, six chemical factories where formaldehyde was produced or used.			
Comments:	this is a meta-study of 10 other studies - unfortunately, data presented are of limited accuracy			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for the Garment workers which is an occupational scenario within the scope of the risk evaluation .
	Metric 4:	Temporal Representativeness	Low	Studies were published from 2004, after the PEL (1992) and the data was from early 1980
	Metric 5:	Sample Size	Medium	mean and ranges values were provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Metadata only included exposure type , but lacks additional metadata, such as sample type, sample durations, exposure frequency and durations and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The study provided range data that can be used to evaluate variability. Information about uncertainty is likely included in the NIOSH method used.
Overall Quality Determination		Medium		

Study Citation:	Duhayon, S., Hoet, P., Maele-Fabry, G.V., Lison, D. (2008). Carcinogenic potential of formaldehyde in occupational settings: a critical assessment and possible impact on occupational exposure levels. International Archives of Occupational and Environmental Health 81(6):695-710.			
HERO ID:	1578389			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Unknown - assumed area sampling: Coggon (2003) TWA >0.1 ppm, 0.1-0.5 ppm, 0.6-2 ppm, >2 ppm			
Number of workers:	14,014			
Comments:	this is a meta-study of 10 other studies - unfortunately, data presented are aggregated in a way that is challenging to clearly determine what emission source the data represent.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	UK - an OECD member
	Metric 3:	Applicability	High	The data are for the chemical workers which is an occupational scenario within the scope of the risk evaluation - it is not very specific.
	Metric 4:	Temporal Representativeness	Medium	Studies were published from 2003, after the PEL (1992) and more than 10 but less than 20 years old
	Metric 5:	Sample Size	Medium	ranges values were provided for exposure bins low, medium and high.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data only included exposure type , but lacks additional metadata, such as sample type, sample durations, exposure frequency and durations and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data f that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1578389 Table: 3 of 5

Study Citation:	Duhayon, S., Hoet, P., Maele-Fabry, G.V., Lison, D. (2008). Carcinogenic potential of formaldehyde in occupational settings: a critical assessment and possible impact on occupational exposure levels. International Archives of Occupational and Environmental Health 81(6):695-710.			
HERO ID:	1578389			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Number of workers:	375			
Comments:	this is a meta-study of 10 other studies - unfortunately, the Hildeheim (2001) data presented are aggregated in a way that is challenging to clearly determine what emission source the data represent.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Taiwan- not an OECD member
	Metric 3:	Applicability	High	The data are for hospital exposure which is an occupational scenario within the scope of the risk evaluation - though it is not very specific.
	Metric 4:	Temporal Representativeness	Low	Studies were published in 2001, but the data used in the study was from 1991-1994.
	Metric 5:	Sample Size	N/A	only exposure duration data were indicated
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include metadata, such as exposure type and durations, but lacks additional metadata, such as sample type, sample durations, exposure frequency, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	only exposure was indicated. Information about variability and uncertainty was not provided.
Overall Quality Determination		Low		

Study Citation:	Duhayon, S., Hoet, P., Maele-Fabry, G.V., Lison, D. (2008). Carcinogenic potential of formaldehyde in occupational settings: a critical assessment and possible impact on occupational exposure levels. International Archives of Occupational and Environmental Health 81(6):695-710.			
HERO ID:	1578389			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Unknown - assumed area sampling: Hauptmann (2004) peak exposure: >0-1.9 ppm, 2.0-3.9ppm, >4.0 ppm (also provided range of average intensity; Marsh & Youk (2005)mean : <1.046 ppm, 1.46-1.177 ppm, >1.178 ppm (range of peak exposures also provided; Marsh & Youk (2007) peak exposure >4.0 ppm			
Number of workers:	25619			
Comments:	this is a meta-study of 10 other studies - unfortunately, data presented are aggregated in a way that is challenging to clearly determine what emission source the data represent.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US - all studies consider the same set of 10 plants
	Metric 3:	Applicability	High	The data are for the production or use of formaldehyde which is an occupational scenario within the scope of the risk evaluation - it is not very specific.
	Metric 4:	Temporal Representativeness	Medium	Studies were published from 2004-2007 but are based on data from 1934-1994.
	Metric 5:	Sample Size	Medium	ranges for mean and peak exposure are provided for exposure bins low, medium and high which vary by study.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include metadata, such as exposure type and durations, but lacks additional metadata, such as sample type, sample durations, exposure frequency, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data for different studies that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Duhayon, S., Hoet, P., Maele-Fabry, G.V., Lison, D. (2008). Carcinogenic potential of formaldehyde in occupational settings: a critical assessment and possible impact on occupational exposure levels. International Archives of Occupational and Environmental Health 81(6):695-710.			
HERO ID:	1578389			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Unknown - assumed area sampling: Marsh (2002) mean: >0-0.03 ppm, 0.03-0.15 ppm, >0.16 ppm			
Number of workers:	7359			
Comments:	This is a meta-study of 10 other studies - unfortunately, data presented are aggregated in a way that is challenging to clearly determine what emission source the data represent.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for plastic production which is an occupational scenario within the scope of the risk evaluation - it is not very specific.
	Metric 4:	Temporal Representativeness	Low	Studies were published in 2002 but are based on data from 1941-1998.
	Metric 5:	Sample Size	Medium	ranges for mean exposure are provided for exposure bins low, medium and high
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include most critical metadata, such as exposure type and durations, but lacks additional metadata, such as sample type, sample durations, exposure frequency, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Dunn, D. W., Johnson, M. L., Hedley, W. H., Pate, J. B., Barrett, G. J., Mckinnery, W. N. (1983). Reducing plant pollution exposure - Control practices at formaldehyde production plants. Chemical Engineering Progress 79(3):35-38.
HERO ID:	5972538
Conditions of Use:	Manufacturing

EXTRACTION				
Parameter	Data			
Worker activity description:	”Pumps used to recirculate the solution are generally single mechanical-seal centrifugal pumps from a variety of manufacturers. Some seal types are more effective than others in controlling leaks. However, during our walkthroughs, most seals showed signs of leakage as evidenced by the formation of solid paraformaldehyde in and around the pump housing... Although operators spend a minimum amount of time in the absorber area, the leakage at the pump seals represents the highest potential for worker exposure to formaldehyde... Single mechanical-seal pumps transfer the solution from the absorber to the distillation column. Because this pump is moving a high formaldehyde concentration, it has leakage and vapor problems similar to the recirculating pumps on the absorber... Formaldehyde loading is a top-fill operation using a dip tube into the tank truck... The formaldehyde operator is generally isolated from the tank truck during loading, often in a nearby building to prevent excess worker exposure. Automatic loading devices are in common use” (pg 3)			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	PBZ data (in ppm):Chief operator: 0.01-0.13Operator: 0.12-2.4Loader: 0.02-2.4Shipper: 0.01-0.06Maintenance worker: 0.24 Corresponding $\mu\text{g}/\text{m}^3$ values can be found in Table 2, pg 3.			
Number of workers:	8 to 141 workers (Table 1, pg 1)			
Personal protective equipment:	Hard Hat, Safety Goggles, Rubber Gloves, Protective Suit, Cartridge Respirator, Dust Mask, Supplied Air Respirator			
Engineering control:	”Formaldehyde loading is a top-fill operation using a dip tube into the tank truck. Personal protective equipment are normally used by the operators as a substitute for engineering controls. Some of the newer or more progressive plants use ventilation to control the vapors and scrubbers to capture the formaldehyde. The formaldehyde operator is generally isolated from the tank truck during loading, often in a nearby building to prevent excess worker exposure. Automatic loading devices are in common use” (pg 3)			
Comments:	Table 2 specifies operator and loader sampling is short-term, assumed full shift TWA for other workers sampled			

EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by evaluating multiple sites, but uncertainty is not addressed.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 5972538 Table: 1 of 1

...continued from previous page			
Study Citation:	Dunn, D. W., Johnson, M. L., Hedley, W. H., Pate, J. B., Barrett, G. J., Mckinnery, W. N. (1983). Reducing plant pollution exposure - Control practices at formaldehyde production plants. Chemical Engineering Progress 79(3):35-38.		
HERO ID:	5972538		
Conditions of Use:	Manufacturing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Dunn, W., Toy, H. D., Wright, A. J., Hedley, W. H., Holmes, L., Barrett, G. J. (1983). Detailed Industrial Hygiene Survey Formaldehyde Production, E. I. DuPont DeNemours and Company, Linden, New Jersey, Report No. CT-114-20b. NIOSH(068-03-3025):068-03.			
HERO ID:	1167915			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	Supervisor - Manages operationChief Operators - operates sulfuric acid and formaldehyde unit controls Formaldehyde unit operators - blending the formaldehyde solution , loading tank trucks and rail, checks, corrects, and cleans up any leakage.Maintenance workers - start up operations, catalyst change, and tank entry, and normal plant maintenanceMethanol tanker driver- provides product sample and connect to unloading lines			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	5 individuals were sampled [Table 3, Concentration column]Long-term sampling:Operator 1 0.09-0.56 ppmOperator 2 0.11 - 0.46 ppmChief operator 1 0.23-0.25 ppmChief operator 2 BDL-0.27 ppmProduction supervisor 0.21-0.46 ppm 8-hr TWA are also provided in Table 3Short term sampling[]:Process, sampling and analysis operator 1 BDL- 0.79 ppmProcess, sampling and analysis operator 2 0.54 - 1.76 ppmTruck loading operator 1 0.96-1.79 ppm			
Area sampling data:	Primary reactor - first floor BDL-3.63 ppmPrimary reactor - second floor 0.06-0.09 ppmAbsorber 0.09-0.58 ppmBlending 0.11-0.16 ppmHCHO storage - west 0.22-0.35 ppmHCHO storage - central 0.17-0.22 ppmTruck loading BDL-0.13-1.55Blending control 0.13-0.69 ppmBlending control hood 0.53-2.6 ppmTWA are also provided in Table 6Source samplesAbsorber bottom pump 115 - 142 ppmHCHO agitation/loading pump 18.7 - 20.2 ppm			
Exposure duration:	8 hour shifts			
Exposure frequency:	plant operates 3 shifts daily, 7 days per week. fourth shift rotated in each week			
Number of workers:	9 (includes an operator and chief operator on each shift and a production supervisor during day shifts)			
Personal protective equipment:	All formaldehyde operations: hard hats and side shield safety glassesStartup operations:Full-face respirators and rubber glovesLoading operations:Rubber glovesFull-faced acid gas cartridge respiratorMaintenance - major leak repair:Self contained breathing apparatus or air supplied respiratorRubber glovesChanging reactor catalyst:Rubber glovesFormaldehyde storage tank cleanoutComplete coverallsRespiratory protection if oxygen or formaldehyde sampling test indicate a needFormaldehyde sample collectionFull-face acid gas cartridge respiratorRubber glovesMethanol analysisRubber gloves			
Engineering control:	Converter - closed system, rupture disks prevent structure damage if over pressurized.Formaldehyde loading - ventilation systemTesting performed in a ventilated laboratory hoodwaste gas combusted in afterburner and boilerinstallation of safety showers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	As this is a joint NIOSH and EPA project, noted that that NIOSH approve the sampling and analytic methods used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (formaldehyde manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Survey was conducted in 1982 which is prior to the PEL (1992)
	Metric 5:	Sample Size	High	Results from each individual sampling event are provided, statistical summaries were not provided but could easily be developed from the data.
Domain 3: Accessibility/ Clarity				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1167915 Table: 1 of 1

...continued from previous page

Study Citation:	Dunn, W., Toy, H. D., Wright, A. J., Hedley, W. H., Holmes, L., Barrett, G. J. (1983). Detailed Industrial Hygiene Survey Formaldehyde Production, E. I. DuPont DeNemours and Company, Linden, New Jersey, Report No. CT-114-20b. NIOSH(068-03-3025):068-03.			
HERO ID:	1167915			
Conditions of Use:	Manufacture			
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	High	neither variance or uncertainty were discussed but as the results from each individual sampling event are provided, an analysis of variance between samples and locations is could easily be developed from the data. Assumed that uncertainty was consider with the NIOSH approved methodology
Overall Quality Determination			High	

Study Citation:	DuPont Haskell Lab, (1980). Industrial hygiene survey on formaldehyde and chloroform inhalation study.			
HERO ID:	5905590			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Organ and tissue preservation following dissection			
Exposure route:	Inhalation			
Personal sampling data:	0.03-0.10 (ppm)			
Area sampling data:	0.01-0.03 (ppm)			
Personal protective equipment:	Surgical rubber gloves			
Engineering control:	Fume hoods			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL. (1986)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple locations along with personal breathing zone samples, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation: Durgam, S., Page, E. (2011). Formaldehyde exposures during Brazilian blowout hair smoothing treatment at a hair salon – Ohio.
HERO ID: 8684525
Conditions of Use: Personal care products

EXTRACTION

Parameter	Data
Worker activity description:	A hairstylist washes hair, applies a smoothing solution, blow dries and flat irons the hair, applies a masque, then washes and styles it. (10/28)
Exposure route:	inhalation (10/28)
Physical form:	liquid (10/28)
Personal sampling data:	The formaldehyde concentrations for the task-based air samples ranged from 0.018–1.1 ppm. The short-term sample concentrations ranged from 0.018–1.3 ppm. (12/28)
Area sampling data:	When no treatment was performed, the GA air concentrations of formaldehyde ranged from 0.0044–0.025 ppm. The highest formaldehyde concentration (0.025 ppm) was measured in the dispensary and may be the result of pouring the Brazilian Blowout Acai Professional Smoothing Solution – Formaldehyde Free Smoothing Formula from the manufacturer’s bottle into a small dish before starting the treatment. When the Brazilian Blowout treatment was performed, the GA air concentrations of formaldehyde ranged from 0.057–0.11 ppm, with the highest formaldehyde concentration measured in the hair treatment room. (13/28)
Personal protective equipment:	The hairstylist wore disposable latex gloves while applying the smoothing solution to the hair. (10/28)
Engineering control:	The hair salon had a thermostatically-controlled residential HVAC system in the basement. The HVAC system used 1-inch thick pleated fiberglass air filters, and the supply air was delivered through floor vents. (10/28)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Uninformative	Data are for commercial use of personal care products, outside of the scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Exposure type, worker info, and sampling data provided, but missing exposure duration, frequency, and number of workers.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at different parts of the salon during different operations.

Overall Quality Determination

Uninformative

Study Citation:	Dykewicz, M.S., Patterson, R., Cugell, D.W., Harris, K.E., Wu, A.F. (1991). Serum IgE and IgG to formaldehyde-human serum albumin: Lack of relation to gaseous formaldehyde exposure and symptoms. Journal of Allergy and Clinical Immunology 87(1 Pt 1):48-57.			
HERO ID:	626265			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Histology technicians, pathology residents and autopsy dieners working at Northwestern Memorial Hospital, Chicago,			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	0.2-0.64 ppm for pathology residents and 0.64 ppm for histology technicians and 0.6-11 ppm for autopsy diener			
Number of workers:	55			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it was noted that Wiiks Moran 1A portable analyzer was used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US Chicago
	Metric 3:	Applicability	High	Data for laboratory technicians are in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL - Published in 1991
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics range of values but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type, but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	ECHA, (2019). Annex XV restriction report, proposal for a restriction: Formaldehyde and formaldehyde releasers.			
HERO ID:	5155562			
Conditions of Use:	Use in building materials			
EXTRACTION				
Parameter	Data			
Area sampling data:	Indoor air residential measurements: (median: 19.7 µg/m3, maximum: 86 µg/m3) were obtained from 567 dwellings in France (Langer et al., 2016); in Sweden showed median concentrations of formaldehyde between 11.1 and 15.7 µg/m3, respectively (Langer et al., 2015); 50th and 95th percentile for indoor air formaldehyde concentrations were found to be, respectively, 22-27 µg/m3 and 46-53 µg/m3 for low energy/passive houses and 31-40 µg/m3 and 59-67 µg/m3 for conventional houses (Wallner et al., 2015). Figure 3 provides formaldehyde concentrations in newly built fabricated homes in germany. Pages 34-37 have more data. Table 5 provides simulated reference room concentrations for different emissions sources for general consumer products (flooring, furniture, walls, windows)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country, EU.
	Metric 3:	Applicability	High	The data are from an non-occupational scenario that does not apply to any occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	No more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinantsof exposure for the sampled site or sector. The monitoring study provides only limited discussion of theuncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Echt, A. (1993). Health Hazard Evaluation Report HETA 93-0028-2366, West Helena - Helena Sportswear, Inc., West Helena, Arkansas.		
HERO ID:	1316765		
Conditions of Use:	Textile Finishing		
EXTRACTION			
Parameter	Data		
Worker activity description:	cutting, fusing, assembling, bundling, sewing, spot cleaning, inspecting, and shipping.		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	Eight PBZ samples for formaldehyde were collected for employees sewing linings, cutting cloth, and bundling cloth. Eight-hour time-weighted average (TWA) PBZ concentrations of formaldehyde ranged from 0.14 to 0.17 ppm. The results of eight PBZ samples for formaldehyde on inhalable dust collected on the same employees ranged from less than the limit of detection to 29 µg/mg. [Job Title, Formaldehyde Conc., TWA conc.] Sewer, 0.22 ppm, 0.16 ppm (TWA) Sewer, 0.22 ppm, 0.16 ppm (TWA) Sewer, 0.23 ppm, 0.17 ppm (TWA) Sewer, 0.23 ppm, 0.16 ppm (TWA) Cutter, 0.18 ppm, 0.14 ppm (TWA) Cutter, 0.20 ppm, 0.15 ppm (TWA) Bundler, 0.20 ppm, 0.15 ppm (TWA) Bundler, 0.21 ppm, 0.16 ppm (TWA) Formaldehyde on inhalable dust Sewer 29 ug/mg inhalable particulate 0.14 mg/m3 Sewer 11 ug/mg inhalable particulate 0.31 mg/m3 Sewer (1.9) ug/mg inhalable particulate 0.38 mg/m3 Sewer (8.1) ug/mg inhalable particulate 0.23 mg/m3 Cutter 3.8 ug/mg inhalable particulate 1.2 mg/m3 Bundler (1.5) ug/mg inhalable particulate 0.99 mg/m3 Bundler 3.5 ug/mg inhalable particulate 0.92 mg/m3"()'' indicate between LOD and LOQ		
Area sampling data:	Eleven GA samples for formaldehyde and total particulate were collected in various locations in the facility. Formaldehyde concentrations measured in GA samples ranged from 0.16 to 0.25 ppm, 8-hour TWA. Total particulate concentrations in GA samples ranged from 0.02 to 0.15 mg/m3 (8-hour TWA). Formaldehyde General Area Samples Table 2 cutting pockets, sewing center backs 0.27 ppm 0.24 ppm (TWA) sewing pockets 0.26 ppm 0.22 ppm (TWA) liners 0.29 ppm 0.25 ppm (TWA) sleeves 0.29 ppm 0.25 ppm (TWA) final press 0.23 ppm 0.20 ppm (TWA) sewing liners 0.30 ppm 0.25 ppm (TWA) spreading and cutting area table 0.25 ppm 0.20 ppm (TWA) Receiving bulk fabric storage 0.17 ppm 0.16 ppm (TWA) Fuser, exit side 0.24 ppm 0.21 ppm (TWA) Shelf near spreading table 0.29 ppm 0.25 ppm (TWA) Collar sewing 0.28 ppm 0.25 ppm (TWA)		
Dermal exposure data:	nan		
Personal protective equipment:	- gloves, - long sleeve shirts		
Engineering control:	- Increase intake air with HVAC,		
Comments:	Samples were also taking outside but not extracted as not related to engineering assessment.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH Methods 2541 and 3500 or equivalent methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	High	The data are for an occupational scenario (textile work) is within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Study was implemented in 1993 after the PEL ((1992), but more than 20 years old.
	Metric 5: Sample Size	Medium	Results from sampling events are provided including TWA so statistic can be decided.
Domain 3: Accessibility/ Clarity			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 1316765 Table: 1 of 1

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Study Citation:	Echt, A. (1993). Health Hazard Evaluation Report HETA 93-0028-2366, West Helena - Helena Sportswear, Inc., West Helena, Arkansas.			
HERO ID:	1316765			
Conditions of Use:	Textile Finishing			
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	Medium	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, and general worker activities, but exposure durations and exposure frequency not quantified
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	High	Information about variance was not provided but results for each sampling event were included which can be helpful in assessing variability between locations and jobs. As NIOSH methods were being used it is assumed that uncertainty is considered in the sampling methodology.
Overall Quality Determination			High	

Study Citation:	Edling, C., Hellquist, H., Odqvist, L. (1988). Occupational exposure to formaldehyde and histopathological changes in the nasal mucosa. British Journal of Industrial Medicine 45(11):761-765.			
HERO ID:	31774			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	TWA range 0.1-1.1 mg/m3 (Peaks up to 5 mg/m3 (1975-1983)			
Particle size characterization:	Wood dust at the two particle board plants 0.6 - 1.1 mg/m3			
Number of workers:	75 exposed men out of 104 invited			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - OECD member
	Metric 3:	Applicability	High	The data are processing particle board and laminae, an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1988, before the most recent PEL (1992) and is more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range and maximum values, uncertain statistics not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided data range values that could be used to assess variability. The study did not provide any discussion of theuncertainty.
Overall Quality Determination		Low		

Study Citation:	Edling, C., Järholm, B., Andersson, L., Axelson, O. (1987). Mortality and cancer incidence among workers in an abrasive manufacturing industry. British Journal of Industrial Medicine 44(1):57-59.			
HERO ID:	626267			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	manufacture of grinding wheels bound by formaldehyde resin			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.1-1 mg/m3			
Number of workers:	521			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden
	Metric 3:	Applicability	High	Data for manufacture of abrasive products are in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL - Published in 1987
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics range of values but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type and exposure type not provided. Also missing: number of samples, Type of sample, exposure duration and frequency and sampling location.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range for personal samplers, but uncertainty is not addressed.
Overall Quality Determination		Low		

Study Citation:	Elliott, L. J., Gupta, S., Sinks, T. (1989). Health Hazard Evaluation Report HETA 88-001-1995, Broward County Library, Ft. Lauderdale, Florida, November 1989.		
HERO ID:	1317198		
Conditions of Use:	Office Environment		
EXTRACTION			
Parameter	Data		
Worker activity description:	county employees for the library.		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	4th floor westside 0.01 ppm4th floor outside 0.01 ppm*6th floor westside 0.07 ppm7th floor eastside 0.01 ppm5th floor southside 0.01 ppm5th floor information desk 0.01 ppmBranch Library information desk 0.01*values between LOD and LOQ, only semi-quantitative, not reliable estimates		
Number of workers:	300		
Comments:	The amount of formaldehyde was very small and the source was unknown. Building was built in 1983, temperature ranged from 65 to 75oF, and relative humidity of 60 to 73%.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling and Analytical methodology is an approved, NIOSH study - Method 3500.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1987-1988 Prior to the PEL (1992) and more than 20 years old
	Metric 5: Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. 7 samples for the site, all taken at different locations within the building.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, and sample durations, but lacks additional metadata, such as exposure durations, exposure frequency, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in Method 3500.
Overall Quality Determination		High	

Study Citation:	Elliott, L. J., Stayner, L. T., Blade, L. M., Halperin, W., Keenlyside, R. (1987). Formaldehyde-exposure characterization in garment-manufacturing plants: a composite summary of three in-depth industrial-hygiene surveys.
HERO ID:	2298103
Conditions of Use:	Textile Finishing
EXTRACTION	
Parameter	Data
Worker activity description:	Administrative Supervision: AD01 Clerical: AD02 Warehouse: AD032 Maintenance: AD04 Service/Training: AD05Cutting Marker, Service: B006 Spreader: B007 Machine Cut: B008 Die Clicker: B009 Bundler: B010Collar Fuse Collar, Collar Stay: CO11 Turn &Press, Top Stitch: C012 Run Collar: C013 Crease Bands: C014 Stitch Bands, Band End, C015 Buttonsew, Buttonhole, label: C016Parts (Cuffs, Pockets, Fronts Back. and Sleeves) Turn &Press Cuffs, Adler: D017 Turn &Top Stitch Cuffs: D018 Crease Pockets, VPockets: D019 Slope Fronts, Match: E020 Label. Buttonhole Sleeve: E021 Buttonsew Front, Pocket Set: E022 Sleeve Facing, Bartack, Blocting: E023 Concealed Yoke: F024 Run-on Sleeve Binding: F025 Trim &Stack: F026Assembly Yoke & join, sarge Yoke: G028 Folder Join, folder Yoke: G029 Run-on Sleeves, Felling: G030 Stitch Down Sleeves: G031 Buttonsew: G032 Cuff set: G033 Hem (Bottom): G034 Folder Felling, Double Needle: G035 Collar Set, Service Bands: G036 Packaging Apparel Press: H037 Button &Fold: H038 Examine , Bag, Box: H039
Exposure route:	inhalation
Physical form:	vapor
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Study Citation:	Elliott, L. J., Stayner, L. T., Blade, L. M., Halperin, W., Keenlyside, R. (1987). Formaldehyde-exposure characterization in garment-manufacturing plants: a composite summary of three in-depth industrial-hygiene surveys.			
HERO ID:	2298103			
Conditions of Use:	Textile Finishing			
EVALUATION				
Domain	Metric		Rating	Comments
Area sampling data:	Plant 3 August 1981Assembly Department9:00-10:00 CEA-555: 0.13 ppm Impinger: 0.18 ppm Charcoal Tube: 0.12 ppm10:15-11:16CEA-555: 0.10 ppm Impinger: 0.16 ppm Charcoal Tube: NA11:20-12:24 CEA-555: Down Impinger:1.99ppm Charcoal Tube: 0.11 ppm12:31- 1:31 CEA-555: 0.22 ppm Impinger: 0.20ppm Charcoal Tube: 0.08 ppm1:40- 2:40 CEA-555: 0.24 ppm Impinger: 0.16ppm Charcoal Tube: 0.08 ppm2:45- 3:45 CEA-555: 0.19 ppm Impinger: 0.29ppm Charcoal Tube: NAParts Department8:41- 9:44 CEA-555: 0.15 ppm Impinger: 0.12ppm Charcoal Tube: 0.09 ppm10:05-11:08 CEA-555: Down Impinger: 0.15 ppm Charcoal Tube: 0.05 ppm1:24- 2:24 CEA-555: 0.09 ppm Impinger: 0.07ppm Charcoal Tube: 0.05 ppm11:51- 1:00 CEA-555: 0.08 ppm Impinger: 0.07ppm Charcoal Tube: 0.05 ppmFused Lining8:44- 8:47 CEA-555: 0.32 ppm Impinger: 0.21 ppm Charcoal Tube: NA9:52-10:58 CEA-555: 0.38 ppm Impinger: 0.32 ppm Charcoal Tube: NA11:16-12:17 CEA-555: 0.16 ppm Impinger: 0.12 ppm Charcoal Tube: 0.09 ppm1:40- 2:44 CEA-555: Down Impinger: 0.09 ppm Charcoal Tube: 0.20 ppm It has been estimated that the sample loss when using P&CAM 318 could range from 30 to 70~ of the total amount collected. All the charcoal tube results reported using this method in plants 1 and 3 should, therefore, be regarded as minimum values.			
Exposure duration:	8 hrs/day			
Number of workers:	Plant 1 had approximately 1000 workers operating on a two shift basis, plant 2 had approximately 500 workers operating on a two shift basis, and plant 3 had approximately 600 workers on a single shift basis.			
Engineering control:	- Local exhaust ventilation hoods should be installed over fused lining machines to capture heat and formaldehyde vapors from this process operation. Areas of a plant should be evaluated for proper dilution ventilation in an attempt to further reduce exposure to formaldehyde.-The heating, ventilation, and air conditioning (HVAC) system should not be set up on a fully (100~) recirculated system as is the case during the summer and coldest parts of the winter. Fresh outside air should be introduced to the HVAC system to improve the dilution ventilation of the plant. The higher energy consumption that this would require could be partially offset by the installation of air-to-air heat exchangers which would pre-COOL (or pre-heat) incoming air with exhausting air. Such an improvement in dilution ventilation of a plant could reduce the formaldehyde exposure levels in the plant.- Local exhaust ventilation should be installed and utilized during the spot cleaning operation and when cleaning stamping devices with organic cleaning solvents.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study methods P&CAM 125 P&CAM 354
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	the data are for an occupational scenario(garment work) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 - Prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized with range, mean, SD mean, SD, 95% confidence intervals for most sampling events.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, and exposure durations worker activities.
Domain 4: Variability and Uncertainty				

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Formaldehyde

Occupational Exposure

HERO ID: 2298103 Table: 1 of 1

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Study Citation:	Elliott, L. J., Stayner, L. T., Blade, L. M., Halperin, W., Keenlyside, R. (1987). Formaldehyde-exposure characterization in garment-manufacturing plants: a composite summary of three in-depth industrial-hygiene surveys.			
HERO ID:	2298103			
Conditions of Use:	Textile Finishing			
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 7:	Metadata Completeness	High	Range, mean, geometric mean, geometric standard deviation and 95% confidence data were provided to allow for evaluation of variance and uncertainty. Additionally it was assumed that uncertainty related to the methods used was considered in the NIOSH methods.
Overall Quality Determination			High	

Study Citation:	Elsevier (1996). Occupational laryngitis due to formaldehyde. Food and Chemical Toxicology 34(7):665.			
HERO ID:	6179475			
Conditions of Use:	Dairy Farm (Use in agriculture, forestry, fishing, and hunting)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Finnish dairy foreman			
Exposure route:	inhalation			
Physical form:	vapor/gas			
Area sampling data:	Typical formaldehyde levels were 0.03 mg/m3.			
Exposure duration:	9 years			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	Data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is from more than 20 years ago.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Elshaer, N.S., Mahmoud, M.A. (2017). Toxic effects of formalin-treated cadaver on medical students, staff members, and workers in the Alexandria Faculty of Medicine. 53(4):337-343.			
HERO ID:	6209493			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Medical students, staff members, and workers at the Anatomy department in the Alexandria Faculty of Medicine. (1/7)			
Exposure route:	"Exposure occurs primarily by inhalation, or via skin absorption of formaldehyde containing fluids. " (1/7)			
Number of workers:	454 medical students, 16 staff members and workers in the anatomy department, and 19 unexposed workers. (1/7)			
Personal protective equipment:	More than 2/3 of the students reported wearing lab coats and hand gloves. (1/7)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Egypt, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (percentages, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology and in conclusion paragraph but variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	ENSR, (1991). AB 2588 Health risk assessment for the Texaco refinery Area 3, Bakersfield, California.		
HERO ID:	6339343		
Conditions of Use:	Petroleum refinery		
EXTRACTION			
Parameter	Data		
Worker activity description:	workers at Bakersfield refinery		
Exposure route:	inhalation		
Physical form:	gas		
Area sampling data:	For Flares - Maximum hourly air concentration (ug/m3) for formaldehyde – 3.15 x 10^-5; Annual average air concentration (ug/m3) – 7.65 x 10^-8. For Heaters and Boilers - Maximum hourly air concentration (ug/m3) for formaldehyde – 8.71 x 10^-4; Annual average air concentration (ug/m3) – 7.01 x 10^-7. For storage tanks - Maximum hourly air concentration (ug/m3) for formaldehyde – 6.9 x 10^-6; Annual average air concentration (ug/m3) – 2.66 x 10^-8.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	data are from the United States
	Metric 3: Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	more than 20 years old
	Metric 5: Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type but no other metadata
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low	

Formaldehyde

Occupational Exposure

HERO ID: 8727392 Table: 1 of 2

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March 2024

Formaldehyde

Occupational Exposure

HERO ID: 8727392 Table: 1 of 2

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Study Citation:	Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.
HERO ID:	8727392
Conditions of Use:	Chemical substances in Construction products

EVALUATION			
Domain	Metric	Rating	Comments

Study Citation:	Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.
HERO ID:	8727392
Conditions of Use:	Chemical substances in Construction products

EXTRACTION	
Parameter	Data

Worker activity description:

Job classifications have been identified which have a potential for chemical or physical agent exposure during the application of polyurethane foam insulation and the activities associated with it. These job classifications have been divided into two general categories on the basis of the type of duties that are performed: Foam Applicators apply the foam to the surface and oversee the application process. Application Assistants prepare the surface for application, set up the application equipment, and perform other duties as required. A description of the duties within these job classifications is presented below by job category:

Foam Applicators

Foam Mechanic (Applicator A) The Foam Mechanic has the major responsibility for providing a satisfactory insulation job. His duties include: determining the method and strategy for opening the structure, application equipment cleaning and assembly, proper conditioning of resin and foaming agent, assuring adequate foam quality, foam application, assisting in opening and, on occasion, closing the structure, cleanup, measuring and sketching the building being insulated, and application equipment maintenance. The Foam Mechanic also serves as the crew chief. Application equipment cleaning and assembly usually takes less than an hour. Resin and foaming agent circulation usually begins about 1 hour before foam application starts. Density testing consists of weighing foam that is shaped into a cube of pre-determined volume. The cube is formed on a bench top in the back of the van. Foam quality testing consists of applying foam onto a plastic sheet. The test is conducted out-of-doors and usually takes a few minutes. For the 5 days of the study during which exterior application was conducted, foam application time varied from 1-3/4 to 3 hours. The Foam Mechanic assists in opening, closing, and cleanup when time permits. The house can be measured and sketched in about an hour.

Applicator (Applicator B) The Applicator has the major responsibility for applying the insulation satisfactorily. His duties include: determining the method and strategy for opening the structure, cleaning and assembling application equipment, proper conditioning of resin and foaming agent, assuring adequate foam quality, foam application, assisting in opening and closing the structure, cleanup, and light maintenance of equipment. The Applicator spends about 1 hour cleaning and assembling the foam application equipment. The foam quality check usually takes less than 10 minutes but may take longer, depending upon conditions. The actual time spent applying foam varies daily; for example, on some days foam is not applied. Conditioning resin and foaming agent involves starting the circulating pump and, if necessary, placing a band heater around the drums or circulating the components through a line heater to raise temperatures. The time spent opening varies; the amount of time spent closing is also variable and will depend on the progress that the Assistant has made in closing the house during the application process. Cleanup operations usually take less than 1 hour. Equipment maintenance is performed as needed.

Application Assistants

Laborer (Applicator A) The Laborers' duties include: opening, washing excess foam from the walls, monitoring for structural stress during foam application, closing, cleanup, scraping foam (open-bay procedure), hanging polyethylene film (open-bay procedure), and performing other duties as required. The Laborers spend most of their time opening and closing during exterior retrofit operations. On occasion, a Laborer will be stationed in the house to monitor for structural stress. Wiping excess foam from an opening can be accomplished in a matter of seconds. Cleanup operations usually last about an hour. Foam-scraping operations can proceed faster than the application process.

Assistant (Applicator B) The Assistant's duties include: opening, closing, cleaning excess foam from the wall after application, cleanup, and light maintenance of equipment. The Assistant may spend a workday or longer performing opening operations. The closing operation usually ends a short time after foam application has been completed; an exception to this is when wood must be filled, sanded, and painted. In many cases, the closing operation is less time-consuming than is foam application. The Assistant spends about the same amount of time performing cleanup and equipment maintenance operations as does the Applicator.

Warehouseman (Applicator B) The warehouseman usually works from 4 p.m. until 7 p.m. He is responsible for cleaning trash from the vans and stocking them for the next jobs. His duties include: removing trash from the vans and placing it into a dumpster outside the warehouse, consolidation of resin and foaming agent where more than one drum of each is present on a van, and preparing fresh foaming agent by diluting the 2.5 gallons of concentrate with 52.5 gallons of water. In all, three vans are serviced.

Foam Application Applicator (Applicator C) The Applicator, who is also the vice president of this company, has the responsibility for applying the polyurethane insulation. His duties include: maintenance, cleaning and assembly of the application equipment, assuring foam quality, foam application, and general cleanup. On days when foam is not applied, he may be involved in preparation and cleaning of the surface/area to be foamed, applying a weatherproof sealant to a foamed surface, or applying another type of thermal insulation material. The Applicator spends about 1 hour inside the truck each day cleaning, assembling, and performing maintenance on the application equipment. The actual time spent performing maintenance may vary; during the survey, there were delays due to equipment malfunction. End-of-day cleanup generally takes less than 1 hour.

Mechanic (Applicator D) The Mechanic's duties include: applying the foam, assuring foam quality, and cleaning and maintenance of the application equipment. The mechanic spends about 1 hour each day cleaning, assembling and performing maintenance on the application equipment. The actual time spent performing maintenance varies; during the survey, there were delays due to equipment malfunction.

Application Assistant Helper (Applicator C) The Helper's duties include: setting up equipment, moving the hoses from the path as the Applicator sprays the foam; making adjustments to the proportioning pump; changing

Occupational Exposure

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Study Citation:	Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.
HERO ID:	8727392
Conditions of Use:	Chemical substances in Construction products

Domain	Metric	EVALUATION Rating	Comments
Exposure route:	inhalation dermal		
Physical form:	vapor and coating on insulation		
Personal sampling data:	16 Applicator AUrea Formaldehyde Foam ApplicationExterior Retrofit activities Foam Mechanic12/6/79 1.2 ppm12/6/79 0.50 ppm12/10/79 0.24 ppm12/10/79 1.1 ppm12/10/79 0.40 ppm12/11/79 0.24 ppm12/11/79 0.14 ppm17 Additional Exterior Retrofit activities Foam Mechanic12/6/79 Opening house 0.16 ppm12/6/79 In truck while resin and foaming agent were circulating 0.34 ppm12/10/79 Opening; observing progress 0.11 ppm12/10/79 Checking resin level in drum; storing application equipment 0.73 ppm12/11/79 Cleaning application gun in truck; begin circulation of foaming agent and resin 0.35 ppm18 Laborers12/6/79 Opening (removing shingles) 0.09 ppm12/6/79 1411-1529 78 Closing (replacing shingles) 0.15 ppm12/10/79 Opening (drilling mortar) 0.11 ppm12/10/79 Closing (with mortar) 0.12 ppm12/10/79 Closing (with mortar) 0.73 ppm12/10/79 In house monitoring for structural stress 0.40 ppm12/10/79 Cleaning up trash foam 0.65 ppm12/11/79 Closing (replacing aluminum siding) 0.20 ppm12/11/79 In house monitoring for structural stress 0.32 ppm12/11/79 Cleaning up trash foam 0.15 ppm19 Warehouseman12/10/79 Cleaning out and stocking two urea formaldehyde vans 0.27 ppm 12/11/79 Cleaning out and stocking urea formaldehyde van #14 0.60 ppm12/11/79 Cleaning out and stocking urea formaldehyde van #15 0.61 ppm22 Formaldehyde Exposure During Open-Bay Urea Formaldehyde Foam Insulation – Foam Mechanic 12/12/1979 1.1 ppm12/12/1979 2.4 ppm12/12/1979 1.1 1.6 ppm23 Formaldehyde Exposure During Open-Bay Scraping Operations - Laborer12/12/1979 0.86 ppm12/12/1979 2.3 ppm12/12/1979 1.6 ppm12/12/1979 2.3 ppm25 Using Draeger Tubes9/17/79 Foam Mechanic's breathing zone while forming a foam cube for density test N.D.9/17/79 Foam Mechanic's breathing zone during urea formaldehyde foam application -exterior N.D.9/18/79 Foam Mechanic's breathing zone during urea formaldehyde foam application-exterior retrofit N.D. 12/6/79 Foam Mechanic's breathing zone while cleaning application gun in back of van unknown12/10/79 Foam Mechanic's breathing zone during urea formaldehyde foam application-exterior retrofit N.D. 12/12/79 Foam Mechanic's beathing zone during open bay urea formaldehyde foam application -measurement was made near the time of completion of the second floor. 4 ppm12/12/79 Foam Mechanic's breathing zone during open-bay urea formaldehyde foam application -measurement was made near the time of completion of the first floor 0.7-1 ppmApplicator B.28 Urea Formaldehyde Foam Insulation Application – Applicator11/28/79 0.10 ppm11/28/79 0.80 ppm11/28/79 0.58 ppm11/29/79 0.45 ppm11/30/79 <0.08 ppm11/30/79 0.43 ppm11/30/79 0.75 ppm11/30/79 1.0 ppm29 Exposure to Formaldehyde During Other Activities – Applicator11/27 /79 Cleaning application equipment; begin circulation of resin and foaming agent 0.18 ppm11/27 /79 Painting hole plugs in truck, while resin and foaming agent were circulating 0.18 ppm11/27/79 Test-foaming; cleaning application equipment 0.07 ppm11/27/79 Cleaning resin pump at shop 0.18 ppm11/27/79 Test-foaming on shop floor 0.52 ppm11/28/79 Cleaning application equipment; begin circulation of resin and foaming agent; on break in van 0.11 ppm11/28/79 Foaming and cleanup operations 0.26 ppm11/30/79 Cleaning and assembling application equipment; begin circulation of resin and foaming agent 0.06 ppm30 Exposure to Formaldehyde – Assistant 11/27/79 Opening; assisting in equipment preparation 0 .06 ppm11/27/79 Assisting Applicator during test foaming in shop 0.37 ppm11/28/79 On break in van 0.09 ppm11/28/79 Closing and cleaning area <0.09 ppm11/28/79 Cleaning excess foam from inside of house; cleaning exterior area 0.26 ppm11/29/79 Opening <0.03 ppm11/29/79 Opening (foaming in progress) 0.13 ppm 11/30/79 Opening <0.04 ppm11/30/79 Opening and wiping excess foam from wall 0.03 ppm11/30/79 Assisting in foaming operation; break 0.10 11/30/79 Assisting Applicator <0.04 ppm31 Exposure to Formaldehyde During Closing Operations 11/28/79 <0 .08 ppm11/28/79 0.06 ppm11/30/79 0.13 ppm33 Draeger Tubes11/27 /79 Applicator's breathing zone while foaming in shop unknown11/27 /79 Applicator's breathing zone while foaming in shop N.D.11/28/79 Applicator's breathing zone N.D.11/28/79 Applicator's breathing zone N.D.11/29/79 Applicator's breathing zone N.D.		

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Formaldehyde

Occupational Exposure

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Study Citation:	Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.		
HERO ID:	8727392		
Conditions of Use:	Chemical substances in Construction products		
EVALUATION			
Domain	Metric	Rating	Comments
Area sampling data:	Note some of the in vehicle sampling may be considered personal sampling given the confined space, but are listed belowApplicator A20 Inside Step Van12/6/79 During opening operations 0.27 ppm 12/6/79 During opening and application operations 0.33 ppm 12/6/79 During application operations 2.0 ppm 12/10/79 During trip to site 0.48 ppm 12/10/79 During opening operations 0.10 ppm12/10/79 During foaming agent and resin circulation 0.25 ppm 12/10/79 During foam application 0.14 ppm12/10/79 During cleanup 0.31 ppm12/10/79 During trip back to warehouse 0.66 ppm12/10/79 During clean out and stocking at warehouse 0.37 ppm12/ 11/79 During trip to site 0.23 ppm12/11/79 During opening operations 0.32 ppm12/11/79 During gun cleaning and resin and foaming agent circulation 0.14 ppm12/11/79 During foam application 0.15 ppm12/11/79 During cleanup 0.39 ppm12/11/79 During trip back to ware- house, van #14 1.0 ppm12/11/79 During clean out and stocking at warehouse, van #14 1.2 ppm12/11/79 During clean out and stocking at warehouse van #15 0.55 ppm2 1In warehouse12/10/79 Employees waiting to leave 0.19 ppm 12/10/79 Cleaning and stocking vans 0.22 ppm12/11/79 Employees waiting to leave 0.17 ppm12/11/79 Cleaning and stocking vans 0.43 ppm12/11/79 Cleaning and stocking vans 0.85 ppm24 Area Samples for Formaldehyde During Open-Bay Urea Formaldehyde Foam Insulation 0.89 ppm 12/12/1979 1.1 ppm 12/12/1979 0.57 ppm 12/12/1979 1.2 ppm 12/12/1979 25 Using Draeger Tubes9/17/79 Front of van prior to leaving warehouse N.D.9/17/79 Back of van while resin and foaming agent were circulating N.D. 9/17/79 Back of van while resin and foaming agent were circulating N.D.9/17 /79 In house during urea formaldehyde foam application N.D. 9/ 18/79 Back of van while resin and foaming agent were circulating N.D.9/18/79 Back of van during foam application N.D.9/18/79 Back of van upon returning to warehouse 2-5 ppm12/10/79 Back of van shortly after density test N.D.12/ 10/79 Resin drum air space 2 ppm12/11/79 Back of van upon return to warehouse prior to removal of trash 4-7 ppm12/11/79 Back of van after servicing by warehouseman 0.7-1 ppm12/11/79 Back of truck while warehouseman removed trash 0.7-1 ppm 12/11/79 Back of van after servicing by Warehouseman 0.7-1 ppmApplicator B.32 Formaldehyde Concentrations in the Step Van 11/27 /79 During trip to site 0.18 ppm11/27 /79 During foam application 0.16 ppm11/27/79 Return trip from site 0.23 ppm11/28/79 During foam application 0.02 ppm11/29/79 While resin and foaming agent were circulating and being brought up to operating temperature 0.02 ppm11/29/79 While resin and foaming agent were circulating and being brought up to operating temperature; some foam application in progress <0.08 ppm11/30/79 During trip to site 0.18 ppm11/30/79 During foaming agent and resin circulation; during foam application <0.02 ppm11/30/79 During foam application <0.03 ppm11/30/79 Return trip from site 0.33 ppm33 Draeger Tubes11/28/79 Back of van during foam application N.D11/28/79 Back of van during foam application N.D11/30/79 Airspace of C.P. resin drum 2 ppm		
Exposure duration:	Operations at both applicators ran one shift, 8-10 hours per day,		
Exposure frequency:	Both Applicator A and B work Monday through Saturday when work is available. 5-7 days per week.		
Number of workers:	There are 20 individuals involved with the application of ureaformaldehyde foam insulation at Applicator A and two (occasionally three) individuals at Applicator B. Applicator C There are 12 employees, 3 of whom are generally involved in polyurethane application. Applicator D The insulation division of this company, which has 10 employees, is involved in the full-time application of polyurethane foam insulation.		
Personal protective equipment:	NIOSH recommends Type C supplied-air respirators with full-facepiece, operated in the positive-pressure mode.Applicator A - Personal protective equipment consists of respirators, goggles, and gloves. 3M 8500 disposable respirators are used, at times, when insulating with cotton fiber and when drilling masonry. This respirator is not NIOSH certified. Tight-fitting, soft plastic goggles are sometimes used when drilling masonry. Rubber gloves are frequently used by the FoamMechanic to prevent contamination of his hands with urea formaldehyde foam. Other than the gloves worn by the Foam Mechanic, no other personal protective equipment was observed in use during the course of the study. Applicator B-Rubber gloves are used during foaming operations and subsequent wall-surface cleaning to prevent contamination of the hands. Respiratory protective devices are not used during the urea formaldehyde foam application process. A wind-driven propeller fan provides ventilation for the van. There is no mechanical ventilation used in association with the application process.Applicator C - Personal protective equipment consisted of respirators and gloves. The respirators (Norton half-mask respirator, NIOSH Approval No. TC-23C-74, approved for pesticides) were used when foam was applied under the overhang of the steeple. Rubber gloves were used by the Applicator while spraying foam. Applicator D - supplies respirators (Willson Model No. 1221 with R-21 organic vapor cartridges, NIOSH certification No. TC-23C-50) fer employees. Company policy requires the use of respirators; however, some workers were observed not wearing respirators while spraying polyurethane foam. The Mechanic used the respirator while spraying foam from the floor level. While on the scaffold, the respirator was generally not used because the spray was directed mostly downward. (The helper stands near the base of the scaffold, but clear of the overspray.) Spraying from thefloor level involved directing the spray upwards, and the resulting overspray settled on the employee. There is no mechanical ventilation associated with the foam application process, and the natural ventilation was limited in the indoor application.		
EVALUATION			
Domain	Metric	Rating	Comments

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Formaldehyde

Occupational Exposure

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Study Citation:	Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.			
HERO ID:	8727392			
Conditions of Use:	Chemical substances in Construction products			
Domain	Metric	EVALUATION		Comments
		Rating		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method P&CAM 125
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (insulation installation) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1979- prior to PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH method P&CAM 125.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations, days and roles.As this is a NIOSH study, it is assumed that uncertainty was considered in Method P&CAM 125.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

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Formaldehyde

Occupational Exposure

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Study Citation:	Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.
HERO ID:	8727392
Conditions of Use:	Reactant Manufacture in Construction Material

Domain	Metric	EVALUATION	
		Rating	Comments

Study Citation:	Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.
HERO ID:	8727392
Conditions of Use:	Reactant Manufacture in Construction Material

EXTRACTION	
Parameter	Data

Worker activity description:

Job classifications have been identified which have a potential for chemical exposure during the manufacturing process of the polyurethane foam insulation system. The activities assigned to each job classification vary within each category with some overlap between categories. Consequently, a precise comparison of exposure by job categories between the two manufacturing plants cannot be performed. The Urea- Formaldehyde Foam Insulation System Resin Batchmakers 1 Cook (Manufacturer A) The Cook has the major responsibility for the production of a satisfactory batch of urea formaldehyde resin. His duties include: adding raw materials to the reactor, monitoring the reaction, and collecting samples. The Cook also performs quality control tests such as pH, temperature, degree of condensation, and viscosity determinations. Normally there are two Cooks; each makes one batch of resin during the day. While not making a batch of resin, the Cook performs other duties such as operating the forklift, assisting in filling containers with foaming agent, and washing drums. Research and Development Chemist (Manufacturer B) The Research and Development Chemist is primarily responsible for production of the resin component of the foam system. His duties include: making additions to the reaction mixture, monitoring the progress of the reaction, collecting samples and performing tests to determine the end point of the reaction, and terminating the reaction. During the survey period, the Chemist typically spent approximately 2 hours per day in the vicinity of the reaction vessel. The Chemist also has overall responsibility for the formulation of the foaming agent, although the foaming agent production is generally performed by the Laborer. The Chemist performs a variety of other functions in the company, including research and development on foam insulation systems. Production Assistants Floorworkers (Manufacturer A) The Floorworkers at Manufacturer A were broken down into three distinct job classifications as follows: Cook's Assistant- The employee's duties include: collecting drummed and bagged raw material for resin manufacturing; assisting in adding raw materials to the addition tank; setting up empty resin drums for filling; labeling resin drums and lids; and filling the resin drums. There are two Cook's Assistants; each normally performs the duties described during the production of one batch only. Other duties performed include: forklift operation, assisting the drum filler by placing lids on the drums, filling orders for application equipment, and repairing application and production equipment. Foaming Agent Blender- There is one Foaming Agent Blender. This individual is responsible for blending and drumming the foaming agent. The raw foaming agent is pumped from plastic drums into a blending tank. The Blender then adds small amounts of hardeners and a catalyst. When blending is complete, the Blender fills containers with the foaming agent. The foaming agent is blended about once a week. When not blending or drumming the foaming agent, this employee may operate the forklift, scrape labels off lids, or perform other duties as required. Drum Washer- The plastic resin drum is a reusable item that is returned to the plant for cleaning. There is one full-time Drum Washer. There is also a part-time Drum Washer who works from 1:00 p.m. to 6:00 p.m. The Drum Washer removes the lids from the returned drums and dumps the small amount of resin that remains into a trench. The washer then sprays the drums with high-pressure hot water. The water is heated in a kerosene-fired, portable steam and hot water generator. The used plastic lids are placed in a kettle of warm water which is located near the reactor. After soaking for a period of time, the Drum Washer removes the lids and scrapes the labels off with a knife. The Drum Washer spends about 10 minutes per day removing labels. Laborer (Manufacturer B) The Laborer's duties include metering ingredients into the reaction vessel, making certain additions to the reaction mixture, drumming the finished resin, mixing and drumming the foaming agent, and performing general cleanup activities. Plant Foreman (Manufacturer B) The Plant Foreman is primarily involved in shipping and receiving, and in general mechanical work in the plant. He assists in the production of the foaming agent, and operates the forklift to move finished drums of resin and catalyst to the shipping area. With the exception of shipping and receiving, this employee does not supervise foam manufacturing activities. Resin Manufacture Compounder (Manufacturer C) The Compounder is responsible for the compounding of polyurethane products including the compounding of drum-sized batches of TDI prepolymers. Work activities are similar for the production of both thermal and other polyurethane products. Specifically, the Compounder adds raw materials to the compounding vessels by following a product formulation sheet. The Compounder weighs each drum of raw material and pours the contents into the top opening of the vessel using an electric drum lifter. He then reweighs each drum. (Due to the high viscosity of many of the raw materials, residue may be left in the drum after pouring.) Certain raw materials, such as the catalysts which are used in small quantities, are first poured into smaller containers for more precise weighing, and then poured by hand into the compounding vessels. After the materials have been compounded, the Compounder collects a sample for quality control by dipping a paper container into the top opening of the vessel; he then takes the sample to the laboratory for a quality control check. adjustments to the resin may be made depending upon the laboratory results. If the sample is acceptable, the Compounder transfers the finished resin into drums. This is performed by lining up the drums on the compounding area floor, making a hose connection to the vessel, and filling the drums one at a time. Exposures may occur when ingredients are poured into the vessels, during the drum loading, and when a sample is collected. The Compounders spend more than 90 percent of their time in the compounding room. Blender (Manufacturer C) The Blender maintains the levels of raw materials in the supply tanks, monitors the flow of finished resin during drum filling, takes periodic samples for laboratory tests, and performs required maintenance and cleaning on

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Formaldehyde

Occupational Exposure

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HERO ID:	8727392		
Conditions of Use:	Reactant Manufacture in Construction Material		
		EVALUATION	
Domain	Metric	Rating	Comments
Exposure route:	Inhalation & dermal		
Physical form:	vapor and liquid		
Personal sampling data:	1 Manufacturer A Cumulative daily SamplingCook 0.27 ppm twa (9/25/79) 0.36 ppm twa (9/26/79) Cook's Assistant 0.47 ppm twa (9/25/79) 0.78 ppm twa (9/26/79) Drum Washer 0.52 ppm twa (9/25/79) 0.30 ppm twa (9/26/79) Foaming Agent Blender 0.24 ppm twa (9/25/79) 0.18 ppm twa (9/26/79) 2 Cook9/25 Working on the floor while reactor was being filled with formalin 0.35 ppm9/25 Cooking first batch of urea formaldehyde resin 0.37 ppm9/25 Cooking first batch of urea formaldehyde resin; washing resin drums 0.22 ppm9/25 Washing resin drums; removing lids from used resin drums 0.20 ppm9/26 Operating forklift while reactor was being filled with formalin 0.12 ppm9/26 a.m. 178 Cooking first batch of urea form aldehyde resin 0.35 ppm9/26 a.m. 125 Cooking first batch of urea form aldehyde resin; material handling; assisting in capping filled resin drums 0.55 ppm9/26 p.m. 99 Operating forklift; assisting the Foaming Agent Blender 0.23 ppm9/26 Operating forklift 0.29 ppm 3 Cook Assistant9/25 a.m. 218 Gathering raw materials for first batch of resin; operating forklift; setting up resin drums for filling 0.17 ppm9/25 Open-top filling of drums with urea 1.s.a formaldehyde resin; some time spent in other activities. 1.8 ppm9/25 Operating forklift; setting up resin drums for filling; gathering raw materials for resin production; placing lids on filled resin drums 0.39 ppm9/26 Gathering raw materials for first batch of resin; labeling resin drum tops 0.29 ppm9/26 Open-top filling of drums with urea formaldehyde resin 5.4 ppm9/26 Operating forklift; various duties in the reactor area 0.31 ppm9/26 Unloading empty resin drums from truck; working in drum-filling area 0.52 ppm9/26 Filling drums with urea formaldehyde resin through lid opening 2.1 ppm9/25 Open-top filling of drums with urea formaldehyde resin 2.6 ppm4 Drum Washer9/25 Washing used resin drums 0.23 ppm9/25 Washing used resin drums; labels off lids scraping 0.74 ppm9/26 Washing used resin drums; unload ing new resin drums from truck 0.20 ppm9/26 Washing used resin drums 0.32 ppm9/26 Washing used resin drums; stacking new resin drums 0.47 ppm5 Foam Agent Blender9/25 Operating forklift; pumping foaming agent into drums 0.15 ppm9/25 Pumping raw foaming agent into holding tank; handling foaming agent drums; cleaning foaming agent area 0.34 ppm9/26 a.m. Operating forklift; unloading truck; setting up foaming agent pails for filling 0.26 ppm9/26 p.m. Setting up foaming agent pails for filling; filling pails with foaming agent 0.06 ppm9/26 p.m. Scraping labels off resin drum lids; unloading truck 0.13 ppm6 Draeger tubes8/29 0.002 Cook's Assistant's breathing zone while filling drums with resin 10 ppm8/29 0.002 Cook's Assistant's breathing zone while filling drums with resin 10 ppm8/29 0.002 Drum Washer's breathing zone while washing drums N.D. 8/29 0.002 Drum Washer's breathing zone while washing drums N. D.9/25 0.002 Cook's Assistant's breathing zone while filling drums with resin 5-10 ppmManufacturer B15 Personal3/3 resin sampling and testing (chemist) 0.34 ppm3/4 resin sampling and testing (chemist) 0.45 ppm3/3 resin drumming (laborer) 0.18 ppm3/3 resin drumming (laborer) 0.69 ppm3/4 resin drumming (laborer) 1.28 ppm3/4 resin drumming (laborer) 0.80 ppm Manufacturer A6 Draeger tubes9/25 0.5/a Reactor platform while reactor was being filled with formalin 2 ppm9/25 0.5/a Lid kettle area while reactor was being filled with formalin 1 ppm9/25 0.5/a Center of plant while reactor was being filled with formalin N.D.Manufacturer B14 Area3/3 reactor deck, upper left side 0.32 ppm3/3 reactor deck, upper left side 0.26 ppm3/4 reactor deck, upper left side 0. 29 ppm 3/4 reactor deck, upper. left side 0. 75 ppm3/3 reactor deck, upper right side 0.14 ppm3/3 reactor deck, upper right side 3. 58 ppm3/3 reactor deck, upper right side 1.04 ppm3/4 I 190 reactor deck, over temperature readout 5.17 ppm 3/3 I 70 near resin drumming 0.21 ppm3/4 I 45 near resin drumming 0.22 ppm3/4 I 46 near resin drumming 0.16 ppm3/4 near foaming agent drumming 0.07 ppm 3/I near foaming agent drumming 0.04 ppm		
Area sampling data:	Operations at the two manufacturing sites ran 1 shift (8 hours) per day,Manufacturer A&BOperations at both manufacturing facilities were limited to the dayshift. Work days were Monday through Friday; however, Manufacturer B's facility may not produce foam on all 5 days. Manufacturer BIn order to produce two batches of resin in a day at Manufacturer A'sfacility, an operating period of about 11 hours is necessary. A Cookarrives about 6:15 a.m. to start the first batch. About 7:00 a.m., oneAssistant arrives. The other production workers, with the exception of a part-time Drum Washer, arrive at 8:00 a.m. The workday ends at 5:00 p.m. for those arriving at 8:00 a.m. The early Cook and Assistant do not necessarily leave after 9 hours. They may stay until drums have been filled with the second batch of resin, which could be as late as 5:00 p.m. The only formal break is lunch, which lasts for about 45 minutes. Other breaks are informal and do not necessarily involve leaving the work area. Under production conditions when one batch of resin is produced per day at Manufacturer B's facility, the Laborer arrives about 6:00 a.m. to begin the day 1s production run. The Plant Foreman also arrives early in the morning and may be involved in the preparations of resin and foaming agent production. The Research and Development Chemist arrives about 8:00 a.m. and takes charge of the resin production run. Typically, the production of a batch of resin and foaming agent is completed by about 3:00 p.m. There are no formal breaks during the workday, with the exception of lunchwhich the workers usually eat in the office area of the plant. Due to the small number of workers involved in the production process, the work schedule is very flexible and the employees generally identify and perform tasks which need to be done with a minimum of supervision.		
Exposure duration:	5 days per week.		
Exposure frequency:	The number of employees involved in production was small--seven employees were involved in production at Manufacturer A while three were involved in production at Manufacturer B. These numbers of employees are representative of the industry.Manufacturer CThere are approximately 80 non-union employees.Manufacturer DThere are 14 production employees at this facility.		
Number of workers:			

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HERO ID:	8727392
Conditions of Use:	Reactant Manufacture in Construction Material

		EVALUATION	
Domain	Metric	Rating	Comments
Personal protective equipment:			Require the use of full-facepiece respirators with organic vapor cartridges by the Applicator during exterior retrofit urea formaldehyde foam insulation application. This type of respiratory protective device should also be worn by employees engaged in open-bay application activities. Methods for reducing formaldehyde exposures during foam application should be investigated. Maximum usage should be made of natural ventilation, such as working upwind. General mechanical ventilation should be utilized where possible. Employees engaged in resin reactor operations, foaming agent blending, foaming agent and resin drumming, raw material handling, and foam application should wear chemical goggles and protective gloves. Install suitable eye washes and safety showers in resin and foaming agent drum fill areas, resin reactor areas, raw material storage areas, and applicator warehouses. A suitable eye wash should be taken into the field by the application crew. In addition, eye protection should be worn by application team members during drilling operations. Manufacturer CA formalized safety program was initiated in 1977. As part of the safety program, all employees are supplied with safety glasses, safety shoes, Nomex flame-retardant work clothes, and hardhats. Rubber gloves are worn when handling raw materials. MSA full-facepiece gas masks approved for use with organic vapors (NIOSH approval No. TC-14G-97) are worn by the Chemical operators when filling drums with TOI.
Engineering control:			Install local exhaust ventilation to reduce formaldehyde exposure levels to below the NIOSH/ACGIH recommended limits during urea formaldehyde drum fill operations. Manufacturer C Exposure control at the blending operation is accomplished through the use of a local exhaust ventilation system, maintenance of the integrity of the components, and use of beveled couplings which insert directly into the drums during filling and prevent spillage. The local exhaust ventilation system vents the displaced air from the drum during filling. The system has branch ducts which lead to the drum locations at the fill station. The ducts terminate in a 3-inch circular, plain (nonflanged) opening located above the open pressure relief bungs. Another branch duct terminates in a flanged canopy hood located over an overflow drum. The distance from the drum opening to the hood opening is about 4 inches; the hood openings were not positioned directly above the drum openings. Air flow measurements indicate an average face velocity of 660 fpm at the face of the first duct and 840 fpm at the face of the second duct (located upstream from the first duct). However, the calculated air velocities at each of the drum openings (based on measured air flows) are only 29 fpm and 37 fpm, respectively. Other controls include a walk-in booth (15' x 18') located in the compounding area which is used for the transfer of TDI and for the mixing of polyurethane products containing TDI. The flow rate was approximately 3300 cubic feet per minute. Located within the booth are flexible hose air ducts which can be placed at the top of a drum during mixing. However, the capture velocity of the air ducts as indicated by use of a smoke tube was insufficient to provide control. This booth has been in operation for 3 years. A walk-in oven, also located in the compounding area, was equipped with a slot hood in 1977. This oven is used to heat drums of raw materials including TDI. Two of the larger compounding vessels are equipped with local exhaust ventilation ducts which vent vapors generated while filling and mixing. The ventilation systems of the oven and the compounding vessels were not evaluated. Manufacturer D Exposure control in the production areas is accomplished through the use of a local exhaust ventilation system at the drum-fill stations and at a blend tank lid. The drum-fill stations are equipped with metal or metal and plastic canopy hoods measuring 18 inches in diameter and 25 inches high. Each hood is connected by a 6-inch diameter, flexible duct to an exhaust fan which is located inside the building. In some cases, the fans exhaust into a common duct before discharging contaminated air to the outside. The hoods, which rest on swivel stands and are equipped with access doors, provide nearly complete enclosure of the funnel and spout. The smaller drum vent opening, which remains open during filling to allow escape of the displaced air, is not covered by the hood. Consequently, vapors present in the displaced air may not be captured by the hood. Only three of the six hoods were used during the survey. One of the blend tanks is equipped with a slot hood around the outer edge of the tank lid. This hood is generally operating while raw materials are being added to the tank. The ventilation system of the vessel was not evaluated. Process controls exist which may indirectly provide exposure controls. These include automatic flow shutoff devices, which interrupt the flow of product when the drum is full, lessening the chance of overflow, and permanent connections between the blend tanks and certain raw materials storage tanks which reduce employee contact with these materials.

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High
			NIOSH Study - Method P&CAM 125
Domain 2: Representativeness	Metric 2:	Geographic Scope	High
	Metric 3:	Applicability	High
			US
			The data are for an occupational scenario (manufacture of insulation materials) within the scope of the risk evaluation.

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Formaldehyde

Occupational Exposure

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HERO ID:		8727392		
Conditions of Use:		Reactant Manufacture in Construction Material		
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 4:	Temporal Representativeness	Low	1979 - Prior to PEL(1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH method P&CAM 125.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between locations, time, and roles. Uncertainty was not discussed but assumed that it was addressed in NIOSH method P&CAM 125.
Overall Quality Determination			High	

Study Citation:	Esswein, E. J. (1992). Health hazard evaluation report no. HETA 91-351-2252, Social Security Administration, District Office, Colorado Springs, Colorado.			
HERO ID:	3970581			
Conditions of Use:	Office Work- Building materials; furnishings			
EXTRACTION				
Parameter	Data			
Worker activity description:	The nature of the work conducted in the SSA space involves interaction with the public regarding management of social security benefits, claims management and associated paperwork processing.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Six air samples were taken at various locations in the office toevaluate for the presence of formaldehyde. As a background sample, one measurement was taken outdoors at the rear of the building. Six indoor air samples, only one measuring 1.7 micrograms per sample or 0.04 milligrams per cubic meter (mg/m3) measured above the minimum detectable concentration of 0.01 mg/m3 based on a sample volume of 40 liters. For this set of samples, the analytical limit of detection (LOD) was reported as 0.5 micrograms per sample (average sample volumes were 36 liters). The remainder of the indoor samples measured 1 or <1 micrograms per sample (an average of 0.02 ppm). Values of 1 or <1 micrograms per sample were between the limit of detection (LOD) and the limit of quantitation (LOQ) for the method. These values cannot be considered "firm" numerical amounts and should be considered semi-quantitative. The concentration for the quantifiable sample was well below the OSHA general industry standard PEL for formaldehyde of 0.75 ppm (0.92 mg/m3). The outdoor sample was reported as non-detectable. NIOSH recommends that exposure to formaldehyde be limited to the lowest feasible level since it is a potential human carcinogen.			
Number of workers:	The SSA District Office employs 35 people.			
Engineering control:	Roof-mounted HVAC exhausts serving the dry cleaning establishment should be evaluated and reconfigured to minimize reentrainment of exhaust effluent into outdoor air serving the SSA office space. The addition of a stack may be necessary to accomplish this.The Carrier three-ton unit should be modified to bring in outsideair in accordance with the current ASHRAE recommendation. Onemethod to accomplish this would be the addition of an economizer.A ventilation engineer should be consulted in regard to this issueparticularly considering that unless the problem with the stack corrected, entrainment of outside air contaminants are a continuedpossibility.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (office work) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1992 - around the time of the PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include critical metadata, such as sample type and exposure type, and worker activities. but lacks additional metadata, such as sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 3970581 Table: 1 of 1

...continued from previous page

Study Citation:		Esswein, E. J. (1992). Health hazard evaluation report no. HETA 91-351-2252, Social Security Administration, District Office, Colorado Springs, Colorado.		
HERO ID:		3970581		
Conditions of Use:		Office Work- Building materials; furnishings		
		EVALUATION		
Domain	Metric	Rating	Comments	
	Metric 7: Metadata Completeness	Medium	The monitoring study does not address variability. Uncertainty was probably considered in Method 3500.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1316877 Table: 1 of 1

Study Citation:	Fayerweather, W. E., Pell, S., Bender, J. R. (1982). [Redacted] Case-control study of cancer deaths in XXX workers with potential exposure to formaldehyde.
HERO ID:	1316877
Conditions of Use:	Manufacturing

EXTRACTION	
Parameter	Data
Area sampling data:	2/3 of the continuous exposure category and been exposed to 0.1ppm or above, 45% of the intermittent exposure category had been exposed at 2ppm or above.
Exposure frequency:	Data are broken down by intermittent or continuous exposure to formaldehyde during work hours.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Study focuses on health parameters and outcomes. Exposure sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The location is unspecified.
	Metric 3:	Applicability	Medium	Though manufacturing and processing is mentioned, due to redactions, it is not fully clear the occupational scenario associated with the data.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment or update and are more than 30 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	Monitoring data do not indicate if data reference personal or area sampling and does not include any needed metadatato understand what the data represent and are not usable in the risk evaluation.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination **Uninformative**

Study Citation:	Fenech, M., Nersesyan, A., Knasmueller, S. (2016). A systematic review of the association between occupational exposure to formaldehyde and effects on chromosomal DNA damage measured using the cytokinesis-block micronucleus assay in lymphocytes. Mutation Research 770(Pt A):46-57.			
HERO ID:	3449394			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	for U.S. 1.4 ppm (Table 2 contains information from various counties)			
Exposure frequency:	for U.S. 0.25 years (Table 2 contains information from various counties)			
Comments:	Tables 2-6 have various ppm concentration of formaldehyde, but it is unclear what portions of this data are occupational, and if so what COUs they fall into.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S. and other countries
	Metric 3:	Applicability	Uninformative	Cannot be determined which data is occupational, and for what COUs.
	Metric 4:	Temporal Representativeness	Medium	Most monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (assumed averages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	Sample type and exposure type not provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by analyzing data from various countries, but uncertainty is not addressed.
Overall Quality Determination		Uninformative		

Study Citation:	Fent, K. W., Evans, D. E., Couch, J. C. (2010). Evaluation of chemical and particle exposures during vehicle fire suppression training.			
HERO ID:	8684528			
Conditions of Use:	Fire suppression of automobile fires			
EXTRACTION				
Parameter	Data			
Worker activity description:	Vehicle fire suppression training has three phases: (1) startup—when the fire is ignited and allowed to build, (2) knockdown—when the fire is suppressed with water, and (3) overhaul—when the fire fighters search for and suppress residual flames or flare-ups. Four fire fighters were involved in the suppression of the engine and cabin fires: a nozzle operator, a backup, a forcible entry, and an officer. The nozzle operator aimed the stream of water, backup assisted with holding the hose, forcible entry pried open doors or the hood to gain better access to the fires, and the officer managed the other fire fighters and assisted where needed.			
Exposure route:	Inhalation			
Physical form:	Gas			
Personal sampling data:	1st fireNozzle operator: not detectedBackup: (0.04) (mg/m^3)Officer: not detectedMotor pump operator: not detectedDuct holder: not detected2nd fireNozzle operator: (0.14) (mg/m^3)Backup: not detectedOfficer: (0.05) (mg/m^3)Motor pump operator: (0.06) (mg/m^3)Duct holder: not detected3rd fireNozzle operator: not detectedBackup: (0.06) (mg/m^3)Officer: not detectedMotor pump operator: not detectedDuct holder: 0.31 (mg/m^3)MDC: 0.06MQC: 0.22			
Exposure duration:	The fire fighters waited 2–5 minutes to let the fires build before knockdown with water. Knockdown took 1–3 minutes and was followed by 1–4 minutes of overhaul.			
Exposure frequency:	Fewer than 4% of its fire responses (~400 total runs per year) are to vehicle fires, which is below the national rate of 20% [Ahrens 2004].			
Personal protective equipment:	The fire fighters wore full turnout gear and SCBAs the entire time they fought the fires, including during overhaul except motor pump operator. Miami Township Fire and Rescue has a comprehensive written respiratory protection program that adheres to the OSHA Respiratory Protection Standard [29 CFR 1910.134] requiring annual medical clearance; respirator fit testing; and training on the use, maintenance, and care of SCBAs.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method (XAD-2 tubes)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Uninformative	The data are from an occupational scenario (firefighter) that does not apply to any occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	The monitoring data were collected after the most recentPEL establishment or update but are generally more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site. The uncertainty canbe determined from the sampling and analytical method.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 8684528 Table: 1 of 1

...continued from previous page

Study Citation:	Fent, K. W., Evans, D. E., Couch, J. C. (2010). Evaluation of chemical and particle exposures during vehicle fire suppression training.
HERO ID:	8684528
Conditions of Use:	Fire suppression of automobile fires

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		Uninformative	

Study Citation:	Fent, K. W., Musolin, K., Methner, M. (2013). Evaluation of chemical exposures during fire fighter training exercises involving smoke simulant.			
HERO ID:	2452610			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Worker activity description:	Exercises involving smoke simulant are conducted to train fire fighters on proper fire-attack and victim-rescue techniques in low visibility conditions inside the training tower. The trainers’ activities before initiating smoke simulant or propane-generated heat and fire included refilling the fog machine reservoirs (usually without wearing gloves), orienting the crew,assigning a trainer to the control room, inspecting the building, checking hose lines, opening valves, checking oil and glycol fluid levels, and turning on the built-in fogging system and/or portable fog machines. For the exercises involving propane-generatedheat and fire, the trainers also preheated the building to 400°F–425°F. The oil-based smoke simulant and propane burners and heaters operated for 10 minutes (timer-controlled). After the exercises, the trainers inside the tower opened doors, windows, and turned off equipment while an exhaust system in the tower was activated remotely to clear the building of smoke simulant and heat.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Estimated From graphsOil-based smoke simulant and propane-generated heat and fire – Personal samples: 6,000 ug/m3 (Figure 12)Glycol-based smoke simulant and propane-generated heat and fire – Personal samples: 1,900 ug/m3 (Figure 13)Oil-based smoke simulant and glycol-based smoke simulant and propane-generated heat and fire - Personal samples: 2,800 ug/m3 (Figure 14)			
Area sampling data:	Estimated From graphsGlycol-based smoke simulant - Area sampling inside room: 60 ug/m3 (Figure 10)Oil-based smoke simulant and propane-generated heat and fire – Area sampling inside the room: 1,800 ug/m3; Area sampling outside the room: 110 ug/m3 (Figure 12)Glycol-based smoke simulant and propane-generated heat and fire – Area sampling inside the room: 4,000 ug/m3 (Figure 13) Oil-based smoke simulant and glycol-based smoke simulant and propane-generated heat and fire – Area sampling inside the room 2 ft height: 3,500 ug/m3; Area sampling inside the room 5 ft height: 1,900 ug/m3; Area sampling outside the room: 450 ug/m3 (Figure 14)			
Particle size characterization:	size profiles are provided for mineral oil aerosols.			
Exposure duration:	15 minutes per episode.			
Exposure frequency:	Fire fighter trainers work 40 hours per week conducting 100 training exercises per year; fire fighters work 24 hours on and 48 hours off			
Number of workers:	255 full time fire fighters and 5 full-time fire fighter trainers; 2-5 fire fighter trainers per day			
Personal protective equipment:	Observations: All the trainers received a respirator fit test for SCBA every year; self-contained breathing apparatus (SCBA), were mandatory for the training exercisesinvolving propane-generated heat and fire. Not uncommon for trainers to wear N95 respirators, occasionally open rooms without respirators; NIOSH recommends: Ensure that trainers do not re-enter the training tower without wearing appropriate respirators until the tower is visibly clear of smoke simulant. Require trainers to wear self-contained breathing apparatus inside the training tower even if they are outside the training room during training exercises that involve heat or fire. Require trainers to wear self-contained breathing apparatus or full-facepiece air purifying respirators with cartridges or canisters that are effective against oil-based aerosol and formaldehyde during training exercises that involve only smoke simulants.Trainers should wear these respirators inside the training tower even if they are outside the training room. Respirators should also be worn during maintenance and adjustment activities if smoke simulant release is expected.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	NIOSH Study using EPA method TO-11A, however, notes that experimental temperatures were above operating range of sampling pumps. NIOSH made some adjustments to measurements to account for this but ‘The ability of the pumpsto accurately draw air at temperatures > 113°F (especially > 400°F) is unknown. (pg. 27)’
Domain 2: Representativeness				
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Formaldehyde

Occupational Exposure

HERO ID: 2452610 Table: 1 of 1

...continued from previous page

Study Citation:	Fent, K. W., Musolin, K., Methner, M. (2013). Evaluation of chemical exposures during fire fighter training exercises involving smoke simulant.
HERO ID:	2452610
Conditions of Use:	Firefighting

Domain		Metric	EVALUATION		Comments
			Rating		
	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	Uninformative	The data are for an occupational scenario for thermal degradation products which is not a COU within the scope (firefighter training).	
	Metric 4:	Temporal Representativeness	High	2013 after PEL (1992) and less than 10 years	
	Metric 5:	Sample Size	Low	Results from individual sampling events were provided in a graph, so uncertain actual value or individual sample value.	
Domain 3: Accessibility/ Clarity					
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.	
Domain 4: Variability and Uncertainty					
	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between combustion equipment configurations. As this is a NIOSH study, it is assumed that uncertainty was considered in the EPA Method used.	

Overall Quality Determination

Uninformative

Study Citation:	Fleig, I., Petri, N., Stocker, W.G., Thiess, A.M. (1982). Cytogenetic analyses of blood lymphocytes of workers exposed to formaldehyde in formaldehyde manufacturing and processing. Journal of Occupational Medicine 24(12):1009-1012.			
HERO ID:	626322			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Operating plant, Shift supervision, maintenance, loading and shipping, tank farm operations, Laboratory work, office work			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	mostly a compliance declaration: Mean 8hr TWA did not exceed 5 ppm prior to 1971 and 1 ppm after that date			
Exposure duration:	8 hrs			
Number of workers:	30 (15 manufacturing of formaldehyde and resins/15 administrative or office staff)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data. (VDI Guideline 3484)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Germany - OECD member
	Metric 3:	Applicability	High	Data for manufacture of formaldehyde and resins are in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL - Published in 1982
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata, missing: number of samples, number of sites, actual test results, exposure frequency, and sampling location.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low		

Study Citation:	Fleisher, J.M. (1987). Medical students’ exposure to formaldehyde in gross anatomy laboratories. New York State Journal of Medicine 87(7):385-388.			
HERO ID:	626323			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	dissection			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Personal sampling done during one day: Lab 1 0.69 ppm; Lab 6 0.18 ppm			
Area sampling data:	Area sampling done during one day: lab 1 0.59 ppm; Lab 2: 0.03 ppm; Lab 6: 0.02 ppm; (see Table 1)			
Exposure duration:	Area sampling: lab 222 minutes; Lab 2: 188 minutes; Lab 6: 190 minutes; Personal sampling: Lab 1 180 minutes; Lab 6 190 minutes			
Exposure frequency:	the duration of the gross anatomy course of study.			
Number of workers:	A major US medical school at which study was conducted has 6 labs and 4 students conduct dissections in each lab. Instructors are also exposed.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US NJ
	Metric 3:	Applicability	High	Data for laboratory technicians are in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL - Published in 1987 data was from 1983
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics single concentration was provided for each lab and an overall range but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Sample type provided but missing: number of samples
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability addressed by providing data for individual labs and range, uncertainty addressed in the sampling methodology
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 626345 Table: 1 of 1

Study Citation:	Fransman, W., Mclean, D., Douwes, J., Demers, P.A., Leung, V., Pearce, N. (2003). Respiratory symptoms and occupational exposures in New Zealand plywood mill workers. Annals of Occupational Hygiene 47(4):287-295.			
HERO ID:	626345			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	Drying; Composing; Pressing; Finishing			
Exposure route:	Inhalation			
Physical form:	vapor			
Personal sampling data:	Personal samples all samples 0.08 mg/m3 geometric mean (3.0 GSD); Dryers 0.07 mg/m3 geometric mean (3.2 GSD); Composer 0.03 mg/m3 geometric mean (1.0 GSD); Pressing 0.16 mg/m3 geometric mean (2.7 GSD); Finishing 0.04 mg/m3 geometric mean			
Number of workers:	112 plywood workers were included in the study			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	New Zealand - OECD member
	Metric 3:	Applicability	High	Data for plywood manufacture workers is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2003
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics: geometric means and GSD for each operation but discrete samples not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type provided but no other metadata such as exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability addressed by providing geometric mean and SD for individual operations, uncertainty addressed in the sampling methodology
Overall Quality Determination		High		

Study Citation:	Freeman, L.E., Blair, A., Lubin, J.H., Stewart, P.A., Hayes, R.B., M, R.N. (2009). Mortality from lymphohematopoietic malignancies among workers in formaldehyde industries: The National Cancer Institute Cohort. Journal of the National Cancer Institute 101(10):751-761.			
HERO ID:	627726			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Number of workers:	25619			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	us
	Metric 3:	Applicability	High	Data are for Formaldehyde and resin production and use which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2009, interviews held 1990-1992
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	Sample type and exposure type not provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Uninformative		

Study Citation:	Friedman, D., Herrera-Moreno, V. (1996). Health hazard evaluation report HETA-95-0313-2589, University of Michigan Hospitals Ann Arbor, Michigan.		
HERO ID:	1317120		
Conditions of Use:	Use of Cleaning and Furniture Care Products		
EXTRACTION			
Parameter	Data		
Worker activity description:	ESD employees reported that floor care products are aerosolized with hand-held chemical sprayers or diluted in water for use with mops or in automatic machines. Hand-held scrubbers are used in areas which are hard to reach using automatic equipment (such as baseboards). A blower is often used to dissipate vapors. In addition to daily floor care, floors are stripped and waxed at least once a year, using at least five coats of finish. High use areas (such as main corridors in the hospitals) are stripped/waxed two to three times a year. Recoating is performed more frequently.Dust Mopping: Daily Hand heldWet Mopping/Light Scrubbing: Daily Hand held and automatic scrubberSpray Buffing: Daily Automatic scrubberBurnishing: Daily 2,000 rpm burnisherScrubbing and Recoating with Automatic Scrubber: >2 months Automatic scrubberStripping with Automatic Scrubber: 1 to 3 times per year Automatic scrubberStripping with Swing Machine: 1 to 3 times per year Automatic scrubber		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	8th Floor general cleaning: Not detected		
Area sampling data:	Corridor 5A: TraceMCHC Lobby: Not detected		
Exposure duration:	8 hours per day		
Exposure frequency:	40 hours per week		
Number of workers:	90 floor cleaners out of 400 custodians		
Personal protective equipment:	Gloves and googles, eye protection		
Engineering control:	Increase ventilation		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The data are for an occupational scenario (floor cleaning) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data from more than 20 years ago.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations, and worker activities.
Domain 4: Variability and Uncertainty			
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Formaldehyde

Occupational Exposure

HERO ID: 1317120 Table: 1 of 1

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Study Citation:		Friedman, D., Herrera-Moreno, V. (1996). Health hazard evaluation report HETA-95-0313-2589, University of Michigan Hospitals Ann Arbor, Michigan.		
HERO ID:		1317120		
Conditions of Use:		Use of Cleaning and Furniture Care Products		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	Medium	Variability is addressed by taking both personal and area samples but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Frigas, E., Filley, W.V., Reed, C.E. (1984). Bronchial challenge with formaldehyde gas: Lack of bronchoconstriction in 13 patients suspected of having formaldehyde-induced asthma. Mayo Clinic Proceedings 59(5):295-299.			
HERO ID:	22222			
Conditions of Use:	Chamber study where individuals were exposed to different concentrations of formaldehyde			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Ranged from 0.1-1.2 ppm			
Exposure duration:	Mask for 20 minutes.			
Number of workers:	13			
Personal protective equipment:	Loosely fitting face mask			
Comments:	*Chamber study where individuals were exposed to different concentrations of formaldehyde to evaluate asthma responses. *Formaldehyde gas or placebo (room air) was delivered from a Dynacalibrator (model 340-23-X, Metronics, Santa Clara, California) at a flow rate of 10 to 14liters/min through Teflon tubing to a loosely fitting face			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from Minnesota, USA and may be representative of the conditions being evaluated.
	Metric 3:	Applicability	Low	The data are intended to represent home and workplace exposures which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1984, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type, but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates
Overall Quality Determination		Low		

Study Citation:	FRM Risk, (2019). [Redacted] Industrial hygiene air contaminant assessment report.			
HERO ID:	10602489			
Conditions of Use:	”blending operations”			
EXTRACTION				
Parameter	Data			
Worker activity description:	The operator lifts the supersacks via hoist on top of the hopper. The operator must then open a small door to the hopper to reach in to untie the supersack in order release paraformaldehyde into the hopper. After opening the supersack, the operator returns to the control room to observe the process. In order to start the process, three or four supersacks are added. Additional supersacks are added one by one throughout the shift to maintain the reaction. (pg 6)			
Physical form:	solid (paraformaldehyde)			
Personal sampling data:	TWA: 0.26, 1.7 ppm (pg 7)Short-term: 0.04, 0.3, 0.52 ppm (pg 8)			
Area sampling data:	TWA: 0.07, 0.024 ppm (pg 7)			
Exposure duration:	TWA sampling durations in table on pg 7; 340-480 min sampling (pg 7)short-term sampling durations in table on pg 8; 17-18 min sampling (pg 8)			
Personal protective equipment:	One employee was equipped with full facepiece (elastomeric) air-purifying respirator with an assigned protection factor (APF) of 50 (pg 2)			
Comments:	An Assay Technologies® (#571) passive dosimeter formaldehyde monitor was utilized as the collection media. In addition, an active air sampling method sampling method was conducted to compare results to the passive dosimeter monitoring. The active and passive methods are both monitoring methods used by OSHA. (pg 6)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved OSHA and NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for ”blending operations”, which may be applicable to multiple COUs but it is not clear the product of this particular facility.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Uncertainty can be determined from the sampling and analytical method, but variability is not addressed.
Overall Quality Determination		High		

Study Citation:	Gagnon, Y. T., Kennedy, E. R., Seitz, T., Teass, A. W. (1992). Development and evaluation of a method to estimate potential formaldehyde dose from inhalable dust/fibers. 7(4):231-240.
HERO ID:	6026019
Conditions of Use:	Finishing agents in textile, apparel, and leather manufacturing (garment manufacturing, waterbed accessory production)

EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Physical form:	dust/fiber and vapor
Area sampling data:	"Not sampling data, but FA concentration ""floor refinishing dust"" (via chromotropic acid method (pg 7): ""Analysis of six filtered and six unfiltered 2-mg samples of the dust weighed into vials gave results of 11.0 +/- 0.8 µg/mg (6.6% RSD) and 74.7 +/- 16.4 µg/mg (20.9% RSD), respectively... [after 21 days to determine loss] The average result of 32 samples was 6.9 +/- 0.2 µg/mg (RSD = 8.2%). It should be noted that this set of samples was prepared from the same bulk sample as the filtered samples described above"" (pg 7) Table 1 (pg 8) provides area sampling data, for dust (mg/m3), formaldehyde bound in dust (µ/m3), and formaldehyde vapor (µ/m3) for garment production facility. Table 2 (pg 9) provides area sampling data, for dust (mg/m3), formaldehyde bound in dust (µ/m3), and formaldehyde vapor (µ/m3) for waterbed accessory plant. "
Comments:	Sampling location: Garment production: "At the turn-and-ticket operation, the sampling stand was placed on top of the vacuum device. In the cutting and layout area, the sampling stand was placed on a mobile cart and intermittently moved to stay in close proximity to the cutters as they worked" (pg 8)Waterbed accessory plant: "Sampling was conducted at a location where two miter saws were used simultaneously to cut waterbed rails to length" (pg 9)Garment production: 8.5 hour sampling (pg 8); Waterbed: 4.5 hour sampling (pg 9)Method: "For sample analysis, either a 4-ml aliquot was analyzed using the chromotropic acid procedure, as outlined in NIOSH Method 3500, (15) or a 1-ml aliquot was treated with 2,4-DNP and a catalytic amount of perchloric acid and analyzed by high-performance liquid chromatography for the resulting 2,4-dinitrophenylhydrazone." (pg 10)

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for fabric finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling multiple sites.

Overall Quality Determination	High

Study Citation:	Galarpe, V.R., Jerusalem, J.G. (2015). Determination of formaldehyde in air in selected hospital-histopathology laboratories in Cagayan de Oro, Philippines. Journal of Chemical Health and Safety 22(1):10-14.			
HERO ID:	6278435			
Conditions of Use:	laboratory use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in histopathology laboratories of three hospitals in Philippines.			
Exposure route:	Inhalation			
Physical form:	Formaldehyde is a colorless liquid and strong-smelling vapor.			
Area sampling data:	Formaldehyde concentrations in three hospitals are as follows: Hospital A [1 hr sample: using DNPH - 0.33 +/- 0.07 and using DNPH-coated silica - 0.61 +/- 0.21; 3 hr sample: using DNPH - 0.42 +/- 0.20 and using DNPH-coated silica - 0.93 +/- 0.04), Hospital B [1 hr sample: using DNPH - 0.14 +/- 0.13 and using DNPH-coated silica - 0.29 +/- 0.41; 3 hr sample: using DNPH - 0.45 +/- 0.01 and using DNPH-coated silica - 0.81 +/- 0.41), Hospital C [1 hr sample: using DNPH - 0.14 +/- 0.07 and using DNPH-coated silica - 0.51 +/- 0.18; 3 hr sample: using DNPH - 0.47 +/- 0.13 and using DNPH-coated silica – 1.03 +/- 0.36).			
Personal protective equipment:	Gloves, Laboratory gown			
Engineering control:	Exhaust fan, Laboratory chemical hood, Fire extinguisher			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described methodology
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	Medium	range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on variability or uncertainty
Overall Quality Determination		Medium		

Study Citation:	Gamble, J.F., Nicolich, M.J., Barone, N.J., Vincent, W.J. (1999). Exposure-response of asphalt fumes with changes in pulmonary function and symptoms. Scandinavian Journal of Work, Environment and Health 25(3):186-206.			
HERO ID:	1314047			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Nondetect			
Number of workers:	170			
Comments:	Note the authors of the paper were from Exxon Biomedical Sciences and it was peer-reviewed by the Asphalt Institute EOC			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	GMD passive formaldehyde monitors were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data from Exxon Biomedical Sciences which is a US company, however, the journal is from Scandinavia
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4:	Temporal Representativeness	Low	The data were published in 1999, after the most recent PEL (1992) But more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	General Motors Co, (1982). Determination of chemicals in the air in Fisher Body Division model shops with cover letter.			
HERO ID:	1312370			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Wood shaping using shaping machines			
Exposure route:	Inhalation			
Area sampling data:	ND (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1982)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering control, PPE, exposure frequency, exposure duration.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Gerster, Melchior, F., Hopf, Brenna, N., Wild, Pierre, P., Vernez, D. (2014). Airborne exposures to monoethanolamine, glycol ethers, and benzyl alcohol during professional cleaning: a pilot study. Annals of Occupational Hygiene 58(7):846-859.			
HERO ID:	2452666			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	apartment, industrial, public space, patient room, and floor cleaning.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	GM = 0.023 mg/m-3; GSD = 3.5; Range = 0.003-0.189 mg/m3			
Number of workers:	Typically 3-4% of working population in developed countries.			
Engineering control:	cross ventilation			
Comments:	Increased FA concentrations observed have been attributed to a reaction between terpenes present in the cleaning products and ozone (Singer et al., 2006a). In the present study, the FA concentrations differed greatly between sampling dates. We did not sample on days where cleaning was not performed; therefore, the FA sources remain unknown.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	FA sampling and analysis were performed according to previously described methods (Huynh, 1998; Huynh and Vu-Duc, 2002). Cartridges (LpDNPH S10 cartridge; Supelco, Bellefonte, PA, USA) was used for sampling and the air sampling pump (Air Check XR5000; SKC Inc.) operated at a flow rate of 1.5 l min–1. Desorption (3ml acetonitrile) was followed by High Performance Liquid Chromatography (HPLC) (Varian, Palo Alto, CA, USA, Prostar, pump model 230, UV Diode Array Detector model 335,wavelength: 365 nm) with a packed (3 μm) column (Spherisorb; Waters, Milford, MA, USA) and equipped with ultraviolet (UV) detection. The LOD was 40ng sample–1.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Switzerland, an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario (cleaners) within the scope of the risk evaluation but source of exposure is unclear if due to cleaning products or other products.
	Metric 4:	Temporal Representativeness	High	2014 - after PEL (1992) and less than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized; geometric mean, geometric standard deviation, and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, and worker activities, but not exposure duration and frequency.
Domain 4: Variability and Uncertainty				
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Formaldehyde

Occupational Exposure

HERO ID: 2452666 Table: 1 of 1

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Study Citation:	Gerster, Melchior, F., Hopf, Brenna, N., Wild, Pierre, P., Vernez, D. (2014). Airborne exposures to monoethanolamine, glycol ethers, and benzyl alcohol during professional cleaning: a pilot study. Annals of Occupational Hygiene 58(7):846-859.		
HERO ID:	2452666		
Conditions of Use:	Compressed Wood Product Manufacturing		
Domain		EVALUATION	
Metric		Rating	Comments
Metric 7:	Metadata Completeness	Medium	The monitoring study provides data on range and standard deviation data on variability. This study noted variability between sampling days and between companies. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		High	

Study Citation:	Ghasemkhani, M., Jahanpeyma, F., Azam, K. (2005). Formaldehyde exposure in some educational hospitals of Tehran. Industrial Health 43(4):703-707.			
HERO ID:	6117989			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in pathology labs, surgery rooms, and endoscopy wards. (2/5)			
Exposure route:	inhalation (2/5)			
Physical form:	vapors from liquid formalin or paraformaldehyde powder (2/5)			
Personal sampling data:	Pathology Labs: 0.96+-0.74 ppm Surgery Rooms: 0.25+-0.22 ppm Endoscopy Wards: 0.13+-0.18 ppm (2/5)			
Area sampling data:	Mean values are presented - Pathology Labs: 0.59-1.30 ppm Surgery Rooms: 0.15-0.51 ppm Endoscopy Laboratories: 0.01-1.62 ppm (3/5)			
Exposure duration:	1 hour, 8 hour			
Number of workers:	1/3 of 1.3 million workers are exposed to formaldehyde in America are working in medical and paramedical institutions and organizations. (1/5)			
Engineering control:	Local exhaust ventilation, typical fans, proper window ventilation, proper tissue storage, and a biological safety cabinet are measures that should be taken to reduce formaldehyde exposure. (3/5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Iran, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, medians, standard deviations, p-values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at 8 hospitals.
Overall Quality Determination		Medium		

Study Citation:	Gibbins, J. D., Brueck, S. E., Sylvain, D., Oza, A. (2017). Health Hazard Evaluation Report: HHE-2010-0001-3295, November 2017. Evaluation of Occupational Exposures at an Insect Rearing Facility.			
HERO ID:	4794995			
Conditions of Use:	Other-Insect Rearing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Insect production - egg preparation, egg infestation, dark room, cutout room, hexcel stripping, egg production, moth production and collection, moth irradiation, moth packaging and shipping; Insect production support - diet weight room, kitchen, hexcel cleaning, carboard cleaning, tray scraping, quality control, maintenance, supervisor.			
Exposure route:	Inhalation, dermal (expected to occur but not measured)			
Personal sampling data:	0.21 ppm, 0.18 pm, 0.17 ppm, and 0.14 ppm; Sampling durations were 102, 134, 101, and 136 minutes respectively			
Area sampling data:	0.12 ppm near formaldehyde tanks and a concentration of 0.098 ppm near drying racks.			
Number of workers:	25 year round and 47 seasonal employees. Seasonal worked from March to October			
Personal protective equipment:	Depending on work area PPE were worn: N95, Elastomeric half mask respirator, gloves, hairnet, gown, lab coat, hearing protection, safety glasses, apron/boots, irradiation badge.			
Engineering control:	LEV. Facility had detailed sanitation and pest management protocols to address pathogens created by adult moths and scales. Floor to roof fire walls separated the administrative office area from the adjacent clean moth production area. The facility did not have a plenum or air exchange between the administrative office and production areas. Fume/work hoods. Negative pressure and baghouses for dust.			
Comments:	Area samples analyzed by NIOSH Method 2016			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source uses NIOSH approved sampling and analytical methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	Low	Information is not clear on the function of formaldehyde in the process, it’s possible that the function is as a fungicide which would be outside of the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data is just over 10 years old (2009).
	Metric 5:	Sample Size	High	Discrete values provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes process description, worker activities, personal and area sampling, number of workers, PPE, engineering controls but lack of clarity on the function of formaldehyde within the process.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at multiple different areas for sampling data. Does not address uncertainty.
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Formaldehyde

Occupational Exposure

HERO ID: 4794995 Table: 1 of 1

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Study Citation:	Gibbins, J. D., Brueck, S. E., Sylvain, D., Oza, A. (2017). Health Hazard Evaluation Report: HHE-2010-0001-3295, November 2017. Evaluation of Occupational Exposures at an Insect Rearing Facility.		
HERO ID:	4794995		
Conditions of Use:	Other-Insect Rearing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Gillett, R.W., Kreibich, H., Ayers, G.P. (2000). Measurement of indoor formaldehyde concentrations with a passive sampler. Environmental Science and Technology 34(10):2051-2056.			
HERO ID:	2443808			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Area sampling data:	Formaldehyde Concentrations in Workplaces (ppbv): office (source - new furniture) - 48.6; graphics office (source - glue, paint) 61.2; graphics workroom (source - glue, paint) - 42.6; chemical laboratory (formaldehyde) - 25.1; dental Laboratory (source – vapor sterilizer) - 21.6; dental surgery (source – chemicals) - 32.7; carpentry workshop (source - fiberboard, plywood) - 57.0; carpentry workshop (particle board) - 30.0.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	data between 10 and 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
Overall Quality Determination		Medium		

Study Citation:	Glas, B., Levin, J.O., Stenberg, B., Stenlund, H., Sunesson, A.L. (2004). Variability of personal chemical exposure in eight office buildings in Sweden. Journal of Exposure Analysis and Environmental Epidemiology 14:S49-S57.			
HERO ID:	90179			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office work			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	9 ug/m3 average (range 3-18 ug/m3) variance among individuals 5.5 ug/m3 and variance among buildings 3.3 ug/m3.			
Number of workers:	79			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Specific methods were not indicated, but it was noted that aldehydes were sampled with diffusive samplers and analyzed using HPLC.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - OECD member
	Metric 3:	Applicability	Uninformative	The data are from an occupational or non-occupational scenario that does not apply to any occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (November 2000 and April 2001, published 2004) after the most recent PEL establishment or update (1992) but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability between different sites and individuals was quantified, nothing was provided for uncertainty
Overall Quality Determination		Uninformative		

Formaldehyde

Occupational Exposure

HERO ID: 2837506 Table: 1 of 1

Study Citation:	Glas, B., Stenberg, B., Stenlund, H., Sunesson, A.L. (2014). Exposure to formaldehyde, nitrogen dioxide, ozone, and terpenes among office workers and associations with reported symptoms. International Archives of Occupational and Environmental Health 88(5):613-622.			
HERO ID:	2837506			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	office workers with and without sick building syndrome			
Physical form:	vapors			
Personal sampling data:	Formaldehyde concentrations (ug/m3) in 2 different places: in Umea – geometric mean – 7.6 +/- 1.7, median – 7.5, range – 0.97 – 45; in Vasa – geometric mean – 8.1 +/- 2.9, median – 9.8, range – 0.23 – 32			
Number of workers:	A total of 209 people participated in the study: 159 in Umeå and 50 in Vasa, 177 women and 32 men, with a mean age of 42.5 years for cases and 42.2 years for controls (range 23–65 years).			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	addresses variabilities and uncertainties
Overall Quality Determination		High		

Study Citation:	Gockel, D.L., Horstman, S.W., Scott, C.M. (1981). Formaldehyde emissions from carbonless copy paper forms. American Industrial Hygiene Association Journal 42(6):474-476.		
HERO ID:	1317354		
Conditions of Use:	Use of Paper Products		
EXTRACTION			
Parameter	Data		
Worker activity description:	use of carbonless copy paper forms.		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	Analysis of 9 carbonless copy forms 0.04-0.25 ppm		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH methods were likely used as the authors noted that the samples were analyzed spectrophotometrically using the chromotropic acid method as in NIOSH P&CM No. 125.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for use of carbonless copy forms, which is an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The article was published in 1981 before the most recent PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	High	testing results from 8 different types of forms were provided in terms of emissions per form or per kg of forms.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, and worker activities, but lacks additional metadata, such as exposure durations, and exposure frequency.=
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The study provided test results for different forms which could be used to evaluate variability. Information about uncertainty is likely included in the NIOSH methods.
Overall Quality Determination		High	

Study Citation:	Godby, M., Knutti, E. (1993). Health hazard evaluation report No. HETA-91-181-2307, Haddon Craftmen, Inc., Scranton, Pennsylvania. NIOSH(HETA-91-181-2307):91-181.
HERO ID:	1320742
Conditions of Use:	Multiple

EXTRACTION	
Parameter	Data
Worker activity description:	One operator and one helper work the Kolbus Tipper machine. Three operators and 8-11 helpers operate each binder (UB4 and UB5).An attendant on each shift diverts the flow of trimmings to the empty room and then pushes the accumulated scrap paper into an unguarded vacuum duct (floor opening) and down into the baler.One operator and one helper are at the Dexter machine producing laminated paper covers. On the ground floor, three Kolbus Liner machines employing 10 workers add reinforcement to hard covers.At the End Paper Combiner, an operator cuts liners for hard covers.Operation of the Compact 45 requires an operator and up to five helpers. The finished books are stacked onto pallets for packaging and shipment.For the shrinkwrap operation, the operator then uses a propane torch to shrink the sheeting. The shrinkwrap operation is only performed on the day shift and requires about 20-30 minutes per day.
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	The report notes one formaldehyde BZ sample was implemented but cannto not determine form the results which sample that was
Area sampling data:	Crathern Casemaker < LOQ Crathern Casemaker < LOQ Crathern Casemaker < LOQ End Paper Combiner 0.09 ppmEnd Paper Combiner 0.07 ppmEnd Paper Combiner 0.07 ppmCompact 45 0.04 ppmCompact 45 0.07 ppmCompact 45 0.07 ppmCompact 45 0.06 ppmCompact 45 0.06 ppmKolbus Liner 0.06 ppmKolbus Liner 0.07 ppmKolbus Tipper voidKolbus Tipper 0.01 ppmKolbus Tipper 0.03 ppmKolbus Tipper Operator 0.01 ppmRemote at breakroom < LOQ Remote at breakroom 0.03 ppmStamper < LOQ Stamper < LOQ UB4 0.07 ppmUB5 0.05 ppmUB5 0.07 ppm
Exposure duration:	3 shifts per day
Exposure frequency:	5 days per week
Number of workers:	265 (235 production workers)
Personal protective equipment:	Dust respirators (3M-8710) are provided to these baling area employees.
Engineering control:	The pre-melt pots' local exhaust ventilation hoods are set 2-3 feet above the pots to allow clearance for adding hot-melt glue pellets. Some of these pots incorporate strip curtains to direct the atmosphere above the pots into the hoods. Some of the various points of glue application are also fitted with an exhaust ventilation hood a few feet above the application point. Other points ofapplication do not incorporate local exhaust ventilation.It is recommended that the existing local exhaust systems over the pre-melt pots be improved to completely enclosing the hot-melt glue pots.While the above is being implemented, assure that all pre-melt pots for the hot-melt glues incorporate strip curtains to direct the atmosphere immediately above the surface of the pots into the local exhaust ventilation hoods, uninterrupted by the circulation of in-plant air. Assure that all elements of strip curtains are present and properly positioned at all times. This will help to contain the vapors within the exhaust ventilation system, and slow thespread of vapors into the work environment.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study - Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (book binding) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1992 - when the PEL was set , but more than 20 years old.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 1320742 Table: 1 of 1

...continued from previous page

Study Citation:	Godby, M., Knutti, E. (1993). Health hazard evaluation report No. HETA-91-181-2307, Haddon Craftsmen, Inc., Scranton, Pennsylvania. NIOSH(HETA-91-181-2307):91-181.			
HERO ID:	1320742			
Conditions of Use:	Multiple			
Domain		Metric	EVALUATION	
			Rating	Comments
		Metric 5: Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH method 3500.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including exposure types, sample durations, exposure durations worker activities, and exposure frequency. It is unclear which of the samples represent breathing zone sample types, and as it is reported that all but one of the sampling events were area sampling, all the results were considered area samples.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in Method 3500.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 474862 Table: 1 of 1

Study Citation:	Godderis, L., Deschuyffeleer, T., Roelandt, H., Veulemans, H., Moens, G. (2008). Exposure to metalworking fluids and respiratory and dermatological complaints in a secondary aluminium plant. International Archives of Occupational and Environmental Health 81(7):845-853.			
HERO ID:	474862			
Conditions of Use:	Use of Metalworking fluid			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	[mg/m3] Extrusion Press 1-0.03, Extrusion Press 2-0.02, Hot Rolling Mill Entrance-0.03, Hot Rolling Mill-0.03, Cold Rolling Mill 1&2-0.02			
Number of workers:	31 workersof one shift (in a three-shift system) were incorporated inthis study: 10 workers from the Extrusion department (5from the Press 1 and 5 from the Press 2), 7 workers fromthe Hot Rolling Mill department and 14 workers from theCold Rolling Mill department (7 from Cold Rolling Mill 1and 7 from Cold Rolling Mill 2).			
Comments:	"The origin of this aldehyde is not yet clear, but we postulate that the formaldehyde could originate either from the combustion of MWF or from formaldehyde-releasing triazines used as biocides."			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology was noted that 2-hydroxymethylpiperidine impregnated tubes/ extracted with carbon disulfide analysis FID GC were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - OECD member
	Metric 3:	Applicability	Uninformative	Data are for formaldehyde as either a combustion byproduct or biocide byproduct, which is not in scope.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Published in 2008 but the data are from 2005
	Metric 5:	Sample Size	Medium	Statistical distribution of samples is fully characterized but only 1 sample taken per location.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, but lacks additional metadata: worker activities, exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by sampling at different locations, however, only 1 measurement per location. Uncertainty in formaldehyde exposure is discussed.
Overall Quality Determination		Uninformative		

Formaldehyde

Occupational Exposure

HERO ID: 12171 Table: 1 of 1

Study Citation:	Golden, A.L., Markowitz, S.B., Landrigan, P.J. (1995). The risk of cancer in firefighters. Occupational and Environmental Medicine 10(4):803-820.			
HERO ID:	12171			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	ND-0.3 ppm inside mask			
Area sampling data:	Concentration of formaldehyde during knockdown and overhaul: up to 8 ppm and 0.4 ppm, respectively. Combined concentrations of formaldehyde and acetaldehyde levels:5 ppm mean (range 1-15 ppm). Concentration of aldehydes, including formaldehyde at 4 of 14 fires: 0.1 to 8.3 ppm. (See PDF pg. 4/18)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified, but references for the extracted data are given (and these references may contain information about sampling and analytical methodology.)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The geographic association of the data is not stated although references for the data are stated.
	Metric 3:	Applicability	High	The data are for firefighters is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Metadata on the firefighting may representative of outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The study ws published in 1994 but the exposure data were collected prior to that time, possibly prior to the 1992 PEL, but definitely more than 20 years old.
	Metric 5:	Sample Size	Low	istribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	The study included sample type (i.e., area sampling) but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	a range of values were provided to give an sense of variability of the data but noting on uncertainty.
Overall Quality Determination		Low		

Study Citation:	Goldman, P., Flach, H. D., Hey, W., H, Hochadel, Petri, N., KU, Strassburger, Thiess, A. M. (1982). Formaldehyde morbidity study by Goldmann P et al (19).
HERO ID:	5908864
Conditions of Use:	Manufacturing

EXTRACTION	
Parameter	Data
Worker activity description:	Regular work includes as operating, measuring, and controlling instrumentation in control stations, control walks through the plants, operation of equipment, mechanical work on plants and packaging work. Irregular work includes sampling, cleaning of filters, opening of equipment, and cleaning with hot water, elimination of leakages on valves and pipelines, etc., disassembling plugged pipelines, and other mechanical work. (6/20)
Exposure route:	inhalation (9/20)
Personal sampling data:	"Group 1, up to 25% of the MAK value: <0.01-0.22 ppm Group 2, up to 60% of the MAK value: <0.01-0.60 ppm Group 3, up to the MAK value:<0.01-1 ppm (9/20)"
Exposure duration:	119 employees- from the Exposed Group worked in 12-hour shifts, alternating between day and night shifts. 80 people worked only 8-hour day shifts. (5/20)
Exposure frequency:	Up to 42 years of exposure, with an average of 18 years. (2/20)
Number of workers:	199 (2/20)
Personal protective equipment:	When carrying out irregular work, the employees are required to protect themselves against formaldehyde exposure by wearing respirators, possibly gas tight protective goggles, protective gloves, rubber boots, and possibly protective clothing if there is danger of skin contact with formaldehyde-containing solutions. (6/20)

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are form the U.S.
	Metric 3:	Applicability	High	Data are for the production of formaldehyde, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by sampling groups from different exposure levels (25% MAK level, etc.) Uncertainty is not addressed.

Overall Quality Determination

High

Formaldehyde

Occupational Exposure

HERO ID: 6025343 Table: 1 of 4

Study Citation:	Goodson, L. A., Jr (1983). Formaldehyde regulations and response of the textile industry. :84-88.			
HERO ID:	6025343			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Area sampling data:	"Formaldehyde Producer: <0.5 ppm TWA, <1.0 ppm ceiling (4/7)"			
Number of workers:	"Formaldehyde Production: 1,400 (3/7)"			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data is for manufacturing, which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (TWA, ceiling values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 6025343 Table: 2 of 4

Study Citation:	Goodson, L. A., Jr (1983). Formaldehyde regulations and response of the textile industry. :84-88.			
HERO ID:	6025343			
Conditions of Use:	Industrial/Commercial Use: Iron Foundry			
EXTRACTION				
Parameter	Data			
Area sampling data:	"Iron Foundry: 18.0 ppm ceiling 4/7)"			
Number of workers:	"Foundries 43,000 (3/7)"			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (TWA, ceiling values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 6025343 Table: 3 of 4

Study Citation:		Goodson, L. A., Jr (1983). Formaldehyde regulations and response of the textile industry. :84-88.		
HERO ID:		6025343		
Conditions of Use:		Processing: Finishing agents in textiles		
EXTRACTION				
Parameter		Data		
Area sampling data:		”Best Textile Finishing: <1.0 ppm TWA, <2.0 ppm ceiling Worst Textile Finishing: 2.0 ppm, 3.0 ppm ceiling Textile Warehouse: 0.5-2.5 ppm TWA, 3.0 ppm ceiling (4/7)”		
Number of workers:		”Textile Finishing: 20,000 Apparel: 897,000 Resins: 6,000 Paints, Dyes, and Pigments: 37,400 (3/7)”		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data is for textile finishing, which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (TWA, ceiling values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 6025343 Table: 4 of 4

Study Citation:	Goodson, L. A., Jr (1983). Formaldehyde regulations and response of the textile industry. :84-88.			
HERO ID:	6025343			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Area sampling data:	"Embalmers: 5.0 ppm ceiling (4/7)"			
Number of workers:	"Funeral Services: 52,000 (3/7)"			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (TWA, ceiling values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Gorman, R., Aw, T. C. (1986). Health Hazard Evaluation Report HETA-1984-248-1694 Wasson Elementary school, Dubois, Pennsylvania.			
HERO ID:	8684537			
Conditions of Use:	Wood and engineered wood products or floor coverings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Administrative staff at al elementary school. (5/24)			
Exposure route:	inhalation (5/24)			
Physical form:	gas (7/24)			
Area sampling data:	Formaldehyde was not detected during area sampling with a LOD of 0.04 ppm. (15/24)			
Exposure duration:	8 hours/day (7/24)			
Engineering control:	The heating, ventilation, and air conditioning (HVAC) system is primarily a zonal system with each zone consisting of a number of ceiling unit ventilators suspended above the false ceiling and a relief damper system designed to limit pressurizing the building when fresh air is brought in via the unit ventilators. Each unit ventilator delivers air through two ceiling diffusers near the outside wall; air is returned to the unit via two ceiling return grills on the inside wall. An outside temperature sensor regulates a damper in each unit ventilator that determines the mix of return air and fresh air. Fresh air enters through a vertical duct directly above each unit . In order for this type of system to work effectively, room air must have a pathway to the relief dampers, which were typically located outside of the classrooms in the corridors. (13/24)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for ambient air in a school, which can be similar to the in-scope occupational scenario of floor coverings, or wood products.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing number of workers, exposure frequency, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Gosselin, N.H., Brunet, R.C., Carrier, G. (2003). Comparative occupational exposures to formaldehyde released from inhaled wood product dusts versus that in vapor form. Applied Occupational and Environmental Hygiene 18(5):384-393.			
HERO ID:	1313865			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Worker activity description:	woodworkers- wood chipping,			
Exposure route:	inhalation			
Physical form:	vapor and dust			
Area sampling data:	assumption 0.38 mg/m3			
Particle size characterization:	Wood chipping 0.6 mg/m3; furniture production 1-2 mg/m3; sawing machine 0.8 mg/m3; sanding and fitting 3.8 mg/m3			
Comments:	This study presents a model to estimate the absorption of formaldehyde as a vapor and via woodworking dust particles. if this study is correct than exposure from woodworking dust is not a significant factor (conservatively speaking dust accounted for 1/100 of the exposure compare to vapors)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - an OECD member
	Metric 3:	Applicability	High	The data are for woodworking, an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The study was published in 2003 after the most recent PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Low	generally single values are provided which one assumes is an mean value
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	very little metadata are provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty in the models input data
Overall Quality Determination		Low		

Study Citation:	Gottschling, L.M., Beaulieu, H.J., Melvin, W.W. (1984). Monitoring of formic acid in urine of humans exposed to low levels of formaldehyde. American Industrial Hygiene Association Journal 45(1):19-23.		
HERO ID:	626435		
Conditions of Use:	Laboratory Use		
EXTRACTION			
Parameter	Data		
Worker activity description:	animal dissection		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	Week 1: 0.11 ppm mean (range 0.04-0.33 ppm); Week 2: 0.11 ppm mean (range 0.02-0.36 ppm); Week 3 0.04 ppm mean (range 0.00-0.23 ppm)		
Exposure duration:	2 hrs per class for 3 consecutive weeks		
Exposure frequency:	per classs		
Number of workers:	36		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Analytical methodology is not specified though h it was noted that 3M monitors were used
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL - Published in 1984 data from 1977 (freshmen class of 1981)
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics mean and range but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Sample type provided but no other metadata such as uncertain about the number of classes per week and sampling and nalytical methods used.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Variability addressed by range and uncertainty was discussed in the conclusions.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 626442 Table: 1 of 1

Study Citation:	Grammer, L.C., Harris, K.E., Shaughnessy, M.A., Sparks, P., Ayars, G.H., Altman, L.C., Patterson, R. (1990). Clinical and immunologic evaluation of 37 workers exposed to gaseous formaldehyde. Journal of Allergy and Clinical Immunology 86(2):177-181.			
HERO ID:	626442			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.003-0.073 ppm			
Number of workers:	37			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH methods used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US Seattle
	Metric 3:	Applicability	High	Data for aircraft manufacturer workers is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL - Published in 1990
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Gunson, T. H., Smith, H. R., Vinciullo, C. (2011). Assessment and management of chemical exposure in the Mohs laboratory. Dermatologic Surgery 37(1):1-9.			
HERO ID:	6199750			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Laboratory technicians that process tissue for Mohs micrographic surgery. (1/9)			
Exposure route:	inhalation, dermal (3/9)			
Physical form:	vapor (7/9)			
Personal sampling data:	The results of atmospheric testing over one 8-hour shift at the decommissioned laboratory demonstrated formaldehyde levels of 9.6 and 4.1 mg/m3 for the personal sampling devices worn by two laboratory technicians. Repeat testing of formaldehyde and aromatic hydrocarbon concentration was performed at the new laboratory. Formaldehyde levels of 0.016 and 0.47 mg/m3 for the two personal sampling devices for a typical 8-hour shift were recorded.(5/9)			
Area sampling data:	The four static measuring devices recorded acceptable formaldehyde levels of 0.075 to 0.31 mg/m3 (5/9)			
Exposure duration:	8 hours (2/9)			
Exposure frequency:	5 days/week (5/9)			
Number of workers:	2 workers were sampled in this study (1/9)			
Personal protective equipment:	The appropriate use of gloves, eyewear, and gowns during the handling of hazardous chemicals should minimize the risk of direct contact. (8/9)			
Engineering control:	"All volatile chemicals are now handled within the fume hood. The position of the slide stainer within the fume hood in the new laboratory minimizes exposure considerably, and, after hours, the baths are covered to minimize vapor release. To minimize formaldehyde exposure, workers should open formaldehyde pots immediately before addition of the specimen and to close them again promptly. (8/9)"			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by performing follow-up sampling at the same laboratory. Uncertainty is not addressed.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 6199750 Table: 1 of 1

...continued from previous page

Study Citation:	Gunson, T. H., Smith, H. R., Vinciullo, C. (2011). Assessment and management of chemical exposure in the Mohs laboratory. Dermatologic Surgery 37(1):1-9.		
HERO ID:	6199750		
Conditions of Use:	Use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 8488494 Table: 1 of 1

Study Citation:	Gunter, B. J. (1977). Health Hazard Evaluation Report No. 77-37-413, Gates Rubber Company, Denver, Colorado.			
HERO ID:	8488494			
Conditions of Use:	Synthetic rubber manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Braiders, rewinders, and stockmen. (8/10)			
Exposure route:	dermal (2/10)			
Physical form:	solution (2/10)			
Area sampling data:	Atmospheric concentrations of formaldehyde ranged from ND-0.04 mg/m3. (8/10)			
Exposure duration:	1-2 hours/day (8/10)			
Number of workers:	40 workers (2/10)			
Engineering control:	Ventilation should be installed in the braiding department to eliminate employee exposure to lint and dust containing formaldehyde. (4/10)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, which is similar to the in-scope occupational scenario synthetic rubber manufacturing in transportation equipment.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure frequency and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		High		

Study Citation:	Gunter, B. J., Klineciewicz, S., Daniels, W. J. (1989). Health Hazard Evaluation Report HETA 88-294-1974, Boeing Aircraft, Seattle, Washington, July 1989.			
HERO ID:	1320761			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Formaldehyde was only quantitated on 6 of 19 personal breathing zone samples, with all of these levels being approximately 0.05 ppm.July 6-7Building 17-54 Orbo 23 Tubes PBM TraceOrbo 23 Tubes PBM NDOrbo 23 Tubes PBM TraceOrbo 23 Tubes PBM TraceOrbo 23 Tubes PBM 0.073 mg/m3Orbo 23 Tubes PBM 0.066 mg/m3Orbo 23 Tubes PBM 0.049 mg/m3Orbo 23 Tubes PBM TraceAugust 16-17 Sampling Building 17-02Orbo 23 tube PBM Station 4 0.056 mg/m3Orbo 23 tube PBM Station 4 0.05 mg/m3Orbo 23 tube PBM Station 4 TraceOrbo 23 tube PBM Station 4 TraceOrbo 23 tube PBM Station 4 TraceOrbo 23 tube PBM Station 4 TraceOrbo 23 tube PBM Station 4 0.038 mg/m3Orbo 23 tube PBM Station 4 TraceOrbo 23 tube PBM Station 4 TraceOrbo 23 tube PBM Station 4 NDOrbo 23 tube PBM Station 4 ND			
Area sampling data:	July 6-7Building 17-54 Orbo 23 Tubes Dispensing Rack NDOrbo 23 Tubes Dispensing Rack NDImpingers Dispensing Rack 0.007 mg/m3Impingers Dispensing Rack TraceOrbo 23 Tubes Area 5 Oven NDOrbo 23 Tube Area 5 - Debagger NDImpingers Area 83 - Back 0.010 mg/m3Impingers Area 83 - Corner TraceImpingers BAT Wing 0.010 mg/m3Impingers BAT Wing TraceBuilding 17-02 Orbo 23 tube Spray booth 0.038 mg/m3Orbo 23 tube Area 66- rework NDOrbo 23 tube Area 66- rework NDOrbo 23 tube Area 4 TraceOrbo 23 tube Area 5 packaging NDImpiners Area 5 packaging 0.010 mg/m3Impiners Area 5 packaging TraceImpiners Layup B-16 0.005 mg/m3Impiners Layup B-16 NDImpiners Oven Area TraceImpiners Oven Area ND August 16-17 Sampling Building 17-02 Impiners Station 4 0.006 mg/m3Impiners Station 4 TraceImpiners Station 4 0.012 mg/m3Impiners Station 4 TraceImpiners Station 4 0.010 mg/m3Orbo 23 tube Station 21 NDOrbo 23 tube Area 5 - Bagging TraceOrbo 23 tube Area 5 - Bagging TraceOrbo 23 tube Station 4 Batwing 0.285 mg/m3 (process)Building 17-05: Area 21Impinger 0.008 mg/m3Impinger TraceImpinger 0.006 mg/m3Impinger Trace			
Exposure duration:	8-10 hours per day			
Exposure frequency:	40 hours per week			
Number of workers:	Building 17-02 489Building 17-05 152			
Personal protective equipment:	Chemical cartridge respirators, white cotton gloves and latex surgical type gloves were available to all workers. Useof all personal protective equipment was optional, and was minimal in all lay-up areas.			
Engineering control:	The ventilation system in Building 17-02 should be adjusted so that workers can use it without discomfort. The discomfort includes excessive cold and drying out of eyes.			
Comments:	Table 1 - 4.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Methods 2501 and 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (aircraft manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1988 - prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH methods 2501 and 3500.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 1320761 Table: 1 of 1

...continued from previous page			
Study Citation:	Gunter, B. J., Klineciewicz, S., Daniels, W. J. (1989). Health Hazard Evaluation Report HETA 88-294-1974, Boeing Aircraft, Seattle, Washington, July 1989.		
HERO ID:	1320761		
Conditions of Use:	Multiple		
Domain	Metric	EVALUATION Rating	Comments
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations,and exposure frequency, but nothing was provided describing worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between locations, jobs and for different times. Uncertainty was not discussed but assumed that it was addressed in NIOSH methods 2501 and 3500.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 1357686 Table: 1 of 1

Study Citation:	Gunter, B. J., Lee, S. A. (1988). Health Hazard Evaluation Report HETA 88-127-1903, CF&I Steel Corporation, Pueblo, Colorado, June 1988.			
HERO ID:	1357686			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Electric arc furnaces are relined with brick, which produces dust and odors, especially when the mortarizing compound is placed on the brick and hot furnace walls (Page 5 of 14)			
Personal sampling data:	0.03 mg/m3 (page 9 of 14 for brief discussion, no additional data points provided)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (steel mill) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1988 - prior to PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, exposure durations, exposure frequency, and worker activities, but lacks sample durations.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study doe not discuss variability. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination		Medium		

Study Citation:	Gylseth, B., Digernes, V. (1992). The European development of regulations and standards for formaldehyde in air and in wood composite boards. :199-206.			
HERO ID:	5937390			
Conditions of Use:	Private home exposure from particleboards			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor/gas			
Area sampling data:	Range between 0.010 - 0.080 ppm, averages from particleboard - 0.054 ppm; from solid wood - 0.022 ppm; from hardboard - 0.040 ppm; and from gypsum board - 0.033 ppm			
Particle size characterization:	Common product standard is 10 mg FA/100 g of board			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Source is not peer reviewed but appears to contain high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is or Norway, an OECD country.
	Metric 3:	Applicability	Medium	Data is for private home exposure, but could be applied to other COUs.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1992).
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes chemical concentration, exposure route, physical form and area sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Includes variability by looking at multiple different types of material. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Gérin, M., Siemiatycki, J., Nadon, L., Dewar, R., Krewski, D. (1989). Cancer risks due to occupational exposure to formaldehyde: Results of a multi-site case-control study in Montreal. International Journal of Cancer 44(1):53-58.			
HERO ID:	626386			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	No exposure concentrations were included in this study instead workers were placed into high (> 1 ppm) medium (0.1-1.0 ppm) and low (0.1 ppm) exposure categories			
Number of workers:	971 patients out of a total 4,259 had occupational exposure to formaldehyde			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Uninformative	Analytical sampling was not used, interviews were used to estimate likely exposure concentration.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - OECD member
	Metric 3:	Applicability	Low	Study does not distinguish exposure between different occupations.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL - Published in 1989
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analysis methods, uses, number of samples, number of sites, worker activities, and exposure duration and frequency and sampling locations were not provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Uninformative		

Study Citation:	Haghighat, F., Donnini, G. (1999). Impact of psycho-social factors on perception of the indoor air environment studies in 12 office buildings. Building and Environment 34(4):479-503.			
HERO ID:	5972608			
Conditions of Use:	Floor coverings; Foam seating and bedding products; Cleaning and furniture care products; Furniture and furnishings not covered elsewhere			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	36-2590 ug/m3			
Number of workers:	877			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved method or is well described and found to be equivalent to approved methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 628930 Table: 1 of 1

Study Citation:	Hagmar, L., Bellander, T., Högstedt, B., Hallberg, T., Attewell, R., Raihle, G., Au, W.W., Legator, M.S., Mitelman, F., Skerfving, S. (1988). Biological effects in a chemical factory with mutagenic exposure. I. Cytogenetic and haematological parameters. International Archives of Occupational and Environmental Health 60(6):437-444.			
HERO ID:	628930			
Conditions of Use:	Unknown			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.6-2.5 mg/m3			
Number of workers:	85			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - OECD member
	Metric 3:	Applicability	Medium	Data are for chemical manufacture which is an in-scope occupational scenario, but the data are not specific enough to be useful for this study.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years and prior to PEL - Article published in 1988
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type is simple said to be "peak exposure levels"
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1512183 Table: 1 of 1

Study Citation:	Halperin, W.E. (1983). Nasal cancer in a worker exposed to formaldehyde. JAMA: Journal of the American Medical Association 249(4):510-512.				
HERO ID:	1512183				
Conditions of Use:	Use of fabric, textile and leather products				
EXTRACTION					
Parameter	Data				
Worker activity description:	Maintenance employee				
Area sampling data:	0.2-1.2 (ppm)				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	Report is from 1980s.	
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination			Low		

Study Citation:	Hameed, Abdel, A. A., Khoder, M. I., Farag, S. A. (2000). Organic dust and gaseous contaminants at wood working shops. Journal of Environmental Monitoring 2(1):73-76.		
HERO ID:	1942922		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	Two wood working shops were selected. They differ in area,location, number of workers, load of work and ventilationconditions. The first workshop has natural and mechanical (fans) ventilators, whereas the second shop has neither natural nor mechanical ventilators. Both workshops use a wide range of soft and hard woods. They produce a range of wood products, such as desks, chairs and furniture.		
Exposure route:	inhalation		
Physical form:	Gaseous		
Area sampling data:	Formaldehyde concentrations ranged from 0.28 to 0.54 ppm (mean = 0.42 ppm) in ventilated workshops and ranged from 0.48 to 0.84 ppm (mean = 0.64 ppm) in unventilated workshops.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low	

Formaldehyde

Occupational Exposure

HERO ID: 5344296 Table: 1 of 1

Study Citation:	Hanazato, M., Suzuki, N., Koga, C., Nakaoka, H., Mori, C. (2018). A study of design for reduction and monitoring of volatile organic compounds in indoor air: The case of a commercial bank in Japan. Journal of Asian Architecture and Building Engineering 17(3):573-579.			
HERO ID:	5344296			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	employees in a new commercial bank in Japan			
Area sampling data:	In Japan, the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) set the acceptable concentration for formaldehyde at <0.08 ppm in the revised Building Standard Law of 2003. The Ministry of Health, Labour, and Welfare of Japan (MHLW) guideline concentrations for VOCs was not exceeded for formaldehyde. Formaldehyde concentrations (ug/m3) in the new commercial bank during December 2013 measurement were 2.2 (lobby), 2.2 (office space), 2.1 (seminar room), and 1.5 (outdoor air). Formaldehyde concentrations (ug/m3) in the new commercial bank during February 2014 measurement were 2.9 (lobby), 3.2 (office space), and 2.7 (seminar room).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data from an OECD country other than the U.S.
	Metric 3:	Applicability	Medium	data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4:	Temporal Representativeness	High	data no more than 10 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
Overall Quality Determination		Medium		

Study Citation: Handlos, V. (1984). Technical aspects of gaseous formaldehyde as a sterilant. Biomaterials 5(2):81-85.
HERO ID: 6233209
Conditions of Use: Use

EXTRACTION

Parameter	Data
Exposure route:	inhalation (1/5)
Physical form:	gas (1/5)
Area sampling data:	"Measurement of airborne formaldehyde in front of the unloaded experimental autoclave showed variations between 0.7 and 1.2 ppm. . . Four hospital autoclaves, ranging in size from 20 L to 5 m3 fell into two groups according to their formaldehyde release. Three of them showed concentrations from 2.5 to 3.5 ppm both in loaded and unloaded conditions. One autoclave, volume 300 L, varied between 0.03 ppm in unloaded condition and 0.9 ppm when loaded with four lab coats. "

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Denmark, an OECD country.
	Metric 3: Applicability	Uninformative	Data are for use as a sterilizer, which is not in-scope or similar to an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges, graphs) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability isn't addressed.

Overall Quality Determination **Uninformative**

Study Citation:	Hanley, K. W., Wilcox, T., Klein, M. (1991). Health hazard evaluation report no HETA 91-143-2136, Western Primary School, Russiaville, Indiana.			
HERO ID:	28602			
Conditions of Use:	Use of Furniture and Furnishings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Classroom exposure			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.016 ppm (less than LOQ) with HVAC off. 0.013-0.030 ppm with HVAC on. Closed classroom supply cabinet 0.11 ppm suggesting the pressboard cabinets are the source of the formaldehyde emissions. Otherwise concentrations in classrooms ranged from 0.02-0.03 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (class room) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 prior to PEL established in 1992
	Metric 5:	Sample Size	Low	13 samples were taken with and without HVAC operations, LOD and LOW provided and results presented as a range. Uncertainty not presented.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include some critical metadata, such as exposure type, but assumed area sampling as school was in recess at the time of the assessment, also assumed worker activities; lacks additional metadata, such as sample durations, exposure durations, exposure frequency,
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study provides only range of sampling results to indicate variability in the determinants of exposure for the sampled site or sector. Assumed that uncertainty was addressed in the NIOSH methodology.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 626483 Table: 1 of 1

Study Citation: Hansen, J., Olsen, J.H. (1995). Formaldehyde and cancer morbidity among male employees in Denmark. Cancer Causes and Control 6(4):354-360.
HERO ID: 626483
Conditions of Use: Multiple

EXTRACTION

Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	Exposure concentrations were grouped into 4 categories, unknown, low, w/o wood dust, high with wood dust
Number of workers:	Four to 13 percent of all male employees in the Danish industry were exposed (pg 2/8). Total number of workers in Danish companies in which formaldehyde was used or produced:49,900

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Denmark - OECD member
	Metric 3: Applicability	Uninformative	lack of differentiation
	Metric 4: Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1995
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Monitoring data do not include any needed metadatato understand what the data represent and are not usable in the risk evaluation.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination

Uninformative

Formaldehyde

Occupational Exposure

HERO ID: 1010267 Table: 1 of 1

Study Citation:	Hansen, J., Schneider, T., Olsen, J.H., Laursen, B. (1993). Availability of data on humans potentially exposed to suspected carcinogens in the Danish working environment. Pharmacology & Toxicology 72(Supplement 1):77-85.				
HERO ID:	1010267				
Conditions of Use:	Multiple				
EXTRACTION					
Parameter	Data				
Personal sampling data:	Table 5 contains data pertaining to formaldehyde. The range is 0.02 to 0.94 mg/m^3				
Comments:	The data pertains to wood and wood product manufacture, furniture manufacturing, iron foundries, metal furniture manufacture				
EVALUATION					
Domain	Metric	Rating			Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	method not stated	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Denmark - OECD country	
	Metric 3:	Applicability	High	data pertains to COUs	
	Metric 4:	Temporal Representativeness	Low	data pertains to pre 1993	
	Metric 5:	Sample Size	Medium	some characterization of sample size	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	According to the source the data is mostly but not completely personal data, and the sampling duration is variable.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	data pertains to multiple industries.	
Overall Quality Determination			Low		

Study Citation:	Hargis, K. M., Tillery, M. I., Ettinger, H. J., Brandt, M. T., Sherman, R. J., Wheat, L. D. (1986). Industrial hygiene study of a true in-situ oil shale retorting facility. American Industrial Hygiene Association Journal 47(8):455-464.			
HERO ID:	2130334			
Conditions of Use:	”Processing aids, specific to petroleum production in: oil and gas drilling, extraction, and support activities and all other basic inorganic chemical manufacturing”			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Formaldehyde concentration (ppm): above retorts - mean - <0.1, max - 0.9; offgas fan - mean - <1, max - 0.7			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methods well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	Medium	limited statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	include some metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainty
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 2861246 Table: 1 of 1

Study Citation:	Hassani, S., Namvar, M., Ghoreishvandi, M., Attarchi, M., Golabadi, M., Seyedmehdi, S.M., Khodarahmian, M. (2014). Menstrual disturbances and hormonal changes in women workers exposed to a mixture of organic solvents in a pharmaceutical company. 28:156.			
HERO ID:	2861246			
Conditions of Use:	Non-TSCA			
EXTRACTION				
Parameter	Data			
Worker activity description:	Laboratory workers			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	PBZ samples: mean concentration in old lab units - 0.03 ppm; in new lab units - 0.01 ppm			
Number of workers:	461 women studied			
Comments:	Source is for menstrual disturbances and hormonal changes in women workers exposed to different organic solvents in a pharmaceutical company.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Unclear if source is peer reviewed but appears to contain high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Study conducted in Iran, a non-OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to use of pharmaceuticals/lab materials
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2011)
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes sample type, number of workers, and exposure route/physical form can be inferred.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at women in different laboratory units with noticeable differences. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Hauptmann, M., Jay, H.L., Stewart, P.A., Hayes, R.B., Blair, A. (2003). Mortality from lymphohematopoietic malignancies among workers in formaldehyde industries. Journal of the National Cancer Institute 95(21):1615-1623.			
HERO ID:	93083			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	10 (3 formaldehyde production plants, 6 resin plants, 6 molding compound plants, 2 molded plastic product plants, 2 photographic film plants and 1 plywood plant)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	for this cohort health effects study concentrations were groups into bins ranging from 0 to > 4.0 ppm which appeared to be provided by the companies participating in this study..			
Number of workers:	25619			
Comments:	data were aggregated into multiple process types: formaldehyde production, resin plants, molding compound plants, molded plastic product plants, photographic film plants and plywood plant			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data were for operations included in the occupational scenarios for the Scope of the risk evaluation unfortunately the data aggregated multiple source types.
	Metric 4:	Temporal Representativeness	Low	Article states Exposure to formaldehyde was estimated from work histories collected through 1980 on the basis of job titles, tasks, visits to the plants by study industrial hygienists, discussions with workers and plant managers, and monitoring data
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Hauptmann, M., Lubin, J.H., Stewart, P.A., Hayes, R.B., Blair, A. (2004). Mortality from solid cancers among workers in formaldehyde industries. American Journal of Epidemiology 159(12):1117-1130.			
HERO ID:	93084			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	industrial workers in formaldehyde industries.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	data were aggregated for all facilities and all industrial operations into bins for average intensity: 0, 0-0.5, 0.5-1.0, >1.0 ppm; peak intensity: <0.5, 0.5-2.0, 2.0-4.0, >4.0 ppm			
Number of workers:	25619 workers			
Comments:	for this cohort study exposure was based on monitoring data linked to job titles			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for the manufacture of use of formaldehyde which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report was published in 2004, but the monitoring data were from earlier possible prior to 1994, the documentation on this is unclear
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Hawley, B., Martin, S., Mugford, C., Boylstein, R. (2016). Health Hazard Evaluation Report: HHE-2015-0011-3253, May 2016. Evaluation of Indoor Air Quality Concerns at an Outpatient Medical Clinic in a Shared-Use Building - West Virginia.			
HERO ID:	4455619			
Conditions of Use:	lab chemical (medical)			
EXTRACTION				
Parameter	Data			
Worker activity description:	study concludes that source may be external to the clinic as higher levels found in adjacent areas (pg 4); possibly wood flooring manufacturer (pg 11)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	TWA (NIOSH Method 2016 (pg 11)): 0.007-0.023 (Table 1, pg 12; discrete samples provided in table)Sampling locations: offices, hallways shared by clinic with neighboring businesses (pg 9); (1) midway down the hallway by the clinic’s mental health offices; (2) Mental Health Provider Office #17; (3) hallway shared by the outpatient clinic and the neighboring health clinic; (4) Exam Room #6; (5) RN Room #41; (6) open plenum space above the clinic hallway, near Mental Health Provider Office #17; (7) Exercise Room; (8) Exam Room #3; and (9) the hallway shared with the wood flooring manufacturer (pg 11)			
Exposure duration:	5-7 hour sampling (pg 11)			
Exposure frequency:	Daily exposure frequency (pg 10),			
Number of workers:	15 (pg 10)			
Engineering control:	postive pressure relative to adjacent businesses via HVAC repairs (pg 4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH (Method 2016) method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for lab chemical, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling both in and outside the clinic, but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Hawthorne, A.R., Gammage, R.B. (1982). Formaldehyde release from simulated wall panels insulated with urea-formaldehyde foam insulation. Journal of the Air Pollution Control Association 32(11):1126-1131.			
HERO ID:	5957355			
Conditions of Use:	Use of wall panels with urea-formaldehyde foam insulation			
EXTRACTION				
Parameter	Data			
Area sampling data:	Formaldehyde concentration over time in a chamber with an insulated panel shown in Figure 2 (Range 1.5-5.5 ppm). Concentrations inside wall cavities in Table 2 (range 0.08 - 6.8 ppm). Concentration in chamber with air flow in Table 4 (range 0.05-0.78 ppm). Additional data in Table , Figure 4, and Table 5.			
Comments:	Source provides data on formaldehyde in chamber and wall cavities with and without air flow. These concentrations can be translated into emission rates using the chamber / cavity volumes and equation provided in the study.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Low	The data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, such as a consumer DIY scenario that is similar to a worker scenario.
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 626512 Table: 1 of 1

Study Citation:	Hayes, R.B., Klein, S., Suruda, A., Schulte, P., Boeniger, M., Stewart, P., Livingston, G.K., Oesch, F. (1997). O6-alkylguanine DNA alkyltransferase activity in student embalmers. American Journal of Industrial Medicine 31(3):361-365.			
HERO ID:	626512			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Worker activity description:	Students in associate or bachelor’s degree programs at a college of mortuary science in Cincinnati who were entering 1Environmental Epidemiology Branch, National Cancer Institute, Bethesda, MD. 2Institute for Toxicology, University of Mainz, Mainz, Germany. 3Division of Surveillance, Hazard Evaluation, and Field Studies, National Institute for Occupational Safety and Health, Cincinnati, OH. 4Department of Environmental Health Sciences, University of Cincinnati School of Medicine. Cincinnati, OH. *Correspondence to: Dr. Richard B. Hayes, Environmental Epidemiology Branch, National Cancer Institute, Bethesda, MD 20892. Accepted for publication 20 June 1996. AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 31:361–365 (1997) r 1997 Wiley-Liss, Inc. the initial laboratory course in embalming technique			
Personal sampling data:	1.5 ppm average concentration: 18.4 ppm-hr mean (range 5.7-82.0 ppm-hr/SD 15.6)			
Exposure frequency:	9 week course of study			
Number of workers:	Sample size: 23			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it ws noted that for personal sampling : PF-20 STEL passive monitor; area short term (peak) exposure measurements using acontinuous reading instrument
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US Cincinnati, OH
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after PEL - Article published in 1997
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics: mean, range and SD, but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure frequency, number of samples.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by providing a range of values and standard deviation, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 85555 Table: 1 of 1

Study Citation:	Hedge, A., Erickson, W.A., Rubin, G. (1995). Individual and occupational correlates of the sick building syndrome. Indoor Air 5(1):10-21.			
HERO ID:	85555			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Bldg 1: 0.020 ppm (Standard error 0.018, 0.023); Bldg 2: 0.020 ppm (Standard error 0.017, 0.023); Bldg 3: 0.019 ppm (Standard error 0.017, 0.021); Bldg 4: 0.018 ppm (Standard error 0.016, 0.020); Bldg 5: 0.020 ppm (Standard error 0.018, 0.022);			
Exposure duration:	3 hour sampling duration			
Number of workers:	939 respondents to a questionnaire			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling is done using EPA method TO-11 (1984) Cartridge impregnated with 2,4-dinitrophenylhydrazine and analytical method was liquid chromatography, appears to be similar to NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Denmark - OECD member
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after the PEL- published 1995
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - distribution characterized by mean and standard error
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing: number of samples, worker activities, and exposure frequency. In addition, presentation of standard deviations is unclear.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variance was by sampling multiple building environments, but nothing on uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Hemmila, V., Meyer, B., Larsen, A., Schwab, H., Adamopoulos, S. (2019). Influencing factors, repeatability and correlation of chamber methods in measuring formaldehyde emissions from fiber- and particleboards. International Journal of Adhesion and Adhesives 95:102420.			
HERO ID:	6064683			
Conditions of Use:	FA emission from fiber and particle boards			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	gas, vapor, dust			
Area sampling data:	Emission values of 0.004 to 0.15 ppm for PB and MDF sampled. For chamber method EN 717-1 (ppm): average - 0.064 +/- 0.003; Chamber method ASTM D 6007: emission range 0.05-0.09: average emissions from tests - 0.053 +/- 0.005, 0.077 +/- 0.008, 0.081 +/- 0.008, 0.084 +/- 0.010, 0.094+/- 0.007; range: 0.09 - 0.15: averages from tests: 0.124 +/- 0.018; 0.146 +/- 0.028; 0.146 +/- 0.016; range <0.05: average emissions - 0.013 +/- 0.002; 0.016 +/- 0.001; 0.022 +/- 0.002; 0.023 +/- 0.002; Emissions for boards without sealing - 0.042 ppm; for board with all edges sealed - 0.030 ppm; board with all faces sealed - 0.014 ppm; board with all edges and faces sealed - <0.001; Emissions (ppm) for board thickness of 2.5 mm - 0.028, 0.048, and 0.041; for 10 mm - 0.049, 0.086 and 0.055; for 16 mm - 0.066, 0.103, and 0.066; for 18 mm - 0.129, 0.241, and 0.118			
Comments:	Source evaluates the accuracy of measurement methods.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Data is peer reviewed so contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for international journal by both Sweden and Germany which are both OECD countries.
	Metric 3:	Applicability	High	Data contains emission data for particleboards and fiber boards.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2019)
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes description of sampling data, physical form, and exposure route.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at different sampling methods. Does not address uncertainty.
Overall Quality Determination			High	

Study Citation:	Hendrick, D., Ramdo, R.J., Lane, D.J., Morris, M.J. (1982). Formaldehyde asthma: Challenge exposure levels and fate after five years. Journal of Occupational and Environmental Medicine 24(11):893-897.			
HERO ID:	22303			
Conditions of Use:	Non-TSCA			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Chamber sampling - estimate formaldehyde exposure for different mixtures of formalin; 25% Fomalin mixture provides an exposure concentration of 4 ppm for the period from 0-5 minutes after a spill; 5 ppm for the period 0-10 minutes, and 5 ppm for the period 0-15 minutes; 10% formalin mixture yields a 3 ppm exposure for the period from 0-5 minutes			
Exposure duration:	0-5; 0-10; and 0-15			
Number of workers:	1.6 million works may be exposed to formaldhyde pluse 11 million mobile home dwellers and hald a million conventional home residents exposed in mild and moderate degrees			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it was noted that for the bubble chamber chromatropic acid analysis was used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US Louisiana
	Metric 3:	Applicability	High	for formalin spill events
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - 1982
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - value for each test run were provided along with the average for each formalin formulation
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	As a chamber study it is missing: sampling an analysis methods, worker activity, and exposure frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability for different periods from the start of the spill, but no indication of uncertainty
Overall Quality Determination			Medium	

Study Citation:	Herbert, F.A., Hessel, P.A., Melenka, L.S., Yoshida, K., Nakaza, M. (1994). Respiratory consequences of exposure to wood dust and formaldehyde of workers manufacturing oriented strand board. Archives of Environmental Health 49(6):465-470.			
HERO ID:	626501			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Oriented strand board production			
Exposure route:	Inhalation			
Physical form:	Vapor, solid (dust)			
Area sampling data:	Range 0.07-0.27 (ppm)			
Exposure duration:	12 hours			
Exposure frequency:	4 12h shifts followed by 4 days off			
Number of workers:	99			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved OSHA/NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for wood products manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at multiple locations at the site.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 79029 Table: 1 of 1

Study Citation:	Herbert, F.A., Hessel, P.A., Melenka, L.S., Yoshida, K., Nakaza, M. (1995). Pulmonary effects of simultaneous exposures to MDI formaldehyde and wood dust on workers in an oriented strand board plant. Journal of Occupational and Environmental Medicine 37(4):461-465.			
HERO ID:	79029			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	production of oriented strand board			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.05 ppm detection limit)			
Exposure duration:	12 hours shifts			
Number of workers:	127 workers included in the health effects assessment (out of 332 workers at the plant)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH methods
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Most likely Canada
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after the PEL- Published in 1995
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics-all results were at or below detection limit
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing: number of samples and exposure frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed
Overall Quality Determination		Low		

Study Citation:	Higashikubo, I., Miyauchi, H., Yoshida, S., Tanaka, S., Matsuoka, M., Arito, H., Araki, A., Shimizu, H., Sakurai, H. (2017). Assessment of workplace air concentrations of formaldehyde during and before working hours in medical facilities. <i>Industrial Health</i> 55(2):192-198.
HERO ID:	4154223
Conditions of Use:	Laboratory Use

EXTRACTION	
Parameter	Data
Worker activity description:	Medical facility workers in Japan.
Exposure route:	Inhalation
Area sampling data:	25 medical facilities consisting of 14 pathology laboratories, 5 anatomy laboratories, 3 organ preservation facilities, 2 disinfection facilities, and one dissecting room for a gross anatomy course were selected for the study. Formaldehyde concentrations recorded in the gross anatomy course were 1.56 – 2.04 ppm. The concentrations of formaldehyde in workplace air collected before working hours by spot sampling were 0.07+/-0.08 ppm, ranging from less than 0.01 ppm in the pathology laboratory to 0.36 ppm in the anatomy laboratory. Mean formaldehyde concentration before working hours was 0.05 ppm for the workplaces where less than 1 liter to 99 liter of the containers storing formaldehyde and formaldehyde-treated materials were stored and 0.13 ppm for those where larger than 100 liter of the containers storing formaldehyde and formaldehyde-treated materials were stored. The formaldehyde concentration before working hours by spot sampling was 0.18 ppm in the organ preservation facility where many loosely sealed plastic storage containers having formaldehyde and formaldehyde-treated materials were placed. The medical facility where 40 sealed buckets containing formaldehyde and formaldehyde-treated organs were stored was maintained at 0.04 ppm formaldehyde. Formaldehyde concentration in a hospital pathology laboratory was measured as 0.12 ppm by spot sampling. Formaldehyde concentrations in the shelf were extremely high ranging from 2.86 to 4.90 ppm. The indoor formaldehyde concentrations before working hours in the medical workplaces were much higher than atmospheric concentrations of formaldehyde in that city. The atmospheric concentration of formaldehyde ranged from 0.78 ug/m3 (0.64 ppb) to 6.7 ug/m3 (5.5 ppb) with the mean value of 2.8 ug/m3 (2.3 ppb) averaged over 6 sampling spots in 2008. More data can be found in table 1.
Engineering control:	Exhaust system

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	Data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study addresses variability by comparing different facilities but uncertainty is not addressed.

Overall Quality Determination

High

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 4154223 Table: 1 of 1

...continued from previous page

Study Citation: Higashikubo, I., Miyauchi, H., Yoshida, S., Tanaka, S., Matsuoka, M., Arito, H., Araki, A., Shimizu, H., Sakurai, H. (2017). Assessment of workplace air concentrations of formaldehyde during and before working hours in medical facilities. Industrial Health 55(2):192-198.			
HERO ID: 4154223			
Conditions of Use: Laboratory Use			
		EVALUATION	
Domain	Metric	Rating	Comments

Study Citation:	Hiipakka, D.W., Dyrdahl, K.S., Cardenas, M.G. (2001). Successful reduction of morticians’ exposure to formaldehyde during embalming procedures. AIHAJ 62(6):689-696.			
HERO ID:	1986712			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Viscera removed during the autopsy were examined and then stored in a container with approximately 2 to 4 L of concentrated formalin. Once the thoracic and abdominal cavities were empty and exposed, the major blood vessels were perfused with preservative fluids and skin colorants using an injection pump.			
Exposure route:	Inhalation			
Personal sampling data:	Initial Passive Dosimeter Screening: 0.065-1.62 (ppm); Personal TWA exposure values during actual embalming ranged from 3.20 to 7.54 ppm with an arithmetic mean of 4.80 ppm (GM = 4.43/GSD = 1.53). Calculated 8-hour TWA exposures ranged from 1.32 to 2.86 ppm for a mean of 1.80 ppm (GM = 1.85/GSD = 1.38).			
Area sampling data:	Pre-ventilation upgrade exposure data: 0.01-20.89 (ppm); Post-ventilation upgrade exposure data: 0.024 - 3.44 (ppm)			
Exposure duration:	8hr TWA; Sample durations kept as close to 15-min duration as possible of OSHA STEL comparison.			
Exposure frequency:	0 - 10 cases per year; must meet a 2-week preservation requirement for overseas case processing and return of the deceased to the continental United States			
Personal protective equipment:	Full-face respirators			
Engineering control:	Local exhaust ventilation described in Figure 1.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is well described and found to be equivalent to approved methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		High		

Study Citation:	Hills, B. W., Kawamoto, M. M. (1992). Health hazard evaluation report no. HETA 90-029-2212; United Technologies Automotive, Port Huron, Michigan.
HERO ID:	NIOSH(HETA-90-029-2212):90-029.
Conditions of Use:	3970662
	Incorporated into an article: Source of formaldehyde was unknown, but the raw material is uncured fibrous glass wool impregnated with phenol-formaldehyde resin.

EXTRACTION

Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	Method 52Plant 2 Employee 1 ND Employee 2 0.02 ppm * Employee 3 ND Employee 4 0.02 ppm* Employee 5 0.02 ppm* Plant 1 Employee 6 ND Employee 7 ND Employee 8 0.02 ppm* Employee 9 0.02 ppm* Employee 10 0.02 ppm* Employee 11 ND Employee 12 0.02 ppm*Not detected. The limit of detection is 1.0 ug per sample* sample results less than the limit of quantitation (3.0 ug/sample).
Area sampling data:	Four area samples for formaldehyde analysis were collected by impingers in each plant. In plant 2, formaldehyde concentrations ranged from 0.05 to 0.07 ppm. In plant 1, concentrations ranged from 0.04 to 0.08 ppm.Fourteen Orbo-23 tubes were also used to collect samples forformaldehyde analysis. Results of nine samples were above the limit of detection (1.0 ug/sample), but all were below the limit of quantitation (3.0 ug/sample).Method 3500Plant 2 Line 7 entrance to mold 0.07 ppm Line 8 entrance to mold 0.05 ppm Line 6 entrance to mold 0.06 ppm Line 6 exit from mold 0.07 ppm Plant 1 Line 5 loading fibrous glass 0.04 ppm Line 2 loading fibrous glass 0.05 ppm Between lines 1 & 2 pre-trim 0.08 ppm Line 2 after marriage 0.04 ppmMethod 52Plant 2 Line 8 0.02 ppm* Line 6 0.02 ppm* * sample results less than the limit of quantitation (3.0 ug/sample).
Dermal exposure data:	nan
Number of workers:	122 at plant 1 and 132 at plant 2
Personal protective equipment:	The company should provide workers with a daily change of laundered work clothes with long sleeves to protect the arms. Gloves or other types of protective clothing may be helpful. Work clothes should not be worn outside the workplace and contamination of street clothes should be prevented. Showers should be available at work for use before workers change into street clothes.
Engineering control:	The local ventilation around the hot wire operations, the fibrous glass cutting and trimming operations, and the curing presses should be improved.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH Study - OSHA Method 52 & Method 3500
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for an occupational scenario (automotive headliner production) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1990 - Prior to PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	High	Statical data not provided but results from individual sampling events were provided and can be used to develop statistical summaries. Uncertainty not discussed but assume to be considered in OSHA Method 52 and Method 3500.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, exposure durations, and exposure frequency but lacks additional meta-data, such as worker activities.

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Formaldehyde

Occupational Exposure

HERO ID: 3970662 Table: 1 of 1

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Study Citation:	Hills, B. W., Kawamoto, M. M. (1992). Health hazard evaluation report no. HETA 90-029-2212; United Technologies Automotive, Port Huron, Michigan.
HERO ID:	NIOSH(HETA-90-029-2212):90-029.
Conditions of Use:	3970662
	Incorporated into an article: Source of formaldehyde was unknown, but the raw material is uncured fibrous glass wool impregnated with phenol-formaldehyde resin.

Domain		Metric	EVALUATION		Comments
			Rating		
Domain 4: Variability and Uncertainty					
	Metric 7:	Metadata Completeness	High		discussion of variability between the plants was included. Also as data from individual sampling events were provided and can be used to evaluate variability between workers. Uncertainty not discussed but assume to be considered in OSHA Method 52 and Method 3500.

Overall Quality Determination	High

Study Citation:	Hirtle, B., Teschke, K., Netten, Van, C., Brauer, M. (1998). Kiln emissions and potters’ exposures. American Industrial Hygiene Association Journal 59(10):706-714.			
HERO ID:	667986			
Conditions of Use:	Use of metal products			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	range <0.013-0.102 ppm			
Exposure duration:	kiln firing bisque 4-20 hrs; Glost firing 4- 13 hours; Rojud firing 30 minutes. Measurements were for 2.5 to 12 hours			
Number of workers:	10,000 potters in British Columbia			
Engineering control:	ventilation systems			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is probably an acceptable methodology - includes use of high-performance liquid chromatography (HPLC) based on Workers’ Compensation Board of British Columbia (WCB) aldehydes method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - OECD member
	Metric 3:	Applicability	High	Data are for pottery workers which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years and after the PEL- Article published in 1998
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing [frequency of exposure].
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by the coefficient of variance and data for 10 plants, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1313452 Table: 1 of 1

Study Citation:	Hisamitsu, M., Okamoto, Y., Chazono, H., Yonekura, S., Sakurai, D., Horiguchi, S., Hanazawa, T., Terada, N., Konno, A., Matsuno, Y., Todaka, E., Mori, C. (2011). The influence of environmental exposure to formaldehyde in nasal mucosa of medical students during cadaver dissection. Allergology International 60(3):373-379.			
HERO ID:	1313452			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	dissection			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	The formaldehyde concentration values measured by the passive method ranged from 0.51 to 0.97 ppm in the center of the laboratory, with an average concentration of about of 0.67 ppm.The concentrations in the corners, ranged from 0.22to 0.70 ppm with an average of 0.44 ppm.			
Number of workers:	41 medical students			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified, though it was noted that passive aldehyde samplers were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Japan - an OECD member
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	This study was derived from data from 2004, after the most recent PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Medium	Average value and range data were provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Occupational Exposure

Study Citation:	Ho, S., Cheng, Y., Bai, Y., Ho, K., Dai, W., Cao, J., Lee, S.C., Huang, Y., Ip, H., Deng, W., Guo, W. (2016). Risk Assessment of Indoor Formaldehyde and Other Carbonyls in Campus Environments in Northwestern China. Aerosol and Air Quality Research 16(8):1967-1980.
HERO ID:	3476957
Conditions of Use:	Office Environment

EXTRACTION	
Parameter	Data
Worker activity description:	Staff at a university in Xi'an, Shaanxi, China, including academic staffs, workers, students.
Exposure route:	Inhalation
Area sampling data:	The monitoring was conducted at 6 workplaces at a university in Xi'an, Shaanxi, China. The six workplaces include (W1) a non-smoking academic office, (W2) a smoking academic office, (W3) a dining room in the student canteen, (W4) a photocopy center, (W5) an underground supermarket and (W6) a lecture room. Formaldehyde concentrations (ug/m3) were found to be as follows: W1 - 72.2 ± 31.0 , W2 - 55.8 ± 24.1 , W3 - 8.01 ± 0.87 , W4 - 5.18 ± 1.51 , W5 - 1.75 ± 0.67 , W6 - 3.02 ± 1.69 . Formaldehyde average concentrations in the academic offices (Site W1 and W2) exceeded the recommended exposure limit (REL) of 20 ug/m3 (16.3 ppbv) for an 8- or 10-hour time-weighted average (TWA) exposure and/or ceiling. These academic offices consisted of wooden furniture and possible carbonyl emission sources including ETS. Formaldehyde was dominant carbonyl at Site W1 and Site W2, which accounted for 80.0% and 57.9%, respectively, of the total quantified carbonyls. In the dining room of the student canteen (Site W3), formaldehyde and acetaldehyde are the two largest molar contributors. Cooking emissions from the semi-open kitchen may influence the air quality in the dining area. The authors found that the formaldehyde levels in normal working hours were 46–58% higher than those in the off-duty or nonoperational periods. Office technologies including electronic copiers and printers can produce ozone by the reactions of high energy electromagnetic radiation and electrical discharge from oxygen, consequently leading to the volatile organic compounds (VOCs) formations.
Exposure duration:	In general, all employers are assumed to work eight hours per day

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology is well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data from a non-OECD country
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	monitoring study does not address variability or uncertainty

Overall Quality Determination	Medium

Study Citation:	Ho, S.S., Ip, H.S., Ho, K.F., Ng, L.P., Dai, W.T., Cao, J., Chan, C.S., Ho, L.B. (2014). Evaluation of hazardous airborne carbonyls on a university campus in southern China. Journal of the Air and Waste Management Association 64(8):903-916.			
HERO ID:	2535460			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Personnel in an university campus associated with (1) departmental general offices, (2) faculty offices, (3) supporting staff offices, (4) lecture theaters, (5) small lecture rooms, (6) a chemistry laboratory, (7) a library, (8) a stationary store, (9) fast food courts, (10) staff restaurants, (11) a commercial bank, (12) grocery stores.			
Exposure route:	inhalation			
Area sampling data:	Estimated number of related workers/occupants in each case were: (1) departmental general offices - 57.6+/-14.4, (2) faculty offices - 39.8+/-9.12, (3) supporting staff offices - 25.2+/-7.78, (4) lecture theaters - 8.60+/-3.82, (5) small lecture rooms - 13.4+/-5.26, (6) a chemistry laboratory - 67.2+/-24.9, (7) a library - 10.6+/-4.55, (8) a stationary store - 16.9+/-5.98, (9) fast food courts - 107 +/- 26.4, (10) staff restaurants - 87.3+/-34.4, (11) a commercial bank - 4.67+/-2.29, (12) grocery stores 12.5+/-4.76.			
Number of workers:	Estimated number of related workers/occupants in each case were: (1) departmental general offices - 600, (2) faculty offices - 1200, (3) supporting staff offices - 500, (4) lecture theaters - 1200, (5) small lecture rooms - 1200, (6) a chemistry laboratory - 200, (7) a library - 80, (8) a stationary store - 10, (9) fast food courts - 60, (10) staff restaurants - 30, (11) a commercial bank - 45, (12) grocery stores 30.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described methods
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	non-OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variabilities and uncertainties
Overall Quality Determination		High		

Study Citation:	Hodgson, A.T., Wooley, J.D., Daisey, J.M. (1993). Emissions of volatile organic compounds from new carpets measured in a large-scale environmental chamber. Journal of the Air and Waste Management Association 43(3):316-324.			
HERO ID:	76255			
Conditions of Use:	Use of Floor coverings			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Nylon 6 carpet tiles with PVC and polypropylene backing: 57.2 ug/m2-hr, 2.37 mg/m2 (after 24 hrs); 18.2 ug/m2-hr 6.61 mg/m2 (after 168 hrs) from Table IV page 5/9 and Table V page 6/9			
Exposure duration:	24 & 168 hours			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though C18 Sep-Pak cartridge impregnated with 2,4-dinitrophenylhydrazine, Analysis HPLC with diode-array UV detector were used	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Chamber study using US carpets	
	Metric 3: Applicability	Medium	similar to an office environment	
	Metric 4: Temporal Representativeness	Low	Monitoring data are greater than 20 years old -Published in 1993	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	as a chamber study missing: sampling and analysis methods, worker activity, number of workers, exposure frequency	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability for different time periods provided but uncertainty are not addressed	
Overall Quality Determination		Low		

Study Citation:	Hollett, B. (1983). Walk-through survey report: Control technology for adhesives at National Veneer Plant, Broyhill Furniture Industries, Inc., Lenoir, North Carolina.		
HERO ID:	6558529		
Conditions of Use:	Processing: Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	The duties of the press crew are mixing, spreading, laying-up panels, loading, unloading, and separating.		
Exposure route:	Inhalation		
Physical form:	Vapor		
Personal sampling data:	See Table 1. Personal exposures for unloaders range from ND - 1.5 mg/m3.		
Area sampling data:	Generally less than 1.2 mg/m3 with the exception of two measurements taken near Press No. 3. One, a 32 minute source sample, taken directly over the hot wood pile is 2.4 mg/m3[2.0 ppm]. Another 28 minute sample taken in the work area of the Unloader is greater than 1.2 mg/m3 [1.0 ppm].		
Number of workers:	89 production workers. The three presses are operated by 11 employees. There is one glue mixer and one spreader operator who feeds the stock through the spreader. Two workers remove the glued layers and lay them in stacks according to the thickness desired. The same workers -then roll the stacks of panel stock on roller conveyors to the press input side.		
Personal protective equipment:	Personal protective equipment provided are gloves and aprons. Employees are encouraged to wash their hands whenever they have contacted glue.		
Engineering control:	Each of the three presses is equipped with a local exhaust system. In addition to the local exhaust, there are pedestal fans which the workers can position to provide cooling air, and there is a wall exhaust fan some distance behind the press area. No replacement air is supplied; it is drawn in through open windows and loading dock doors. Data on air velocity provided in Appendix.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure frequency.
Domain 4: Variability and Uncertainty			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 6558529 Table: 1 of 1

...continued from previous page

Study Citation:	Hollett, B. (1983). Walk-through survey report: Control technology for adhesives at National Veneer Plant, Broyhill Furniture Industries, Inc., Lenoir, North Carolina.				
HERO ID:	6558529				
Conditions of Use:	Processing: Wood Product Manufacturing				
		EVALUATION			
Domain		Metric	Rating	Comments	
	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability - air samples from different job types. The monitoring study also addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.	
Overall Quality Determination			High		

Formaldehyde

Occupational Exposure

HERO ID: 3564 Table: 1 of 2

Study Citation:	Holmstrom, M., Wilhelmsson, B., Hellquist, H., Rosen, G. (1989). Histological changes in the nasal mucosa in persons occupationally exposed to formaldehyde alone and in combination with wood dust. Acta Oto-Laryngologica 107(1-2):120-129.			
HERO ID:	3564			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	Liquid contact, Vapor. Dermal, Inhalation			
Personal sampling data:	0.05 - 0.5 mg/m; median of 0.3 mg/m3 (resin production)			
Number of workers:	70 workers at plant that produced resin for impregnation of paper for laminate production			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country (Sweden).	
	Metric 3: Applicability	High	The data are for resin production, an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Data collected in 1985. Published in 1989.	
	Metric 5: Sample Size	Medium	Data characterized by median and range, but full statistical distribution not provided.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone, dust) but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty not addressed.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 3564 Table: 2 of 2

Study Citation:	Holmstrom, M., Wilhelmsson, B., Hellquist, H., Rosen, G. (1989). Histological changes in the nasal mucosa in persons occupationally exposed to formaldehyde alone and in combination with wood dust. Acta Oto-Laryngologica 107(1-2):120-129.			
HERO ID:	3564			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Personal sampling data:	0.2 - 0.3 mg/m3; mean of 0.25 mg/m3 (furniture production) and 0.08 - 0.17 mg/m3, mean 0.09 mg/m3 (control)			
Particle size characterization:	'Dust was measured with the membrane filter method. The sampling time for total dust was 4 hours and for respirable dust 8 hours. In addition to measurements with personal sampling of dust, measurements of the mass size distribution (weight relations) of dust were made, using a cascade impactor (Sierra Mrpel 266. USA)... Most of the particles were less than 10 pm in diameter (Table II)...We found a very limited variation in the size of the WD particles... Irrespective of the type of working process or the type of wood.			
Number of workers:	100 workers at 5 different furniture factories working with particle board and and glue components			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country (Sweden).
	Metric 3:	Applicability	High	The data are for furniture production, an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data collected in 1985. Published in 1989.
	Metric 5:	Sample Size	Medium	Data characterized by median and range, but full statistical distribution not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone, dust) but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty not addressed.
Overall Quality Determination			Low	

Study Citation:	Holmström, M., Wilhelmsson, B. (1988). Respiratory symptoms and pathophysiological effects of occupational exposure to formaldehyde and wood dust. Scandinavian Journal of Work, Environment and Health 14(5):306-311.			
HERO ID:	1314558			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Group 1 worked in chemical plant where formaldehyde was produced and resins and impregnation of paper for laminate production.			
Exposure route:	inhalation			
Physical form:	Vapor			
Area sampling data:	impregnation of paper: 0.26 mg/m3 mean SD 0.17 (range 0.05 - 0.5 mg/m3)			
Number of workers:	[Number of workers included in survey study, uncertain if total workers per site] Formaldehyde resin/laminates- 70 workers/site,;			
Comments:	Dust-impregnating paper Peak 1 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - an OECD member
	Metric 3:	Applicability	High	The data are for resin/paper making which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were published in 1988, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples was characterized with mean, standard deviation, and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include metadata, such as exposure types and sample durations, but not sample type , exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided standard deviation and range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Holmström, M., Wilhelmsson, B. (1988). Respiratory symptoms and pathophysiological effects of occupational exposure to formaldehyde and wood dust. Scandinavian Journal of Work, Environment and Health 14(5):306-311.			
HERO ID:	1314558			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	Group 3 worked in a government building in same town.			
Exposure route:	inhalation			
Physical form:	Vapor			
Area sampling data:	Group 3- mean over a year was 0.09 mg/m3			
Number of workers:	[Number of workers included in survey study, uncertain if total workers per site] Government building- 36 workers/site			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - an OECD member
	Metric 3:	Applicability	Medium	The data are for office building but no information on sources and unknown if potential sources include the excluded wood products, therefore EPA assumes an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were published in 1988, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples was characterized with mean, standard deviation, and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include metadata, such as exposure types and sample durations, but not sample type , exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided standard deviation and range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1314558 Table: 3 of 3

Study Citation:	Holmström, M., Wilhelmsson, B. (1988). Respiratory symptoms and pathophysiological effects of occupational exposure to formaldehyde and wood dust. Scandinavian Journal of Work, Environment and Health 14(5):306-311.			
HERO ID:	1314558			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Group 2 worked in furniture production using glued wood. Group 3 worked in a government building in same town.			
Exposure route:	inhalation			
Physical form:	Vapor			
Area sampling data:	Group 2 - 0.2-0.3 mg/m3 [mean value in 1985: 0.25 (SD 0.05)mg/m3]. Group 3- mean over a year was 0.09 mg/m3			
Number of workers:	[Number of workers included in survey study, uncertain if total workers per site] furniture production 100 workers/site; Government building- 36 workers/site			
Comments:	Introduction references particleboard but article never directly states which wood products are used at the site.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - an OECD member
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were published in 1988, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples was characterized with mean, standard deviation, and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include metadata, such as exposure types and sample durations, but not sample type , exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided standard deviation and range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Holness, D.L., Nethercott, J.R. (1989). Health status of funeral service workers exposed to formaldehyde. Archives of Environmental and Occupational Health 44(4):222-228.				
HERO ID:	2840				
Conditions of Use:	Embalming				
EXTRACTION					
Parameter	Data				
Area sampling data:	mean: 0.36 ppm, 0.19 ppm standard deviation during 22 embalming procedures. The mean levels for autopsied caes were 0.44 ppm. Other levels are also included on page 225 (pdf page 4).				
Number of workers:	84 funeral service workers and 38 control subjects.				
Comments:	A total of 67 of the funeral service workers assessed were actively embalming at the time of the study, whereas 17 were no longer active embalmers. 55 were licensed active embalmers whereas 12 were apprentices.				
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Canada, an OECD country.	
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the publication which was 1989.	
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (e.g., mean, standard deviation) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination			Low		

Study Citation:	Hopf, N. B., Bolognesi, C., Danuser, B., Wild, P. (2019). Biological monitoring of workers exposed to carcinogens using the buccal micronucleus approach: A systematic review and meta-analysis. Mutation Research: Reviews in Mutation Research 781:11-29.			
HERO ID:	6117902			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor/gas			
Area sampling data:	Formaldehyde exposures depend on the amount used by all workers in the same ventilated area, and the liquid-air surface area where a greater surface area of exposed liquid will increase the formaldehyde air concentration. Three studies were identified by the authors for their meta-analysis of which one covered two job types. One third of the participants were smokers, a known source of formaldehyde. Occupational formaldehyde air concentrations were measured according to occupational hygiene standards in all three studies. Air concentrations were similar (0.16–0.21 ppm) and below occupational exposure limit value (0.3 ppm for 8 hours) set by the European Scientific Committee on Occupational Exposure Limits for Chemical Agents (SCOEL). Frequency ratio for formaldehyde ranged between 2.15 (pathology and anatomy staff) and 9.77 (mortuary operators). Air concentration of formaldehyde for different job types were reported as: for pathology and anatomy staff - ranged between 2 and 7 ppm; for histopathology lab workers - 0.16 ppm; operator - 0.21 ppm, for technician – 0.28 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods (method can be found in reference articles).
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The article is less than 10 years old but most of the data used is more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by comparing different studies but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Hornung, R.W., Herrick, R.F., Stewart, P.A., Utterback, D.F., Feigley, C.E., Wall, D.K., Douthit, D.E., Hayes, R.B. (1996). An experimental design approach to retrospective exposure assessment. American Industrial Hygiene Association Journal 57(3):251-256.			
HERO ID:	1512313			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Dissection and embalming of bodies			
Area sampling data:	0.29-8.72 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1995)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing PPE, engineering control, exposure duration, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by testing multiple ventilation rates.
Overall Quality Determination		Medium		

Study Citation:	Huff, J. (2001). Sawmill Chemicals and Carcinogenesis. Environmental Health Perspectives 109(3):209-212.			
HERO ID:	1328012			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Varnishing of furniture and wooden floors			
Personal sampling data:	>1 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The data are for an occupational scenario, furnishings, within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2001)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 8684550 Table: 1 of 1

Study Citation:	Hunninen, K. (1986). Health Hazard Evaluation Report HETA-85-323-1677 Cuyahoga Community College, Cleveland, Ohio.		
HERO ID:	8684550		
Conditions of Use:	Photographic supplies		
EXTRACTION			
Parameter	Data		
Worker activity description:	Developing film manually or automatically with the Luth Mini 500.		
Exposure route:	Inhalation		
Physical form:	Vapor		
Area sampling data:	No formaldehyde was detected using detector tubes during thecolor film and the litho reversal development, where formaldehyde was a reagent.		
Exposure duration:	Employees spend an average of 4 to 6 hours for processing.In Room B, a long-term area sample for formaldehyde indicated an average concentration of 0.01 ppm over a six-hour time period.		
Number of workers:	Three full- and three part-time employees work at the printing laboratory.		
Personal protective equipment:	NIOSH recommends the use of aprons, gloves, and goggles while handling chemicals.		
Engineering control:	Local exhaust ventilation in the form of a canopy hood over the Luth Mini. A portable air cleaning unit was also operating in the area and was designed to filter up to 8000 cfm every 30 minutes.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data are more than 20 years old.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by considering various areas.
Overall Quality Determination		High	

Study Citation:	Hutter, H.P., Moshammer, H., Wallner, P., Damberger, B., Tappler, P., Kundi, M. (2006). Health complaints and annoyances after moving into a new office building: a multidisciplinary approach including analysis of questionnaires, air and house dust samples. International Journal of Hygiene and Environmental Health 209(1):65-68.			
HERO ID:	1313723			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.046, 0.047, and 0.051 ppm (3 rooms sampled)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Formaldehyde was measured using active air sampling in accordance with the German Standard VDI 4300 part 3E (VDI, 1997), followed by application of the acetylacetone photometric method (Austrian Standard Institute, 1995).
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is from Austria, an OECD country
	Metric 3:	Applicability	Low	The data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Data is more than 10 years old but less than 20 (2005).
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE, exposure duration, exposure frequency, worker activity description.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1104286 Table: 1 of 1

Study Citation:	IARC, (2012). Chemical Agents and Related Occupations.			
HERO ID:	1104286			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Personal sampling data:	2-5 ppm; 2.5-6.1 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Country of origin not provided.
	Metric 3:	Applicability	High	Data are for in-scope occupational scenarios
	Metric 4:	Temporal Representativeness	Medium	Date data were collected was not provided but source is from 2006; therefore, data are expected to have been collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	Sample type and exposure type not provided. Data provided as an overall range across conditions of use, not able to discern which values pertain to which conditions of use.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Uninformative		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Processing as a reactant: resin manufacture and paper production			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	16-30 ppm (1961)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Assumed that it is US as data are from National Institute for Occupational Safety and Health (1976) and the National Research Council (1980)	
	Metric 3: Applicability	Medium	The data are for resin manufacturing and paper production which is an occupational scenario within the scope of the risk evaluation, though the data are aggregated which makes it less useful.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized only by a range and uncertain statistics are not provided.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no additional metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	A range is provided that can be used to assess variability but uncertain statistics were not provided.	
Overall Quality Determination		Low		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	incorporation into article: paper conditioning			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.9-1.6 ppm (1961)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Assumed that it is US as data are from National Institute for Occupational Safety and Health (1976) and the National Research Council (1980)	
	Metric 3: Applicability	Medium	The data are for paper conditioning which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized only by a range and uncertain statistics are not provided.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no additional metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	A range is provided that can be used to assess variability but uncertainty discussions were not provided.	
Overall Quality Determination		Low		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	incorporation into article: textile garment production			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.9-2.7 ppm (1966)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Assumed that it is US as data are from National Institute for Occupational Safety and Health (1976) and the National Research Council (1980)	
	Metric 3: Applicability	Medium	The data are for textile garment production which is an occupational scenario within the scope of the risk evaluation,	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized only by a range and uncertain statistics are not provided.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no additional metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	A range is provided that can be used to assess variability but uncertainty discussions were not provided.	
Overall Quality Determination		Low		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Use of Fabric, textile, and leather products- Retail			
EXTRACTION				
Parameter	Data			
Worker activity description:	retail			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Dress shop: 0.13-0.45 ppm (1959); Clothing store: 0.9-3.3 (1966)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Assumed that it is US as data are from National Institute for Occupational Safety and Health (1976) and the National Research Council (1980)
	Metric 3:	Applicability	High	The data are for dress shop workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized only by a range and uncertain statistics are not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	A range is provided that can be used to assess variability but lacks discussion on uncertainties.
Overall Quality Determination		Medium		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	incorporation into article: textile production			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.0-2.7 ppm (1968)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Assumed that it is US as data are from National Institute for Occupational Safety and Health (1976) and the National Research Council (1980)	
	Metric 3: Applicability	Medium	The data are for textile production which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized only by a range and uncertain statistics are not provided.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no additional metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	A range is provided that can be used to assess variability but uncertainty discussions were not provided.	
Overall Quality Determination		Low		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Incorporated into article-Wood Processing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	31.2 max (1968)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Assumed that it is US as data are from National Institute for Occupational Safety and Health (1976) and the National Research Council (1980)
	Metric 3:	Applicability	Medium	The data are for an occupational scenario, EPA assumes it refers to the manufacture of wood composite products but description lacks clarity.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is characterized only by a max value and uncertain statistics are not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	study does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 27010 Table: 7 of 22

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Use: Laminating plants			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.04-10.9 ppm (1971)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Assumed that it is US as data are from National Institute for Occupational Safety and Health (1976) and the National Research Council (1980)	
	Metric 3: Applicability	Medium	The data are for laminating which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized only by a range and uncertain statistics are not provided.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no additional metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	A range is provided that can be used to assess variability but uncertainty discussions were not provided.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 27010 Table: 8 of 22

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Use in Fabric, Textile, and leather			
EXTRACTION				
Parameter	Data			
Worker activity description:	fabric cutting and sewing			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1-11 ppm (1955)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Assumed that it is US as data are from National Institute for Occupational Safety and Health (1976) and the National Research Council (1980)
	Metric 3:	Applicability	High	The data are for textile workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized only by a range and uncertain statistics are not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	A range is provided that can be used to assess variability but uncertainty discussions were not provided.
Overall Quality Determination		Medium		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	incorporation into article: textile processing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	< 5.0 ppm (1971)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Assumed that it is US as data are from National Institute for Occupational Safety and Health (1976) and the National Research Council (1980)
	Metric 3:	Applicability	Medium	The data are for textile processing which is an occupational scenario within the scope of the risk evaluation, though the lack of clarity on scenario described makes it less useful.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is characterized only by a maximum value and uncertainty statistics are not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 27010 Table: 10 of 22

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	incorporation into article: Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Sheepskin dyeing			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	4.07-63.41 ppm (1971)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Assumed that it is US as data are from National Institute for Occupational Safety and Health (1976) and the National Research Council (1980)
	Metric 3:	Applicability	High	The data are for sheepskin dyeing which is an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized only by a range and uncertain statistics are not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	A range is provided that can be used to assess variability but uncertainty discussions were not provided.
Overall Quality Determination		Medium		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Rubber processing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.4-0.8 ppm (1975)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Assumed that it is US as data are from National Institute for Occupational Safety and Health (1976) and the National Research Council (1980)
	Metric 3:	Applicability	Medium	The data are for rubber processing which is an occupational scenario within the scope of the risk evaluation but description lacks certain clarity of use.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized only by a range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study provides a range that could be used to estimate variability but does not address uncertainty.
Overall Quality Determination			Low	

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	incorporation into the article: Textile			
EXTRACTION				
Parameter	Data			
Worker activity description:	Textile Plant: Finishing and dyeing substances			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.2 cm3/m3 mean (range 0.1-0.5 cm3/m3) (1977-1979)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/ analytical methodology is specified, chromotropic acid method was used at sampling times between 10min to 2 hrs.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD member
	Metric 3:	Applicability	High	The data are for textile workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by mean, number of samples and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type , sampling/analytical method, description of exposure but lacks additional meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provides a range that could be used to estimate variability but does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	incorporation into the article: Wood Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Exposure from urea and melamine formaldehyde resins for plywood and phenolic and urea-formaldehyde resins for particleboard			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Particleboard Plant: 1.15 cm3/m3 mean (range 0.1-4.9 cm3/m3) Plywood Plant: 0.35 cm3/m3 mean (range 0.1-1.2 cm3/m3) (1977-79))			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/ analytical methodology is specified, chromotropic acid method was used at sampling times between 10min to 2 hrs.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD member
	Metric 3:	Applicability	Medium	The data are for an occupational scenario, EPA assumes based on meta-data refers to manufacturing of plywood which is in scope but notes lack of clarity in description of scenario.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by mean, number of samples and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provides a range that could be used to estimate variability but does not address uncertainty.
Overall Quality Determination			Medium	

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Other Use: Shoe factories			
EXTRACTION				
Parameter	Data			
Worker activity description:	formalin spraying			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1.9 cm3/m3 mean (range 0.9-2.7 cm3/m3) (1977)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/ analytical methodology is specified, chromotropic acid method was used at sampling times between 10min to 2 hrs.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD member
	Metric 3:	Applicability	Medium	The data are for shoe manufacturing which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean and range, low number of samples.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provides a range that could be used to estimate variability but does not address uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 27010 Table: 15 of 22

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Incorporation into the article: wooden furniture manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	Exposure from adhesives, lacquers, and paints			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1.35 cm3/m3 mean (range 0.1-5.4 cm3/m3) (1977-79)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/ analytical methodology is specified, chromotropic acid method was used at sampling times between 10min to 2 hrs.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD member
	Metric 3:	Applicability	Medium	The data are for wooden furniture manufacture which is an occupational scenario within the scope of the risk evaluation. However, the lack of additional meta-data makes it unclear if data contains use of particleboard, plywood, or fibreboard, which are out of scope.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by mean, number of samples and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provides a range that could be used to estimate variability but does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Use of electrical and metal products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Exposures at foundries (furan resin), welding and machine shops (from plastic tape, paints, and corrosion prevention), Workshops manufacturing electrical machinery: soldering, lacquering, treatment of plastics			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Foundries: 2.7 cm3/m3 mean(1972-75); 0.6 cm3/m3 mean (range 0.05-2.0 cm3/m3) (1977-79)); welding and machine shops (from plastic tape, paints, and corrosion prevention)- 0.5 cm3/m3 (range 0.05-1.2 cm3/m3)(1977-80) ;Workshops manufacturing electrical machinery- solder: <0.1 cm3/m3 mean; Lacquer, melamine-formaldehyde plastic 0.35 cm3/m3 (range 0.2-0.5 cm3/m3) (1977-79)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/ analytical methodology is specified, chromotropic acid method was used at sampling times between 10min to 2 hrs.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD member
	Metric 3:	Applicability	High	The data are for foundries which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean, number of samples range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provides a range that could be used to estimate variability but does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	other uses: hospital disinfection			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.7 cm3/m3 (range 0.05-3.5 cm3/m3) (1977-79)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/ analytical methodology is specified, chromotropic acid method was used at sampling times between 10min to 2 hrs.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD member
	Metric 3:	Applicability	Uninformative	The data are for hospital disinfection, which is an occupational scenario but is a non-TSCA use (FIFRA).
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean and range, no discussion of uncertainty was provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provides a range that could be used to estimate variability but does not address uncertainty.
Overall Quality Determination		Uninformative		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Chemical Substances in Construction, Paint, Electrical, and Metal Products-lacquers			
EXTRACTION				
Parameter	Data			
Worker activity description:	at construction sites			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Lacquer 2.8 cm3/m3 (range 0.5-7.0 cm3/m3) (1974-75)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/ analytical methodology is specified, chromotropic acid method was used at sampling times between 10min to 2 hrs.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD member
	Metric 3:	Applicability	High	The data are for construction, which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean, number of samples and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provides a range that could be used to estimate variability but does not address uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 27010 Table: 19 of 22

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Other uses: Embalming			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Funeral home: 0.09-5.26 ppm (1975)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Assumed that it is US as data are from National Institute for Occupational Safety and Health (1976) and the National Research Council (1980)
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from the National Institute for Occupational Safety and Health (1976) and the National Research Council (1980), before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized only by a range and uncertain statistics are not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	A range is provided that can be used to assess variability but uncertain statistics were not provided.
Overall Quality Determination			Low	

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Other Use: Embalming			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	nonautopsied: 0.1-0.4 ppm; Autopsied Max 2.1 ppm; levels up to 4.8 mg/m3 when the exhaust ventilation system was not functioning.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by range and max value for autopsied bodies and when the ventilation system is not functioning.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study provides a range, tested multiple funeral homes that could be used to estimate variability but does not address uncertainty.
Overall Quality Determination		Low		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Formulation: Adhesives			
EXTRACTION				
Parameter	Data			
Worker activity description:	Exposure from use of urea-formaldehyde resin at adhesives plant			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1.75 cm3/m3 mean (range 0.8-3.5 cm3/m3) (1977)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/ analytical methodology is specified, chromotropic acid method was used at sampling times between 10min to 2 hrs.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD member
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean, number of samples and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provides a range that could be used to estimate variability but does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Various: office and schools			
EXTRACTION				
Parameter	Data			
Worker activity description:	Exposures from insulation foams, adhesives, and lacquers			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.24 cm3/m3 (range 0.05-0.77 cm3/m3) (1977-80)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/ analytical methodology is specified, chromotropic acid method was used at sampling times between 10min to 2 hrs.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD member
	Metric 3:	Applicability	High	The data are for offices and schools, which is an occupational scenario within the scope of the risk evaluation .
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean and range, no discussion of uncertainty was provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provides a range that could be used to estimate variability but does not address uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 84225 Table: 1 of 5

Study Citation:	IARC, (1995). Wood dust and formaldehyde.			
HERO ID:	84225			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	range <0.03-1.6 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	Data are for an in-scope occupational scenario but could use more information about what chemicals are produced
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - published 1995 but data are from 1983
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics -only range provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional information provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	variance provided but noting on uncertainty
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 84225 Table: 2 of 5

Study Citation:	IARC, (1995). Wood dust and formaldehyde.			
HERO ID:	84225			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.5 ppm mean			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden - OECD member	
	Metric 3: Applicability	High	Data are for an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - published 1995 but data are from 1979-1985	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics -only mean provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no additional information provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 84225 Table: 3 of 5

Study Citation:	IARC, (1995). Wood dust and formaldehyde.			
HERO ID:	84225			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.3 ppm mean			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - OECD member
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Monitoring data were collected prior to the most recent PEL and is older than 20 years - published 1995 but data are from 1980
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics -only mean provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional information provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	neither variance nor uncertainty provided
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 84225 Table: 4 of 5

Study Citation: IARC, (1995). Wood dust and formaldehyde.	
HERO ID: 84225	
Conditions of Use: Compressed Wood Product Manufacturing	
EXTRACTION	
Parameter	Data
Worker activity description:	gluing and sawing
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	0.3 ppm mean (range 0.2-0.4 ppm)
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Sampling and Analytical Methodology
Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Medium	Finland - OECD member
Metric 3:	Applicability
High	Data are for an in-scope occupational scenario.
Metric 4:	Temporal Representativeness
Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - published 1995 but data are from 1961
Metric 5:	Sample Size
Medium	Sample distribution characterized by limited statistics - mean and range provided
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
Low	no additional information provided
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
Medium	variance provided as range but uncertainty not provided
Overall Quality Determination	
Low	

Formaldehyde

Occupational Exposure

HERO ID: 84225 Table: 5 of 5

Study Citation: IARC, (1995). Wood dust and formaldehyde.	
HERO ID: 84225	
Conditions of Use: Compressed Wood Product Manufacturing	
EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	warehouse 0.3 ppm mean (0.1-0.5 ppm); shearing press 0.08 ppm mean (range 0.06-0.11 ppm)
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Sampling and Analytical Methodology
Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Medium	Italy - OECD member
Metric 3:	Applicability
High	Data are for an in-scope occupational scenario.
Metric 4:	Temporal Representativeness
Low	Monitoring data are greater than 20 years old but after the PEL- published 1995 but data are from 1992
Metric 5:	Sample Size
Medium	Sample distribution characterized by limited statistics - mean and range provided
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
Low	no additional information provided
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
Medium	variance provided as range but uncertainty not provided
Overall Quality Determination	
Low	

Formaldehyde

Occupational Exposure

HERO ID: 2167598 Table: 1 of 1

Study Citation:	Ihrig, D. F., Hanke, M., Ihrig, C., Tischer, M. (2004). Exposure to hazardous substances during electronic waste recycling. 6:3293-3298.			
HERO ID:	2167598			
Conditions of Use:	Use of electrical and electronic products			
EXTRACTION				
Parameter	Data			
Area sampling data:	All concentrations of formaldehyde in air sampling were very far from the OEL. (5/6)			
Number of workers:	16 companies sampled had a total of 530 employees. (2/6)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.	
	Metric 3: Applicability	High	Data are for electric and electronic products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.	
	Metric 5: Sample Size	Low	Sample distribution is described qualitatively.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Only number of workers and air sampling results provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Low		

Study Citation:	Imbus, H.R., Tochilin, S.J. (1988). Acute effect upon pulmonary function of low level exposure to phenol-formaldehyde-resin-coated wood. AIHA Journal 49(9):434-437.			
HERO ID:	24514			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	blending, finishing , flake, grade, knife, log yard, maintenance, press, sander and shipping			
Exposure route:	inhalation			
Physical form:	vapore			
Area sampling data:	PLANT A: Finish 0.03 ppm dust 0.05 mg/m3; Flake <0.03 ppm, dust 0.28 mg/m3; Grade <0.02 ppm, dust 0.4 mg/m3;Knife <0.03 ppm, dust 0.09 mg/m3; Log 0.03 ppm; dust 0.57 mg/m3; Maintenance 0.04 ppm; 0.21 mg/m3; Press 0.06 ppm; dust 0.03 mg/m3; Sander <0.03 ppm, dust 0.02mg/m3; Shipping 0.03 ppm, dust 0.03 mg/m3; PLANT B: Blend 0.05 ppm, dust 0.2 mg/m3; Finish 0.03 ppm dust 0.5 mg/m3; Flake <0.01 ppm, dust 0.3 mg/m3; Knife <0.01 ppm, dust 0.1 mg/m3; Log <0.01 ppm; dust 0.6 mg/m3; Maintenance 0.04 ppm; 0.2 mg/m3;			
Number of workers:	130 (plant A) 110 (plant B) production and maintenance employees			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	suggested that NIOSH method used for analysis but specifics not provided
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - 1988
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	missing: details about sampling and analytic methods used, number of samples, exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology, but variability not addressed
Overall Quality Determination		Medium		

Study Citation:	Ioras, F., McNulty, T., Natthondan, V., Ratnasingam, J. (2010). Dust, noise and chemical solvents exposure of workers in the wooden furniture industry in South East Asia. Journal of Applied Sciences 10(14):1413-1420.			
HERO ID:	6022557			
Conditions of Use:	Processing: Wood Products Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Sprayers, handlers, and general workers in the surface coating department of wooden furniture factories. (4/9)			
Exposure route:	inhalation (3/9)			
Physical form:	vapors from aqueous solvents (3/9)			
Personal sampling data:	Average formaldehyde exposure was 1.93 ppm, with a range of 1.66-2.18 ppm. (6/9)			
Exposure duration:	Average sampling time of 30 min.			
Number of workers:	200 workers sampled in each of 4 countries (4/9)			
Personal protective equipment:	Masks with charcoal filters or masks with a supply of pressurized air are highly recommended based on the study. (7/9)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Malaysia, Indonesia, Thailand, and Vietnam, none of which are OECD countries.
	Metric 3:	Applicability	High	Data are for sealants in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (average, range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at 30 different sites across 4 countries.
Overall Quality Determination			Medium	

Study Citation:	Ioras, F., Ratnasingam, J. (2010). The safety and health of workers in the Malaysian wooden furniture industry: An assessment of noise and chemical solvents exposure. Journal of Applied Sciences 10(7):590-594.			
HERO ID:	6229076			
Conditions of Use:	Wood product manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in the wooden furniture industry, specifically in the surface coating departments (including sprayers, handlers and general workers), in Malaysia			
Exposure route:	inhalation			
Area sampling data:	Average formaldehyde concentration was 1.93 ppm, ranging between 1.66 and 2.18 ppm (Permissible exposure limit = 0.3)			
Number of workers:	85			
Personal protective equipment:	Workers used personal face mask, but these face masks provided insufficient protection to the workers from chemical solvents and formaldehyde exposure.			
Comments:	The air sampling was carried out over 3 subsequent days in the surface coating departments of the factories on a total of 85 workers selected randomly from the surface coating departments (including sprayers, handlers and general workers), with a total of 500 parallel samples of solvents and formaldehyde collected over an average sampling time of 30 min, throughout the 8 h shift of the workers.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from a non-OECD country.
	Metric 3:	Applicability	High	Data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Data between 10 and 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	IT Corporation, (1995). Final report, a study to characterize air concentrations of methyl tertiary butyl ether (MTBE) at service stations in the northeast, with cover letter dated 04/20/95.		
HERO ID:	2859246		
Conditions of Use:	Automobile Exhaust		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	NJ 0.016 ppm geometric means, 1.20 ppm GSD, 0.017 ppm median (range 0.013-0.019 ppm); NY 0.012 ppm geometric means, 1.27 ppm GSD, 0.012 ppm median (range 0.009-0.016 ppm); CT 0.011 ppm geometric means, 1.24 ppm GSD, 0.011 ppm median (range 0.008-.015 ppm)		
Area sampling data:	NJ Stage II full-service: geometric mean 0.014-0.016 ppmNY Stage II self-serve: geometric mean 0.01-0.012 ppmCT non-stage II self-serve: geometric mean 0.011-0.012 - subject to metrological conditions.		
Comments:	Initially only the measurements near the pumps were extracted. Now includes perimeter, pumps and BZ.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Midget impingers containing DNPH. samples were collected at perimeter locations and one pump location at each station and in breathing zones for customers for the NY and Connecticut locations and for attendant breathing zones for New Jersey stations. In addition, four-hour charcoal tube samples were collected in the breathing zones of all stations. Analysis was performed using HPLC method TO5
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for worker exposure at vehicle service stations which is an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The data were published in 1994 based on testing implemented in 1993, after the most recent PEL (1992) but more than 20 years old.
	Metric 5: Sample Size	High	The average concentration for both testing cycles for each location was provided as well as summary statistics that include geometric means, GSD, median and range data
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Metadata included sample type, exposure type, sample durations, but lacks additional metadata, such as exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided results for individual testing events for each location along with standard deviation and range data that can be used to evaluate variability. TO5 method includes uncertainty assessment that includes analysis of duplicate samples and blanks.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 4037946 Table: 1 of 1

Study Citation:	J-P, Farant, Baldwin, M., Repentigny, De, F., Robb, R. (1992). Environmental conditions in a recently constructed office building before and after the implementation of energy conservation measures. Applied Occupational and Environmental Hygiene 7(2):93-100.				
HERO ID:	4037946				
Conditions of Use:	Use as chemical substance in construction product				
EXTRACTION					
Parameter	Data				
Physical form:	Off-gas from construction materials				
Area sampling data:	Samples at or below acceptable limit and detection limit				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.		
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Canada, an OECD country.		
	Metric 3: Applicability	High	Data are for use in construction materials, an in-scope occupational scenario.		
	Metric 4: Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.		
	Metric 5: Sample Size	Low	Sample distribution is described qualitatively.		
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Sample type provided but no other metadata.		
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.		
Overall Quality Determination		Low			

Study Citation:	Jafari, M.J., Rahimi, A., Omidi, L., Behzadi, M.H., Rajabi, M.H. (2015). Occupational Exposure and Health Impairments of Formaldehyde on Employees of a Wood Industry. 5(4):296-303.			
HERO ID:	4480770			
Conditions of Use:	Wood product manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Production line worker (particleboard and plywood production) at North Wood Factory in Northern Iran			
Physical form:	Vapor			
Personal sampling data:	Range from 0.50 ppm to 1.52 ppm with median 1.30 ppm			
Exposure duration:	6 hr morning shift			
Number of workers:	Thirteen workers of the production line (case group) and 30 administrative staffs (control group) participated in the study.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Iran, a non-OECD country.
	Metric 3:	Applicability	High	Data are for use in wood products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (min, max, median) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency and specific worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Jamalunlaili, A., Qi, J.K., Tan, S.C., Gilbert, T.T., Win, S.Y. (2019). A field study of indoor air quality and occupant perception in experimental laboratories and workshops. Management of Environmental Quality 30(2):467-482.			
HERO ID:	6154340			
Conditions of Use:	Laboratory chemical (labs and workshops at a university)			
EXTRACTION				
Parameter	Data			
Worker activity description:	E&E (electrical and electronics) Lab, S&D (statics and dynamics) Lab, MB (molecular bio-sciences) Lab, MW (machining workshop) Workshop, WW (welding and fabrication) Workshop. Work activities include pipette tube and lab glassware disposal, chemical storage (pg 11).			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Table 5 (pg 7) presents means and ranges in ppm for FA in the various labs/workshops E&E: Range 0-0.100 ppm, Mean 0.047 ppm S&D: Not detectedMB: Range 0.220-1.580 ppm, Mean 0.318 ppmMW: Not detectedWW: Not detected			
Exposure duration:	Table VIII (pg 9) presents "time spent in laboratory" data for the time ranges of <30 min, 30-59 min, 60-89 min, and >90 min, for each lab.			
Number of workers:	Table VIII (pg 9) presents number of workers participating in questionnaire for each lab			
Engineering control:	Ventilation types studied: split unit AC, centralized AC, fan-assisted natural ventilation (Table II, pg 4)			
Comments:	Method: HAL-HFX205 Handheld Formaldehyde meter, +/- 1% accuracy (table III, pg 4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Malaysia, a non-OECD country.
	Metric 3:	Applicability	High	Data are for lab chemical, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as number of samples, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability is addressed by sampling different labs/workshops with different kinds of ventilation. Uncertainty is addressed in sampling methodology.
Overall Quality Determination		Medium		

Study Citation:	James, J. T. (1997). Carcinogens in spacecraft air. Radiation Research 148(5 Supplement):S11-S16.			
HERO ID:	4075441			
Conditions of Use:	aerospace interiors			
EXTRACTION				
Parameter	Data			
Worker activity description:	Spacecraft workers-hardware off-gassing and possibly leakage from experiments involving fixatives (pg 5)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	>0.05 mg/m3 (pg 5)			
Engineering control:	Activated charcoal, regenerable beds in combination with disposable filters, water-soluble contaminants removed in humidity condensate (pg 2)			
Comments:	Sampling type: Assumed area (pg 5), but PBZ also sometimes conducted (pg 3). Formaldehyde badges sample for 12-24 hours, exposure can occur up to 180 days (pg 3).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for aircraft interiors, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old (source from 1997), uncertain when exactly monitoring was conducted.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics (just says concentrations have exceeded 0.05 mg/m3).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing other metadata such as number of workers, exact duration of sampling, etc.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Jankovic, J., Jones, W., Burkhart, J., Noonan, G. (1991). Environmental study of firefighters. Annals of Occupational Hygiene 35(6):581-602.			
HERO ID:	13496			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Worker activity description:	fire knockdown and overhaul			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	knock down (ND-8 ppm; Overhaul ND-0.4 and inside mask ND-0.3 ppm			
Particle size characterization:	knock down ND- 560 mg/m3; overhaul ND-45 mg/m3			
Personal protective equipment:	SCBA mask			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling methodology is not specified but the use of polymer tubes for sampling and FID GC appears to be appropriate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for firefighters, an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The study was published in 1991, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	a range of values is provided for knockdown, overhaul and inside the mask
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	most critical metadata, such as sample type and exposure type, butlacks additional meta-data, such as sample durations, exposure durations, number of workers, exposure frequency, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	ranges are provided for each type of fire control operation but nothing on uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Jia, X., Jia, Q., Zhang, Z., Gao, W., Zhang, X., Niu, Y., Meng, T., Feng, B., Duan, H., Ye, M., Dai, Y., Jia, Z., Zheng, Y. (2014). Effects of formaldehyde on lymphocyte subsets and cytokines in the peripheral blood of exposed workers. PLoS ONE 9(8):e104069.			
HERO ID:	2452680			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers making glue, pressing ground wood scraps with glue at a high temperature, stacking boards, sanding boards and post-processing.			
Personal sampling data:	See Table 1			
Number of workers:	118			
Comments:	Note, the monitoring data seems to have combined PBZ measurements for multiple groups (wood product and food additive workers).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2014)
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	Monitoring data combines measurements from multiple activities, unable to tell which measurements are for the COU of interest.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing low- and high-exposure groups but uncertainty is not addressed.
Overall Quality Determination		Uninformative		

Study Citation:	Jia, Y., Li, X., Liu, Y., Shi, L., Wang, Y., Xu, L., Yao, D. (2015). Indoor air quality real-time monitoring results of pathology department. Journal of Environmental Protection 6(8):851-856.			
HERO ID:	6022288			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Area sampling data:	The average concentration of formaldehyde at 3 am, 10 am, 1 pm, 4 pm, 10 pm (Beijing time) was (1.32 ± 0.86) mg/m3			
Exposure duration:	24 hours real-time monitoring for pathology department technical room			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, but lacks additional metadata, such as exposure frequency, and/or worker activities.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability by measuring at different times of the day. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.	
Overall Quality Determination		Medium		

Study Citation:	Jiang, S., Yu, L., Cheng, J., Leng, S., Dai, Y., Zhang, Y., Niu, Y., Yan, H., Qu, W., Zhang, C., Zhang, K., Yang, R., Zhou, L., Zheng, Y. (2010). Genomic damages in peripheral blood lymphocytes and association with polymorphisms of three glutathione S-transferases in workers exposed to formaldehyde. Mutation Research 695(1-2):9-15.			
HERO ID:	626082			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Making glue; Spreading and mixing glue with the wood scraps; Grinding mixture of glue and wood scraps in high temperature; Pressing mixture grinded in high temperature; Sawing boards just pressed; Stacking up boards just sawed; Sanding; Packing; Workers near FA area: Shaving wood ; Stoking boiler			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Making glue 2.56 ppm median (range 0.81–6.30 ppm); Spreading and mixing glue with the wood scraps 0.44 ppm median (range 0.39–0.48 ppm); Grinding mixture of glue and wood scraps in high temperature 0.41 ppm median (range 0.34–0.47 ppm); Pressing mixture grinded in high temperature 0.36 ppm median (range 0.30–0.42); Sawing boards just pressed 0.34 ppm median (range 0.30–0.39 ppm); Stacking up boards just sawed 0.30 ppm median (range 0.26–0.35 ppm); Sanding 0.30 ppm median(range 0.28–0.33 ppm); Packing 0.26 ppm median (range 0.24–0.28 ppm); Shaving wood 0.12 ppm median (range 0.09–0.14 ppm); Stoking boiler 0.11 ppm median (range 0.08–0.15 ppm)			
Exposure duration:	8 hr TWA			
Exposure frequency:	Exposure By bin 0.6–1 years 33 employees; 1–3 years 68 employees; 3–25 years 50 employees			
Number of workers:	151 workers; Making glue 13; Spreading and mixing glue with the wood scraps 9; Grinding mixture of glue and wood scraps in high temperature 17; Pressing mixture grinded in high temperature 7; Sawing boards just pressed 10; Stacking up boards just sawed 11; Sanding 10; Packing 14; Shaving wood 34; Stoking boiler 26			
Personal protective equipment:	All 13 workers injob title of making glue wore the respirators when they were visu-ally inspecting the readiness of the glue because of direct mucousmembrane irritation by FA. Workers in other positions did not wearrespirators during our study.			
Comments:	References average FA concentration of 2.37ppm for medical students for anatomy class from HERO ID:626642			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Chinese protocol GB/T 18204.26-2000 but Active air samplers 224-PCXR8, SKC company, USA followed by gas chromatography were used
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China - not an OECD member
	Metric 3:	Applicability	High	Data are for plywood manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old - published in 2009
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (range, median, and number of samples).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities..
Domain 4: Variability and Uncertainty				
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Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 626082 Table: 1 of 1

...continued from previous page

Study Citation:	Jiang, S., Yu, L., Cheng, J., Leng, S., Dai, Y., Zhang, Y., Niu, Y., Yan, H., Qu, W., Zhang, C., Zhang, K., Yang, R., Zhou, L., Zheng, Y. (2010). Genomic damages in peripheral blood lymphocytes and association with polymorphisms of three glutathione S-transferases in workers exposed to formaldehyde. Mutation Research 695(1-2):9-15.				
HERO ID:	626082				
Conditions of Use:	Compressed Wood Product Manufacturing				
Domain		Metric		EVALUATION	
				Rating	Comments
	Metric 7:	Metadata Completeness		Medium	The monitoring study provides discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination				Medium	

Study Citation:	Jones, L., Burgess, J. L., Evans, H., Lutz, E. A. (2016). Respiratory protection for firefighters-Evaluation of CBRN canisters for use during overhaul II: In mask analyte sampling with integrated dynamic breathingmachine. Journal of Occupational and Environmental Hygiene 13(3):177-184.			
HERO ID:	3420796			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Worker activity description:	Firefighting, specifically "overhaul" (pg 3), the second phase of firefighting where potential reignition sources are identified and extinguished after all visible flame has been extinguished.			
Exposure route:	inhalation			
Personal sampling data:	PBZ sampling data all experimental, goal of article is to determine effectiveness of different respirator canisters. Page 6 has ambient concentrations after experimental burns			
Personal protective equipment:	SCBA; APRs; Chemical, biological, radiological, and nuclear (CBRN) canisters (pg 2-3); Pg 8 has % reduction for the 3 CBRN and one non-CBRN canisters tested, ranging from 32-100% reduction			
Comments:	STEL (15/60 min durations used for experimental sampling). Analytic Method: NIOSH 2016			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Uninformative	Data are for firefighting (and also experimental) which is not in-scope or similar to an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by evaluating different respirator canisters, but uncertainty is not addressed.
Overall Quality Determination		Uninformative		

Study Citation:	Jones, R.M., Dell, L., Torres, C., Simmons, C.E., Poole, J., Boelter, F.W., Harper, P. (2015). Exposure Reconstruction and Risk Analysis for Six Semiconductor Workers With Lymphohematopoietic Cancers. Journal of Occupational and Environmental Medicine 57(6):649-658.			
HERO ID:	3420798			
Conditions of Use:	Processing aid			
EXTRACTION				
Parameter	Data			
Worker activity description:	Operators and maintenance workers in semiconductor wafer fabrication lines - tin plating area (part of packaging area).			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Exposure monitoring near tin-plating area indicate the median (and mean) formaldehyde concentration to be 0.0058 ppm (0.0059 ppm).			
Area sampling data:	The 8-hour time-weighted average concentration of formaldehyde was described by a log-normal distribution with geometric mean 0.0058 mg/m3 and geometric standard deviation of 1.19. The 75th percentile of the distribution is 0.0065 mg/m3 (0.0053 ppm). The 95th percentile of the distribution is 0.0077 mg/m3 (0.0094 ppm).			
Number of workers:	6			
Personal protective equipment:	Gloves were worn as part of personal protective equipment throughout the 1990s and 2000s.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country, other than the U.S
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data no more than 10 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	monitoring study does not address variability or uncertainty
Overall Quality Determination		Medium		

Study Citation:	Joob, B., Wiwanitkit, V. (2016). Formaldehyde Level in Anatomy Laboratory Teaching Room and Risk for Cancer. 64(4):132.			
HERO ID:	6128891			
Conditions of Use:	Laboratory chemical use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Medical students enrolled in gross anatomy			
Area sampling data:	Reported concentration of air formaldehyde in anatomy laboratory was between 71.42 and 143.72 ppb or 85.70 and 172.46 ug/kg (formaldehyde 1 ppb = 1.2 ug/kg; density of formaldehyde = 8.153×10^{-4} kg/m3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data less than 10 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Jurvelin, J.A., Edwards, R.D., Vartiainen, M., Pasanen, P., Jantunen, M.J. (2003). Residential indoor, outdoor, and workplace concentrations of carbonyl compounds: Relationships with personal exposure concentrations and correlation with sources. Journal of the Air and Waste Management Association 53(5):560-573.		
HERO ID:	106738		
Conditions of Use:	Office Environment		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	Personal 21.4 ppb mean (SD 11.1 GM 18.7 Max 40.3 ppb);		
Area sampling data:	Indoor residential 33.3 ppb mean (SD 17.9 GM 28.3 Max 62.3 ppb); outdoor residential 2.6 ppb mean (SD 2.9 GM 1.6 Max 10.9 ppn); Workplace 12.0 ppb mean (SD 6.1 GM 11.0 Max 26.4 ppb)		
Exposure duration:	48 hours of sampling exposure		
Number of workers:	15 participants		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified, though it was noted that 2,4-dinitrophenylhydrazine - silica cartridges attached to PEM or MEM, HPLC analysis were used
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Finland - OECD member
	Metric 3: Applicability	Medium	unclear what industry the workplace represents
	Metric 4: Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after the PEL- published in 2003 but the data are from 1997
	Metric 5: Sample Size	High	full statistics (mean, geometric mean, standard error and standard deviation)were provided
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	missing sampling/analysis methods, exposure frequency, worker activity and number of sites
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variance can be discerned from the statistics but uncertainty not addressed
Overall Quality Determination		Medium	

Study Citation:	Kacergis, J. B., Jones, R. B., Reeb, C. K., Turner, W. A., Ohman, J. L., Ardman, M. R., Paigen, B. (1996). Air quality in an animal facility: Particulates, ammonia, and volatile organic compounds. American Industrial Hygiene Association Journal 57(7):634-640.			
HERO ID:	1320735			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Changing mice from soiled to clean cages, cleaning floors and changing foam inserts in pressurized individual cages.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	4.9 +/- 0.3 ug/m3 mean			
Particle size characterization:	range 4,000 - 600,000 counts per 10 minute sample			
Engineering control:	Use of capture-type ventilated changing table (designed and tested)			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that sampling was implemented with 2,4-dinitrophenylhydrazine reagent in Waters DNPH-silica Sep-Pak cartridges (Millipore). HPLC analysis was conducted on each sample.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for animal caretakers exposure at a mouse facility, which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1996, after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean values and standard error data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, and worker activities, but lacks additional metadata, such as exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided standard error data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Study Citation:	Kagi, N., Fujii, S., Tamura, H., Namiki, N. (2009). Secondary VOC emissions from flooring material surfaces exposed to ozone or UV irradiation. Building and Environment 44(6):1199-1205.			
HERO ID:	567619			
Conditions of Use:	Use of Floor coverings			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	low formaldehyde flooring flux (1 hrs exposure): ozone exposure 31 ug/m2hr; IR Lamp 68 ug/m2hr; Sun lamp 82 ug/m2hr; UV-A lamp 4 ug/m2hr; UVb lamp 7 ug/m2hr. Natural wood flooring flux (1 hrs exposure): ozone exposure 288 ug/m2hr; IR Lamp 103 ug/m2hr; Sun lamp 180 ug/m2hr; UV-A lamp 83 ug/m2hr; UVb lamp 83 ug/m2hr			
Exposure duration:	1 hr			
Comments:	Article looks at "secondary emissions" caused by products being exposed to UV/Sunlight. Could be useful for degradation/byproducts			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it was noted that 2,4-dinitrophenylhydrazone impregnated cartridges attached to PEM or MEM, HPLC analysis were used
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Japan - OECD member
	Metric 3:	Applicability	High	The data are for formaldehyde emissions from wood products and/or floor coatings which is within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - published 2009
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - only flux rates were provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	flux rates were provided but no additional data. note chamber study and field sampling. Missing: sampling/analysis methods, number of samples, number of sites, worker activities, exposure frequency, number of workers and sampling locations
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed
Overall Quality Determination			Medium	

Study Citation:	Kaiser, E. A., Sylvain, D. C. (1994). Health hazard evaluation report No. HETA-94-0023-2473, Veterans Administration, White River Junction, Vermont.			
HERO ID:	1317748			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees in Veterans Administration Medical and Research Center, White River Junction, Vermont			
Exposure route:	inhalation and skin absorption			
Physical form:	colorless gas with a strong odor			
Area sampling data:	Air sampling performed by VA staff indicated that formaldehyde concentrations exceeded 0.1 parts per million (ppm) on several dates in July 1992, in several different areas of Building 44, but primarily on the ground floor. Repeat formaldehyde sampling later that summer found concentrations to be approximately one tenth of the previous readings. Air sampling in March 1993 indicated concentrations of 0.2 ppm formaldehyde in room G-107. Two other repeat samples found <0.04 ppm in this room. Formaldehyde sampling conducted by the VA in 1992 and 1993 found concentrations ranging from none detected to 0.6 ppm. On February 17, 1994, the NIOSH investigators returned to conduct area air sampling for formaldehyde. Very low levels (<0.01 ppm) of formaldehyde were detected in the area air samples from the research laboratories. The OSHA PEL is 0.75 ppm as an 8-hour TWA and 2 ppm as a STEL. The current ACGIH TLV is 0.3 ppm as a ceiling limit.			
Exposure duration:	10 hours per day			
Exposure frequency:	40 hours per week			
Engineering control:	No engineering control was suggested relevant to formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is approved by NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5967399 Table: 1 of 1

Study Citation:	Kamath, Y.K., Hornby, S.B., Bergeron, D., Weigmann, H.D. (1985). Effect of pH and the role of n-methylol hydrolysis in formaldehyde release from durable press fabric. Textile Research Journal 55(12):766-773.			
HERO ID:	5967399			
Conditions of Use:	Textile finishing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	gas			
Area sampling data:	Formaldehyde release (ug/g) under different conditions: As received (unwashed – 5246, washed DW 21 deg C – 419, washed DW 60 deg C – 276, washed DW pH 9.5, 60 deg C – 164, washed DW pH 12, 60 deg C – 440); cured 0.12 ks (2 mins) at 150 deg C (unwashed – 3048, washed DW 21 deg C – 942); cured 0.24 ks (4 mins) at 150 deg C (unwashed – 3358, washed DW 21 deg C – 1038, washed DW 60 deg C – 1203, washed DW pH 9.5, 60 deg C – 1121, washed DW pH 12, 60 deg C – 994); cured 0.48 ks (8 mins) at 150 deg C (unwashed – 1973, washed DW 21 deg C – 1001, washed DW 60 deg C – 681, washed DW pH 9.5, 60 deg C – 995, washed DW pH 12, 60 deg C – 717).			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data more than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
Overall Quality Determination		Medium		

Study Citation:	Kanjanasiranont, N., Prueksasit, T., Morknoy, D., Tunsaringkarn, T., Sematong, S., Siriwong, W., Zapaung, K., Rungsiyothin, A. (2016). Determination of ambient air concentrations and personal exposure risk levels of outdoor workers to carbonyl compounds and BTEX in the inner city of Bangkok, Thailand. Atmospheric Pollution Research 7(2):268-277.			
HERO ID:	3367647			
Conditions of Use:	General Population			
EXTRACTION				
Parameter	Data			
Worker activity description:	Street vendor, motorcycle taxi driver, security guard			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Personal samples: Street vendors - 22.4 +/- 4.95; 7.92 +/- 3.60; 19.6 +/- 12.3; 20.9 +/- 11.3; 14.5 +/- 10.4; average - 17.1 +/- 5.9; Motorcycle taxi drivers - 15.8 +/- 9.1; 11.7 +/- 6.9; 9.11 +/- 2.72; 9.63 +/- 6.85; 18.1 +/- 7.0; mean - 12.8 +/- 3.9. Another set of personal exposures are in Table 2 (ug/m^3): 13.5 +/- 1.9; 12.3 +/- 1.2; 6.76 +/- 2.80; 9.63 +/- 2.24; 8.24 +/- 3.22; 10.2 +/- 2.2; mean - 10.1 +/- 2.5; Figure 3A provides range of data for formaldehyde.			
Area sampling data:	Figure 2 provides ambient air conditions of formaldehyde with range between 10 and 17 ug/m^3 with a mean around 11 ug/m^3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is for Thailand a non-OECD country.
	Metric 3:	Applicability	Low	Data is for typical non-COUs such as street vendors, security guards and delivery drivers. Could be applied to similar COUs to these.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (sampled in 2012-2013)
	Metric 5:	Sample Size	Medium	Range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes sample type, exposure type, worker activity.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Addresses variability by looking at different worker activities and sampling across different street locations. Addresses uncertainty by providing LODs for various chemicals and for formaldehyde (0.002 ug/m^3).
Overall Quality Determination		Medium		

Study Citation:	Kauppinen, T. (1986). Occupational exposure to chemical agents in the plywood industry. Annals of Occupational Hygiene 30(1):19-29.			
HERO ID:	993067			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	varies based on process: 1975-84 Peeling <0.1 ppm mean, <0.1 ppm median (range <0.1 ppm); Drying and sorting veneers 1975-84: range 0.1 ppm; Patching of veneers 1975-84: 0.3 ppm mean, 0.3 ppm median (range <0.1-0.4 ppm); Jointing of veneers 1965-74: range 0.7-0.8 ppm; 1975-84: 0.12 ppm mean, 0.13 ppm median (range 0.02-0.2 ppm); Scarfing of veneers 1965-74: 0.6 ppm mean, 0.7 ppm median (range <0.1-1.0 ppm); 1975-84: 0.30 ppm mean, 0.20 ppm median (range 0.03-0.9 ppm); Sawing of veneers 1965-74: range 0.5-0.6 ppm; 1975-84 range 0.3-0.4 ppm; Glue preparation 1965-74: 2.2 ppm mean 1.9 ppm median (range 0.6-5.0 ppm); 1975-84: 0.67 ppm mean, 0.48 ppm median (range 0.10-2.3 ppm); Assembling 1965-74: 1.5 ppm mean, 1.2 ppm median (range <0.1-4.4 ppm); 1975-84: 0.57 ppm mean, 0.33 ppm median (range <0.02-6.8 ppm); Hot pressing 1965-74: 2.0 ppm mean, 1.2 ppm median (range <0.1-7.7 ppm); 1975-84: 0.53 ppm mean, 0.40 ppm median (range 0.06-2.1 ppm); Sawing of plywood 1965-74: 0.5 ppm mean, 0.6 ppm median (range 0.3-0.8 ppm); 1975-84: 0.12 ppm mean, 0.14 ppm median (range <0.02-0.22 ppm); Sanding of plywood 1975-84: 0.08 ppm mean, 0.07 ppm median (range <0.02-0.18 ppm); Finishing of plywood 1975-1984: range 0.10 ppm; Coating of plywood 1965-74: 1.0 ppm mean, 0.9 ppm median (range 0.5-1.8 ppm; 1975-84: 0.26 ppm mean, 0.25 ppm median (range <0.01-0.6 ppm); Spraying of plywood 1975-84: range 1.0-2.0 ppm			
Particle size characterization:	1-4 mg/m3 Respirable dust 15-40% (breathing zone) 65% for general areaof total			
Comments:	See tables			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling implemented using a dilute sodium bisulphite solution, followed by spectrophotometric determination after the evaporation of the sample solution and the addition of a colour-forming reagent, chromotropic acid (SFS-STANDARD 3862, 1978). The analytical method for measurements taken before 1975 was titrimetric.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD member
	Metric 3:	Applicability	High	The data are for plywood manufacture is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1986, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Data did not include sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 993067 Table: 1 of 1

...continued from previous page

Study Citation:		Kauppinen, T. (1986). Occupational exposure to chemical agents in the plywood industry. Annals of Occupational Hygiene 30(1):19-29.		
HERO ID:		993067		
Conditions of Use:		Compressed Wood Product Manufacturing		
Domain		Metric	EVALUATION	
	Metric 7:	Metadata Completeness	Rating	Comments
			Medium	Mean, median and range data were provided to characterize variability between different operations, uncertainty was not discussed.
Overall Quality Determination			Medium	

Study Citation:	Kauppinen, T., Teschke, K., Savela, A., Kogevinas, M., Boffetta, P. (1997). International data base of exposure measurements in the pulp, paper and paper product industries. International Archives of Occupational and Environmental Health 70(2):119-127.			
HERO ID:	665017			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	24% of the samples, but results not provided			
Area sampling data:	61% were area samples, but results not provided.			
Number of workers:	total 100,000 employees			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	sampling and analysis were implemented but nor specified in this study	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Study included 13 countries though not specified in this paper.	
	Metric 3: Applicability	High	The data are from pulp and paper industries which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	the study was implemented from 1992-1995, after the PEL was developed (1992) but over 20 years ago.	
	Metric 5: Sample Size	Low	Results specific for formaldehyde were not provided, only general qualitative observations were made.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Data structure was provided that included a complete list of meta data (e.g., mill type, job code, sampling method, duration of sampling, analytic methods and an assessment of representativeness of the results) but these data were not provided in this paper.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	an an assessment of whether the values were over or under predicting concentrations was a data field, but no results were provided.	
Overall Quality Determination		Low		

Study Citation:	Kauppinen, T.P., Niemelä, R.I. (1985). Occupational exposure to chemical agents in the particleboard industry. Scandinavian Journal of Work, Environment and Health 11(5):357-363.			
HERO ID:	6148710			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Chipping, preparation of glue mixture, blending, forming, prepressing, hot pressing, ceiling care, planing, sawing, grinding, grading, packing, coating, jointing of particleboard. (4/8)			
Exposure route:	inhalation (2/8)			
Area sampling data:	""""The ranges of the means in different work phases were 0.8-4.8 ppm in 1965-1974 and about 0.1-2.3 ppm in 1975-1984."" (Three large tables of data available) (4/8)""			
Exposure duration:	sampling time 4-6 hours/day (3/8)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for adhesives and sealant chemicals in wood product manufacturing, am in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, medians, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at different plants that use the same technology.
Overall Quality Determination		Medium		

Study Citation:	Kavanagh, B., Williamson, J. (1987). Vinyl chloride monomer and other contaminants in PVC welding fumes. American Industrial Hygiene Association Journal 48(5):432-436.		
HERO ID:	6013508		
Conditions of Use:	Commercial Use: Metal Products		
EXTRACTION			
Parameter	Data		
Worker activity description:	PVC welders		
Exposure route:	inhalation		
Physical form:	gas		
Area sampling data:	3 formaldehyde measurements were taken, all of which were under the TLV-TWA values.		
Exposure duration:	8 hours/day		
Exposure frequency:	5 days/week		
Engineering control:	”1) good welding practices; in particular, overheating of the PVC sheeting resulting in charring and evolution of white fumes should be avoided 2) maintenance of good ventilation conditions during welding of PVC sheeting.”		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination		Medium	

Study Citation:	Kawamoto, M. M., Echt, A., Reh, C. M. (1999). Health hazard evaluation report HETA 96-0016-2777, Eagle-Picher Industries, Joplin, Missouri, March 1999.			
HERO ID:	1577133			
Conditions of Use:	Other Byproduct			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in the soldering area work with formaldehyde. Soldering area: The soldering operation evaluated during this investigation takes place in a clean room. Contacts are soldered on batteries using soldering irons, 70/30 tin lead solder, a rosin flux, and small amounts of isopropanol.			
Exposure route:	Inhalation			
Personal sampling data:	Less than MDC of 1ppm			
Number of workers:	10 employees in the soldering area			
Personal protective equipment:	nothing mentioned particularly for formaldehyde			
Engineering control:	Air in the room is recirculated after being cleaned with a carbon filter and electrostatic precipitator and tempered.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is an approved NIOSH method(2539)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Uninformative	The data are for an occupational scenario(decomposition product of soldering), which is outside of the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	Medium	Discrete values are provided with only two samples taken.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include sample type, exposure type, but lacks additional metadata, such as exposure durations or exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability with samples taken at different points in the day. The uncertainty in measurements is assumed to be addressed from the sampling and analytical method.
Overall Quality Determination		Uninformative		

Study Citation:	Kawata, S., Marutani, E., Hirai, S., Hatayama, N., Omotehara, T., Nagahori, K., Li, Z., Miyaso, H., Pieroh, P., Naito, M., Itoh, M. (2019). Spraying urea solution reduces formaldehyde levels during gross anatomy courses. <i>Anatomical Science International</i> 94(2):209-215.
HERO ID:	6131386
Conditions of Use:	Laboratory chemical (gross anatomy courses)

EXTRACTION

Parameter	Data
Worker activity description:	cadaver dissection
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	"The FA levels in the area sampling and cadaver sampling were 1.10±0.09 ppm and 1.35±0.07 ppm, respectively, for the without urea group (2015); 0.70±0.08 ppm and 1.07±0 ppm, respectively, for the one practice group (2016); and 0.65±0.10 ppm and 0.79±0.28 ppm, respectively, for the every practice group (2017)" (pg 5) (differences between 2015/16/17 sampling groups detailed on pg 3)
Exposure frequency:	During the gross anatomy course, which was held for 35 practice days from April to July, the FA levels in the dissection hall weremeasured on the 14th day, when the chest and abdomen of each cadaver were opened and the FA levels were highest.
Engineering control:	""FA at a concentration of 3.8% (w/v) was prepared through the dilution of 19% (w/v) FA (Maskedform B®, Japan Tanner Corporation, Osaka, Japan) in water five times. The 3.8% (w/v) FA solution contained 1.38 mol/l of FA, so this concentration was defined as the 1× FA scavenger solution. Urea solutions with concentrations of 2×, 1/2×, and 1/4×were also created, as was a control solution without any scavengers"" Urea and L-cysteine were FA scavengers used, dissolved separately in water or 70% ethanol (pg2) ""The volatilized FA levels from the wet paper towels containing FA (n=5) exceeded 5.0 ppm when no spraying was performed. These FA levels did not change significantly after spraying the solution without urea (4.94±0.13 ppm), but they did decrease significantly (1.16±0.17 ppm) after spraying the 1× urea solution. In addition, the FA levels were significantly higher after spraying the 1/4× urea solution (2.18±0.41 ppm) or 1/2× urea solution (1.78±0.16 ppm) than after spraying the 1× urea solution. On the contrary, the FA levels after spraying 2× urea solution (1.20±0.20 ppm) were not significantly different from the FA levels after spraying1× urea solution"" (pg 4) Similar data also provided for scavenger effectiveness over time, as well as for spraying organs (as opposed to paper towels) (pg 4-5)"
Comments:	"FA levels were measured at nine points (area sampling) in the dissection hall (18.2 m×10.9 m×4.4 m) and at two points near the heads and legs of the cadavers (cadaver sampling) under air conditioning (temperature; 21.5–24.5 °C, humidity; 38–52%)"Method: Known volumes of air samples (500 mL) were gathered in gas detector tubes (GV100; GASTEC, Tokyo, Japan)... could measure FA levels of either 0.05–1.0 ppm (91LL; GASTEC) or 0.1–5.0 ppm (91L; GASTEC) (pg 3)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			

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Formaldehyde

Occupational Exposure

HERO ID: 6131386 Table: 1 of 1

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Study Citation:	Kawata, S., Marutani, E., Hirai, S., Hatayama, N., Omotehara, T., Nagahori, K., Li, Z., Miyaso, H., Pieroh, P., Naito, M., Itoh, M. (2019). Spraying urea solution reduces formaldehyde levels during gross anatomy courses. Anatomical Science International 94(2):209-215.			
HERO ID:	6131386			
Conditions of Use:	Laboratory chemical (gross anatomy courses)			
		EVALUATION		
Domain		Metric	Rating	Comments
	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure duration.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple years, but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Keil, C.B., Akbar-Khanzadeh, F., Konecny, K.A. (2001). Characterizing formaldehyde emission rates in a gross anatomy laboratory. Applied Occupational and Environmental Hygiene 16(10):967-972.			
HERO ID:	33780			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Instructors and Students in gross anatomy laboratories; Exposure from cadavers			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Another study- Breathing zone: 1.52 mg/m3 mean (0.09-3.61 mg/m3)			
Area sampling data:	Average daily concentrations ranged from: 0.635-1.82 mg/m3			
Exposure duration:	3-4 hrs/day			
Number of workers:	34			
Engineering control:	Not employed during study but possible examples given-"An approach to LEV for dissecting tables is the modification of the table to include lateral exhaust slots along the perimeter of the area that supports the cadaver. This modification resulted in large (>80%) reduction in vapor concentrations 5-10 cm above the cadaver at moderate exhaust rates (1.4m3/min)... Another LEV approach is to build dissecting tables with downdraft slots along the perimeter of the surface the cadaver rests on. The table has an internal air mover and treated absorbent bed to remove vapors prior to returning the air to the room. This system has reduced concentrations near the cadaver to <0.1mg/m3. These units are, however, extremely expensive."			
Comments:	Measured over 15 lab sessions with 47 dissecting tables; 0.635 to 1.82mg/m3; General ventilation rate of 9.8 air changes per hour measured over 3 different days with no local exhaust ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Used OSHA Method 52 which is similar to NIOSH Method 2541
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 2001, more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
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Study Citation:	Keil, C.B., Akbar-Khanzadeh, F., Konecny, K.A. (2001). Characterizing formaldehyde emission rates in a gross anatomy laboratory. Applied Occupational and Environmental Hygiene 16(10):967-972.			
HERO ID:	33780			
Conditions of Use:	Laboratory Use			
		EVALUATION		
Domain		Metric	Rating	Comments
	Metric 7:	Metadata Completeness	High	The study addressed variability by measuring at different locations, separate days over a 16 week span. Uncertainty was accounted for in accounting for potential interferences and comparing data with previous studies.
Overall Quality Determination			High	

Study Citation:	Kelly, J. E. (1992). HETA 92-045-2260 US Department of the Interior National Park Service, New River Gorge National River, West Virginia. :92-045.			
HERO ID:	1482575			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Worker activity description:	fire fighters			
Exposure route:	inhalation			
Personal sampling data:	Formaldehyde concentrations ranged up to 0.10 ppm.			
Area sampling data:	Formaldehyde exposures ranged up to 0.10 ppm. The average exposure was 0.07 ppm.			
Exposure duration:	12 hr day, 6 - 7 days per week			
Personal protective equipment:	During suppression activities, fire fighters typically wear Nomex pants and shirt, Vibram-soled boots, hard hats, goggles and leather gloves.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Uninformative	The data are for an occupational scenario, however, it is a COU (wildfire) which is not within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides limited discussion of variability in the determinants of exposure . The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		Uninformative		

Study Citation:	Keskin, H., Kucuktuek, M., Guru, M. (2015). The potential of poppy (Papaver somniferum Linnaeus) husk for manufacturing wood-based particleboards. Construction and Building Materials 95:224-231.			
HERO ID:	3073235			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	Used as an adhesive/resin but exposure is from vapor			
Area sampling data:	Formaldehyde emission data from experimental panels provided in Table 5 (ppm): 60.00 +/- 2.0548, 69.70 +/- 2.2136, 74.90 +/- 1.7920, 82.00 +/- 1.4907, 84.30 +/- 2.1628. Each sample described has their composition described in Table 1 ranging from particleboards consisting of 100% poppy husk up to 100% pine wood. Trend saw that as composition of pine wood increased, FE emission increased. Table 5 is shown graphically in Figure 9.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is from Turkey, an OECD country.
	Metric 3:	Applicability	High	Data is applicable to manufacturing of wood particleboards with formaldehyde adhesives/resins.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2015)
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Only contains exposure route, physical form and concentration of formaldehyde used in the resin.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at emission rates of particleboards with different compositions of wood. Does not address uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 6613 Table: 1 of 1

Study Citation:	Khamgaonkar, M.B., Fulare, M.B. (1991). Pulmonary effects of formaldehyde exposure—an environmental-epidemiological study. Indian Journal of Chest Diseases and Allied Sciences 33(1):9-13.			
HERO ID:	6613			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in the anatomy and histopathology college departments.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Range 0.036 - 2.27 ppm; mean 1.002 +/- 0.556 ppm at study group work places. 0 - 0.52 ppm; mean 0.102 +/- 0.115 ppm control group			
Exposure frequency:	Breathing zone air samples collection using the standard impinge method. . . analyzed by MBTH method. 30 minute sampling period.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country (i.e., Vidarbha, India).
	Metric 3:	Applicability	High	The data are for medical students, an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data collected before the most recent PEL (1992). Published in 1991. Sample collection before then.
	Metric 5:	Sample Size	Medium	Data characterized by median and range, but full statistical distribution not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty not addressed.
Overall Quality Determination		Low		

Study Citation:	Kilburn, K.H., Seidman, B.C., Warshaw, R. (1985). Neurobehavioral and respiratory symptoms of formaldehyde and xylene exposure in histology technicians. Archives of Environmental and Occupational Health 40(4):229-233.		
HERO ID:	69078		
Conditions of Use:	Laboratory Use		
EXTRACTION			
Parameter	Data		
Worker activity description:	preparing tissue slides		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	tissue specimen preparation 0.2 -1.9 ppm		
Number of workers:	76 women		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling and analytical methodology was not specified though it was noted that sorbent tubes were used for sampling and analyzed by gas chromatography at a NIOSH laboratory
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for Histology laboratories which are an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1985, before the most recent PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range while uncertainty statistics were not provided.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The study provides range data that can be useful in assessing variability, it is assumed that uncertainty was considered in analysis at the NIOSH lab.
Overall Quality Determination		High	

Study Citation:	Kilburn, K.H., Warshaw, R., Thornton, J.C. (1989). Pulmonary function in histology technicians compared with women from Michigan: effects of chronic low dose formaldehyde on a national sample of women. Occupational and Environmental Medicine 46(7):468-472.			
HERO ID:	6614			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.2 - 1. ppm with peaks to 5 ppm			
Number of workers:	280 histology technicians			
Comments:	Area sampling done for 1 to 4 hours by the regional NIOSH lab using sorbent tubes and impingers analyzed by gas chromatography.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for medial lab technician, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data collected before the most recent PEL (1992). Sample collection from 1982 - 1986.
	Metric 5:	Sample Size	Low	Data characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., area measurements) but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty not addressed.
Overall Quality Determination		Medium		

Study Citation:	Kim, C.W., Song, J.S., Ahn, Y.S., Park, S.H., Park, J.W., Noh, J.H., Hong, C.S. (2001). Occupational asthma due to formaldehyde. Yonsei Medical Journal 42(4):440-445.			
HERO ID:	1222843			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Worker activity description:	A factory that produced crease resistant trousers. The worker activity involved a heat-treatment process, which was performed in a large heating chamber maintained at a temperature between 165 to 170 C			
Physical form:	vapor			
Personal sampling data:	0.12 to 0.13 ppm (short term exposure level)			
Area sampling data:	0.06 ppm (mean value in the area around the heat chamber).			
Comments:	Concentrations were measured while factory production was reduced. At another garment factory in which crease-resistant cloth was used, worker exposure level were in the range of 0.2-1.2 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Korea, an OECD country.
	Metric 3:	Applicability	High	Data are for finishing agents in textiles, apparel, and leather manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2001)
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		High		

Study Citation:	Kim, H., Kim, Y.D., Cho, S.H. (1999). Formaldehyde exposure levels and serum antibodies to formaldehyde-human serum albumin of Korean medical students. Archives of Environmental Health 54(2):115-118.			
HERO ID:	1239600			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.194-11.245 (mg/m^3)			
Number of workers:	167			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method. (NIOSH 3500)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from South Korea, an OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1990)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE, exposure frequency, exposure duration.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Kimmelman, B. B., Hillman, E. E. (1983). Formaldehyde vapor in the dental environment: Absence of potential hazard. ASDC Journal of Dentistry for Children 50(1):55-57.			
HERO ID:	5951811			
Conditions of Use:	Laboratory chemicals			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	"Formocresol, 70 degrees F, one inch away: >15 ppm Formocresol, 70 degrees F, 4 inches away: <0.2 ppm Formocresol, 115 degrees F, one inch away: >15 ppm Formocresol, 115 degrees F, 4 inches away: <0.2 ppm Sargenti N-2, 70 degrees F, one inch away: <0.2 ppm Sargenti N-2, 70 degrees F, 4 inches away: <0.2 ppm Sargenti N-2,115 degrees F, one inch away: >15 ppm Sargenti N-2,115 degrees F, 4 inches away: <0.2 ppm Tissue fixing solution, 70 degrees F, one inch away: 0.5 ppm Tissue fixing solution, 70 degrees F, 4 inches away: <0.2 ppm Tissue fixing solution, 115 degrees F, one inch away: 4.0 ppm Tissue fixing solution, 115 degrees F, 4 inches away: 0.9 ppm"			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing most other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling three different dental chemicals.
Overall Quality Determination		Medium		

Study Citation:	King, B., Mccullough, J. (2006). Health hazard evaluation report no. HETA-2001-0030-3020, Carolinas Medical Center, Charlotte, North Carolina.			
HERO ID:	6558304			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Surgeons, others standing at the operating table, scrub nurses, circulating nurses, and surgical technicians. (9/29)			
Exposure route:	inhalation and skin absorption (10/29)			
Physical form:	smoke (6/29)			
Personal sampling data:	Formaldehyde concentrations during the procedures ranged from nondetectable to 0.021 ppm.(13/29)			
Area sampling data:	Two background samples taken outside a closed-door OR revealed levels of 0.007 and 0.005 ppm. (13/29)			
Exposure duration:	8-10 hours/day (8/29)			
Exposure frequency:	The average time spent working in ORs at Carolinas Medical Center was 8.3 years, and average total time working in ORs during their careers was 12.8 years. (13/29)			
Number of workers:	69 surgical nurses, 29 surgical technicians, and 6 in the “other” category (including physicians, nurse anesthetist, nurse managers). (13/29)			
Engineering control:	Recommended ventilation techniques include a combination of general room and local exhaust ventilation (LEV). General room ventilation is not by itself sufficient to capture contaminants generated at the source. The two major LEV approaches used to reduce surgical smoke levels for health care personnel are portable smoke evacuators and room suction systems. (27/29)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for medical electrocautery knives, which is similar to the in-scope occupational scenario commercial use electronic products.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling on three separate days and sampling during many different procedures.
Overall Quality Determination		High		

Study Citation:	King, B., Page, E. (2013). Health hazard evaluation report: HHE-2012-0135-3184, June 2013. Evaluation of potential employee exposures at a medical examiner's office.
HERO ID:	6558294
Conditions of Use:	Use

EXTRACTION	
Parameter	Data
Worker activity description:	"Personnel in the fourth floor histology laboratory worked with tissues collected during autopsies, processing them for microscopic examination of the tissue cells. Personnel in the toxicology laboratory on the fifth and sixth floors evaluated drugs, poisons, and other toxic compounds in body fluids and tissues." (8/38)
Exposure route:	inhalation (3/38)
Personal sampling data:	Full-shift, time-weighted average (TWA) concentrations ranged from 0.01–0.03 ppm in autopsy workers. 15-minute TWA samples ranged from ND-0.04 ppm. Full-shift, time-weighted average (TWA) concentrations ranged from 0.01–0.02 ppm in histology workers. 15-minute TWA samples ranged from ND-0.06 ppm. (20/38)
Area sampling data:	No formaldehyde detected in area sample in the autopsy suite. (20/38)
Exposure duration:	About 400 minutes (20/38)
Exposure frequency:	Four or five autopsies typically were performed per day, with ten autopsies performed on a busy day. (8/38)
Number of workers:	30 employees in the autopsy suite, 20 in the toxicology suite, 12 in the histology suite (8/38)
Personal protective equipment:	""During autopsies, we observed employees using face shields, nitrile or latex gloves, aprons, scrubs, booties, and head covers. N95 filtering facepiece respirators, appropriate for autopsy procedures, were used correctly and in accordance with the OSHA respiratory protection standard. "" (12/38)"
Engineering control:	"Provide local exhaust ventilation when using cranial autopsy saws during autopsies. Mobile bone dust collection systems that attach to a variety of cranial autopsy saws and provide high efficiency particulate air filtration are commercially available. ." (18/38)
Comments:	See table A1

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling three laboratory areas with different work functions.

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Formaldehyde

Occupational Exposure

HERO ID: 6558294 Table: 1 of 1

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Study Citation:	King, B., Page, E. (2013). Health hazard evaluation report: HHE-2012-0135-3184, June 2013. Evaluation of potential employee exposures at a medical examiner's office.		
HERO ID:	6558294		
Conditions of Use:	Use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	King, B.S., B. S., Musolin, K., Choi, J. H. (2013). Evaluation of potential employee exposures during crime and death investigations at a county coroner's office.
HERO ID:	2995043
Conditions of Use:	Laboratory Use

EXTRACTION	
Parameter	Data
Worker activity description:	During a typical autopsy, a pathologist and forensic assistant opened the decedent's chest cavity to remove and examine the internal organs. Organ tissue samples were removed and placed in open containers of a formalin solution. To gain access to the brain tissue, the skull cap of the decedent was removed with a hand-held oscillating Clean Cut Autopsy Saw system. Tissues collected during autopsies were fixed, processed, embedded in paraffin wax, sectioned, mounted on a slide, and stained for microscopic examination of the tissue cells in the histology laboratory. Following autopsies, these tissues were delivered to the laboratory in containers of 100–300 milliliters of formalin solution containing 37% formaldehyde. The tissues, contained in small cassettes, were removed from the containers and loaded into a tray for further processing. Processing of the tissues sequentially removed the tissue fluids and replaced them with alcohol and paraffin so that the tissue was fixed in a block of paraffin. After processing, the block was sliced, and the tissue specimens were mounted on a slide, stained, and viewed under a microscope
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	Autopsy SuitePathologist 1 0.28 ppm, 0.13 ppmPathologist 2 0.27 ppmForensic assistant 1 0.29 ppm, 0.15 ppm, 0.10 ppmForensic assistant 2 0.46 ppm, 0.23 ppm, 0.15 ppmHistology Laboratory,Histologist 0.05 ppm
Area sampling data:	Autopsy SuiteAutopsy table 0.18 ppmHistology LaboratoryTissue preparation 0.01 ppmTissue processing 0.01 ppm
Particle size characterization:	Most particles measured were 0.3–0.5 micrometers (µm) indiameter.
Exposure duration:	Most employees worked approximately 9.5 hours a day. The forensic medical assistants worked a rotating schedule of varying lengths of days on and off in order to have a minimum of three employees on duty at a time.
Exposure frequency:	Most employees worked approximately 40 hours a week,The number of years worked at the facility ranged from 1 to 24 years, with an average of 10 years.
Number of workers:	50 full time and part time staff
Personal protective equipment:	Provide employees with recommended personal protective equipment including respirators, lab coats, gloves, safety goggles or glasses, and face shields. Make sure that employees are using this equipment for specific work practices taking place in the facility.
Engineering control:	Increase room exhaust in the autopsy suite. This will increase the number of air changes per hour in that area. Install downdraft tables in the autopsy suite to help control formaldehyde exposures.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study Method 2016
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario(crime lab) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	2013- after PEL (1992) and less than 10 years
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.

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Formaldehyde

Occupational Exposure

HERO ID: 2995043 Table: 1 of 1

...continued from previous page

Study Citation:	King, B.S., B. S., Musolin, K., Choi, J. H. (2013). Evaluation of potential employee exposures during crime and death investigations at a county coroner’s office.		
HERO ID:	2995043		
Conditions of Use:	Laboratory Use		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, worker activities, exposure durations and exposure frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations/jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination		High	

Study Citation:	Kinnes, G. M. (1990). Health Hazard Evaluation Report No. HETA-88-279-2026, Kardon Industries, St. Paris, Ohio. :88-279.			
HERO ID:	1320756			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Area sampling data:	Area above wax injector: 0.027 (ppm)On conveyor between injector and inspection are: 0.024 (ppm)Inspection area: 0.027 (ppm)Packaging area: 0.024 (ppm)On platform next to injector: 0.029 (ppm)Over wax drum: 0.029 (ppm)Across aisle from the wax machine: 0.027 (ppm)			
Number of workers:	100			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for paints and coatings, applicable to all occupational exposure scenarios.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a mean with no other statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling multiple locations in the facility.
Overall Quality Determination		High		

Study Citation:	Kinnes, G. M. (1993). Health hazard evaluation report no. HETA 89-162-2331, Growth International, Bennett Industries Division, Peotone, Illinois.			
HERO ID:	3970579			
Conditions of Use:	Plastic Material and Resin Manufacturing; Plastic Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	expected to operate machines, manually operate silk screening machine, inspection and packaging			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	During the manufacture and silk screening of plastic containers, airborne formaldehyde concentrations ranged 0.02 to 0.28 ppm. Three of the samples were also above the 0.1 ppm OSHA limit that requires worker training. The highest formaldehyde concentrationswere detected during the automatic (offset) silkscreening operation.			
Number of workers:	Bennett Industries employed 181 people at Growth International, 86 in the plastic container division, 77 in the metal container division, and 18 in general machine maintenance.			
Engineering control:	The drying ovens in the painting, roller-coat, litho, and both silkscreen operations should be properly ventilated with local exhaust ventilation. Upgrades to the paint booths and existing local exhaust ventilation systems should be implemented. These upgrades should include the control of exposures during the actual roller-coat, litho, and silkscreen application.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study - Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (silk screening onto plastic containers) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1990 - prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics were not provided but assumed they were considered in the NIOSH method 3500
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Study Citation:	Kinnes, G. M., Echt, A. S., Shults, R. A. (1996). Health hazard evaluation report 91–0153-2581 Unocal Corporation Kenai, Alaska June 1996.		
HERO ID:	8048799		
Conditions of Use:	reactant: Intermediate in fertilizer and other agricultural chemical manufacture.		
EXTRACTION			
Parameter	Data		
Worker activity description:	Daily blowdown operation in the granulation plant. During this operation, an operator uses a compressed air hose to clean settled dust off equipment in the plant. The operator, who wears a half-face respirator equipped with HEPA cartridges, starts on the top deck and cleans each deck in successive order until all the dusts accumulated on the ground floor, where it can be swept up.		
Exposure route:	inhalation		
Physical form:	Vapor or as fraction of PM		
Personal sampling data:	Airborne formaldehyde vapor concentrations ranged from less than 0.006 to 2.2 ppm, with the highest concentrations encountered during the unloading of a tanker containing the formaldehyde based additive (UF-85). A PBZ sample collected from the operator performing this unloading operation had a concentration of 0.25 ppm. Unloading Operator - sorbent tube (4/14/92) 0.25 ppm Particulate Formaldehyde Equivalent Plant #2 - Operator - back end (8/8/91) 2.0 ug/m3 Plant #2 - Prill Tower Operator (8/8/91) 2.3 ug/m3 Plant #2 - Maintenance (8/9/91) 3.6 ug/m3 Plant #2 - Maintenance (8/8/91) 9.0 ug/m3 Plant #5 - Process Operator (8/8/91) 0.6 ug/m3 (sampling pump failure) Plant #5 - Helper (building scaffolds) (8/8/91) 11.5 ug/m3 Plant #5 - Operator (8/8/91) 2.9 ug/m3 Plant #5 - Electrician (8/8/91) 7.4 ug/m3 Plant #5 - Electrician (8/8/91) 5.8 ug/m3 TWA for above 2 consecutive samples (8/8/91) 6.4 ug/m3 Granular Warehouse - Loader Operator (4/13/92) 12.4 ug/m3 Granular Warehouse - Loader Operator (4/13/92) 31.2 ug/m3 Operator Performing Blow-Down (4/13/92) 363 ug/m3 (Filter damaged) Followed Operator Performing Blow-Down (4/13/92) 984 ug/m3 (filter likely overloaded) Operator Performing Blow-Down (4/14/92) 1511 ug/m3 (filter likely overloaded) Operator Performing Blow-Down (4/14/92) 1052 ug/m3		
Area sampling data:	Plant #2 - Area Near Prill Tower Melt Box (8/8/91) ND Plant #2 - Area Near Sizing Screens (8/8/91) ND Plant #5 - Area on second Deck (8/8/91) ND Plant #5 - Area on third Deck (8/8/91) trace Plant #2 - Area Near Prill Tower Melt Box (4/14/92) 0.024 ppm Plant #2 - Area Near Prill Tower Melt Box (4/14/92) 0.028 ppm Prill Warehouse - Area Near Wall (4/14/92) 0.007 ppm Granular Warehouse - Area Near Grizzly (4/13/92) 0.004 ppm Granular Warehouse - Area at South End (4/13/92) 0.004 ppm Unloading of UF-85 Tanker Area Between Tanker & Transfer Pipes (4/14/92) 2.2 ppm Area Between Tanker & Transfer Pipes – sorbent tube (4/14/92) 1.6 ppm Unloading Operator - sorbent tube (4/14/92) 0.25 ppm Particulate Formaldehyde Equivalent Area samples collected from the prill and granular plants Plant #2 - Near Sizing Screens (8/8/91) 7.9 ug/m3 Plant #2 - Near Sizing Screens (8/8/91) 5.6 ug/m3 TWA for above 2 consecutive samples (8/8/91) 6.6 ug/m3 Plant #2 - Prill Tower Melt Box (8/8/91) 7.9 ug/m3 Plant #2 - Prill Tower Melt Box (8/8/91) 5.6 ug/m3 TWA for above 2 consecutive samples (8/8/91) 6.7 ug/m3 Plant #2 - Prill Tower Melt Box (4/14/92) 16.2 ug/m3 Plant #2 - Prill Tower Melt Box (4/14/92) 28.0 ug/m3 Plant #5 - Third Deck 8/8/91 20.3 ug/m3 Plant #5 - Third Deck (8/8/91) 7.1 ug/m3 Plant #5 - Third Deck (8/8/91) 42.0 ug/m3 TWA for above 3 consecutive samples (8/8/91) 21.1 ug/m3 Plant #5 - Second Deck (8/8/91) 8.3 ug/m3 Plant #5 - Second Deck (8/8/91) 6.0 ug/m3 Plant #5 - Second Deck (8/8/91) 4.7 ug/m3 TWA for above 3 consecutive samples (8/8/91) 6.4 ug/m3 Prill Warehouse - Area Outside Loader (4/14/92) 397 ug/m3 (filter likely overloaded) Prill Warehouse - Area Inside Loader (4/14/92) 48.4 ug/m3 Prill Warehouse - Area on Floor (4/14/92) 115 ug/m3 (filter likely overloaded) Granular Warehouse - Area Inside Loader (4/13/92) 13.8 ug/m3 Granular Warehouse - Area on Floor (4/13/92) NDDaily blow-down operation in Plant 5 Area on third Deck (4/13/92) 641 ug/m3 (filter likely overloaded)		
Number of workers:	200		
Personal protective equipment:	Operators unloading the tanker are required to wear Tyvek® suits coated with polyethylene, rubber gloves, and a face shield with chemical goggles. When there is the possibility of exposure to formaldehyde vapor, such as during this operation, the Unocal safety procedures dictate that a MSA full face piece chest mounted respirator with yellow GMC-SS supersize canisters should be worn.		
Engineering control:	The use of compressed air to perform the blowdown operation in the granular plant and clean off individual uniforms should be eliminated. The feasibility of alternative methods, such as wet methods or vacuuming, should be investigated.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High NIOSH study Methods 3500, 2541 and 5700
Domain 2: Representativeness			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 8048799 Table: 1 of 1

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Study Citation:		Kinnes, G. M., Echt, A. S., Shults, R. A. (1996). Health hazard evaluation report 91–0153-2581 Unocal Corporation Kenai, Alaska June 1996.			
HERO ID:		8048799			
Conditions of Use:		reactant: Intermediate in fertilizer and other agricultural chemical manufacture.			
Domain		Metric	EVALUATION		Comments
	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	High	The data are for an occupational scenario (fertilizer manufacture) within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Medium	1991 & 1992 Report published in 1996 - After PEL (1992) but more than 20 years old	
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.	
Domain 3: Accessibility/ Clarity					
	Metric 6:	Metadata Completeness	High	Monitoring data include most critical metadata, including sample types, exposure types, sample durations, worker activities but lacks additional data.	
Domain 4: Variability and Uncertainty					
	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations, jobs and sampling dates. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.	
Overall Quality Determination			High		

Study Citation:	Kinnes, G. M., Hine, G. A. (1998). Health hazard evaluation report 96–0171–2692 Bureau of Alcohol, Tobacco, and Firearms Washington, D.C. May 1998.			
HERO ID:	1320509			
Conditions of Use:	Combustion Byproduct			
EXTRACTION				
Parameter	Data			
Worker activity description:	A fire department’s involvement at a fire scene typically occurs in three distinct phases; suppression, overhaul, and investigation. During the suppression phase, fire fighters are actively extinguishing the fire and ventilating the structure to remove heat and smoke. After the fire has been extinguished, fire fighters will search for hidden fire in walls, ceiling spaces, or other areas that are not easily accessible. This phase is termed overhaul and includes opening walls, pulling down ceiling materials, removing flooring, etc. to ensure that the fire has been completely extinguished. The final phase is the fire scene investigation which involves the determination of the origin and cause of the fire. Fire investigators will also determine whether the fire was accidental or incendiary in nature. Depending on the jurisdiction involved, the fire scene investigation can occur in conjunction with overhaul, where the investigators often direct the overhaul activities to ensure the preservation of evidence, or up to several days after the fire. In addition, several differences can occur in the way fire investigations are conducted, based on each jurisdiction’s standard operating procedures.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Living room scenario ND (sorbent tubes)Bedroom scenario trace (sorbent tubes)Office scenario ND (sorbent tubes)			
Area sampling data:	Nelson Place fire scene ND (sorbent tubes)Lamont Drive fire scene trace (sorbent tubes)Living room scenario 0.06 ppm and ND (sorbent tubes)Bedroom scenario 0.16 ppm and trace (sorbent tubes)Office scenario 0.18 ppm and ND (sorbent tubes)			
Exposure duration:	up to 10 hours per day			
Exposure frequency:	40 hours per week			
Personal protective equipment:	SCUBAHalf-face, air-purifying respirators equipped with combinationfilter cartridges (high–efficiency particulate, VOCs, acid mists, and formaldehyde) or powered air-purifying respirators with the appropriate filter cartridges should be used. If half-face respirators are used, they should be used in conjunction with eye goggles to help prevent eye irritation. To reduce the potential for contaminants being carried home by fire investigators, the use of disposable coveralls, boots, and gloves should be considered. If disposable items are not used, the laundering of any potentially contaminated clothing should be provided by a contractor.			
Engineering control:	The use of mechanical ventilation equipment thatremoves the contaminants from the areas where fireinvestigators are working should be utilizedwhenever possible.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (fire fighting) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1996 & 1997 - after PEL (1992) but more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH method 3500.
Domain 3: Accessibility/ Clarity				
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Study Citation:	Kinnes, G. M., Hine, G. A. (1998). Health hazard evaluation report 96–0171–2692 Bureau of Alcohol, Tobacco, and Firearms Washington, D.C. May 1998.
HERO ID:	1320509
Conditions of Use:	Combustion Byproduct

			EVALUATION	
Domain		Metric	Rating	Comments
	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in Method 3500 .

Overall Quality Determination	High

Study Citation:	Kinnes, G. M., Mortimer, V. D. (1999). Health hazard evaluation report, HETA 97-0106-2770: Sommer-Allibert Industries, USA, Inc., Kansas City, Missouri, December 1999.			
HERO ID:	1317228			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	There are typically one or two paint mixers who work in the paint kitchen per shift. All of the various colored base coats, the adhesive promoter, and the finishing coat have specific formulas and viscosities which have to be maintained for the pneumaticdistribution system to properly supply the robotic paint line. The main task of the paint mixers is to periodically check the viscosity of all the mixing totes, and, based on the formulation for the individual coating, either manually add solvents or raw coating to keep the liquid at the specified viscosity. The paint mixers also refill the totes as needed. The solvents and raw coatings are obtained in the preparation area and carted into the distribution area by the paint mixers. The paint mixers are also responsible for moving the 55 gallon drums of solvents or raw coatings to and from the storage area as needed.Approximately 75% of the paint mixer’s time is spent in the distribution area checking the mixing totes. The remaining 25% of their work time is split between the preparation and storage areas. All of the mixing totes are covered, but are not hermetically sealed. Therefore, the volatilization ofthe solvents and coatings continuously occurs from the mixing totes.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Formaldehyde concentrations determined from area samples ranged from 0.03 to 0.11 parts per million (ppm). The two samples collected in the distribution area had concentrations of 0.07 and 0.1 1 while the preparation and storage areas had concentrations of 0.08 and 0.03 ppm, respectively. As with the other analytes, the highest formaldehyde concentration was found in the distribution area.			
Number of workers:	120			
Personal protective equipment:	Because the mixing process generates most of the airborne contaminants, the paint mixers are required to wear half-mask air-purifying respirators when working in this distribution area. No respiratory protection is required in the other two areas. The paint mixers also use various types of protective gloves when handling the solvents and coatings.			
Engineering control:	improve HVAC in the paint distribution room.increase stack height of exhaust from the paint kitchen			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study - Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (painting operation) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1997 - after the PEL (1992) but more than 20 years old
	Metric 5:	Sample Size	Medium	Range of values was provided for the distribution area, while single values were presented for preparation and storage areas.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
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Formaldehyde

Occupational Exposure

HERO ID: 1317228 Table: 1 of 1

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Study Citation:	Kinnes, G. M., Mortimer, V. D. (1999). Health hazard evaluation report, HETA 97-0106-2770: Sommer-Allibert Industries, USA, Inc., Kansas City, Missouri, December 1999.			
HERO ID:	1317228			
Conditions of Use:	Use of Paints/Coatings			
		EVALUATION		
Domain		Metric	Rating	Comments
	Metric 7:	Metadata Completeness	Medium	Variability was mentioned relative to different sampling locations. Uncertainty was not discussed, but assumed to be addressed in method 3500.
Overall Quality Determination			High	

Study Citation:	Kirk, K. M., Logan, M. B. (2019). Exposures to air contaminants in compartment fire behavior training (CFBT) using particleboard fuel. Journal of Occupational and Environmental Hygiene 16(7):432-439.			
HERO ID:	5432006			
Conditions of Use:	Building and construction materials (firefighting)			
EXTRACTION				
Parameter	Data			
Personal sampling data:	Formaldehyde concentrations in air outside structural firefighting ensembles (from passive sampling) was between 0.53 and 3.2 mg/m3 during 4 compartment fire behavior training (CFBT) sessions. Some of the readings were higher than the Australian short-term exposure limit (15 min STEL) of 2.5 mg/m3. Formaldehyde concentrations in air outside and inside structural firefighting ensembles (from active sampling) were as follows; outside – 1.3 to 2.2 mg/m3; inside – concentration less than reporting limit to 0.2 mg/m3. Exposure standards in Australia is 1.2 mg/m3 compared to that in US (0.92 mg/m3).			
Exposure duration:	nan			
Personal protective equipment:	Each participant donned a structural firefighting ensemble (jacket and overtrousers) (Australian Defence Apparel, Coburg, Australia) constructed of an outer shell of Nomex IIIA (Dupont, Wilmington, DE), a moisture barrier consisting of a breathable polyurethane membrane, and thermal barrier of Sontara E89 (Sontara AG, Basel, Switzerland). Additional personal protective clothing included firefighting gloves, boots, flash hood, and structural firefighting helmet. Selfcontained breathing apparatus was worn for the duration of each session, with an assigned protection factor of 10,000.			
Engineering control:	To minimize contamination, all components of the personal protective clothing were laundered according to manufacturer’s instructions prior to each CFBT session. In addition, instructors who had been involved in other firefighting activities during that work shift showered and changed all clothing (including undergarments) prior to participating in each CFBT session.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data no more than 10 years old
	Metric 5:	Sample Size	Medium	characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
Overall Quality Determination		High		

Study Citation:	Kitwattanavong, M., Prueksasit, T., Morknoy, D., Tunsaringkarn, T., Siriwong, W. (2013). Health risk assessment of petrol station workers in the inner city of Bangkok, Thailand, to the exposure to BTEX and carbonyl compounds by inhalation. Human and Ecological Risk Assessment 19(6):1424-1439.			
HERO ID:	2858419			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Worker activity description:	petrol station workers			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	12.2+/-3.1 ug/m3 mean (range 7.56-18.83 ug/m3)			
Area sampling data:	11.1+/- 2.8 ug/m3 (range 5.31-15.12 ug/m3)			
Exposure duration:	8 hr/day is used in calculation of chronic daily intake (pg. 1428)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	2,4 dinitrophenylhydrazine cartridges and charcoal glass tubes connected to a personal air pump during eight working hours at six petrol stations. The samples were eluted by 5.0 mL of HPLC grade acetonitrile and analyzed by HPLC.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Thailand - not an OECD country
	Metric 3:	Applicability	High	The data are for workers at a petro filling station which is occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The data were published in 2013 based on data from 2010, after the most recent PEL (1992) and approximately 10 years old.
	Metric 5:	Sample Size	High	mean, standard deviation and range provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Metadata included, sample type, exposure type, sample durations, exposure durations, but lacks exposure frequency and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided standard deviation and range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Klein, R.C., King, C., Castagna, P. (2014). Controlling formaldehyde exposures in an academic gross anatomy laboratory. Journal of Occupational and Environmental Hygiene 11(3):127-132.			
HERO ID:	2542464			
Conditions of Use:	Laboratory use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Students and professors and assistants in an academic gross anatomy laboratory			
Exposure route:	Inhalation			
Personal sampling data:	Personal formaldehyde concentrations (ppm)recorded in the laboratory during different periods: between 1996–1999 (Original lab with general room exhaust only) – range - 0.13–1.90 with an average of 0.79 +/- 0.69 and median of 0.64; between 2000–2002 (enhanced lab with general room exhaust only) – range - 0.21–0.67 with an average of 0.50 +/- 0.17 and median of 0.55; between 2003–2012 (new lab with general room and local exhaust) – range - 0.02–0.10 with an average of 0.05 +/- 0.02 and median of 0.06			
Area sampling data:	Area formaldehyde concentrations (ppm) recorded in the laboratory during different periods: between 1996–1999 (Original lab with general room exhaust only) – range - 0.20–2.50 with an average of 0.88 +/- 0.58 and median of 0.67; between 2000–2002 (enhanced lab with general room exhaust only) – range - 0.19–0.70 with an average of 0.49 +/- 0.15 and median of 0.52; between 2003–2012 (new lab with general room and local exhaust) – range - 0.002–0.14 with an average of 0.03 +/- 0.03 and median of 0.02			
Exposure duration:	Results presented were for the duration of the class only (typically 3 hours), and only for those sessions involving initial dissection of the abdominal and thoracic cavities.			
Exposure frequency:	2 sessions/weekly			
Engineering control:	Use of ventilated dissection table and air monitoring			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Medium	Data analyzed ranged from 1996-2012.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Contains most critical metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Does not discuss uncertainty but addresses variability between different laboratory conditions.	
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Formaldehyde

Occupational Exposure

HERO ID: 2542464 Table: 1 of 1

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Study Citation:	Klein, R.C., King, C., Castagna, P. (2014). Controlling formaldehyde exposures in an academic gross anatomy laboratory. Journal of Occupational and Environmental Hygiene 11(3):127-132.		
HERO ID:	2542464		
Conditions of Use:	Laboratory use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Klein, R.C., Schiff, G., Gershey, E.L. (1997). An exhaust hood for animal perfusions. Contemporary Topics in Laboratory Animal Science 36(1):84-86.			
HERO ID:	6105610			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Laboratory workers conducting animal perfusion.			
Exposure route:	inhalation, dermal			
Physical form:	aqueous solution, vapors			
Area sampling data:	”Left side of hood, sash height of 8 in: <0.5 ppm Right side of hood, sash height of 8 in: <0.5 ppm End of hood, sash height of 8 in: <0.5 ppm Left side of hood, sash height of 16 in: 2.71 ppm Right side of hood, sash height of 16 in: 1.33 ppm End of hood, sash height of 16 in: 0.85 ppm Sampler moved in and out of hood, 16 in: 4.91 ppm ”			
Engineering control:	An exhaust hood facilitates perfusion procedures and provides laboratory workers with a high degree of protection against exposures to formaldehyde as well as an inherent barrier against spills or splashes of potentially infectious material. A linear exhaust air flow rate into the hood is required to be 80-100 ft/min			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (averages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at two different exhaust hood sash heights.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 8198674 Table: 1 of 1

Study Citation:	Klincewicz, L., S., Reh, C. M. (1989). HETA 87-411-1972 June 1989 Naval Weapons Support Center Crane, Indiana.			
HERO ID:	8198674			
Conditions of Use:	Electrical and electronic products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Electronic component fabrication, repair, and testing. (1/22)			
Exposure route:	inhalation, dermal (4/22)			
Physical form:	vapor (4/22)			
Area sampling data:	Formaldehyde concentrations in the four buildings were fairly consistent, ranging from 0.02-0.04 ppm. (6/22)			
Exposure duration:	Solderers reported engaging in this operation for a mean of 13.7 hrs/week. Spray painting was reported by 14 workers (19%) for a mean time of 5.6 hrs/week. Twelve employees (16%) used glues an average of 2.4 hrs/week. (5/22)			
Number of workers:	100 employees in an electronic component fabrication building, 44 employees in a general office building. (5/22)			
Engineering control:	In the shop area, soldering operations are performed at work benches without local exhaust ventilation. Spray painting is performed in a separate spray paint booth with an exhaust system vented directly to the outside. (2/22)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for electric and electronic products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure frequency and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 3001774 Table: 1 of 1

Study Citation:	Knight, J.L., Sleeth, D.K., Larson, R.R., Pahler, L.F. (2013). An analysis of OSHA inspections assessing contaminant exposures in general medical and surgical hospitals. Workplace Health & Safety 61(4):153-160.			
HERO ID:	3001774			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Health care worker in general medical and surgical hospitals			
Personal sampling data:	79 personal samples. For all samples (personal and area): Median - 0; mean - 0.1 ppm (SD - 0.40); range - 0-3.1 ppm.			
Area sampling data:	Typical indoor formaldehyde concentrations range from 0.02 to 4 ppm (ATSDR 2008). The range of measured concentrations observed in these hospital data, 0 to 3.10 ppm, is consistent with this. The average concentration of all the formaldehyde samples was 0.1 ppm. 19 area samples.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Unclear if source is peer reviewed but references ATSDR, OSHA and NIOSH when comparing its samples with literature data so likely high quality.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to hospital and healthcare workers.
	Metric 4:	Temporal Representativeness	Medium	Data from 2005-2009.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Worker activity and personal/area samples provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Koda, S., Kumagai, S., Ohara, H. (1999). Environmental monitoring and assessment of short-term exposures to hazardous chemicals of a sterilization process in hospital working environments. Acta Medica (Hradec Králové) 53(5):217-223.			
HERO ID:	56714			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	pathology (dissection)			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.70 - 1.61 ppm; Large specimen storage & dissection 2.3 mean (range 0.8-5.0 ppm) peaks during dissection 8.6 ppm			
Area sampling data:	Pathology using at hospital A (no large specimen storage); 0.3 mean (range: 0.2-0.4 ppm)			
Exposure frequency:	2-3/week			
Number of workers:	5			
Engineering control:	recommended using local exhaust ventilation systems at work stations where formalin is used. when the technician opened a window concentration delcined from 8.6 ppm to 0.6-1.0 ppm, when the window was closed concentration increased to 6.3 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology may be equivalent to an approved OSHA or NIOSH method. For this study a photoacoustic infra-red detection method was used (Bruel & Kjaer Multi-gas monitor Type 1303) employing optical files type UA-0986 for formaldehyde. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Japan - OECD member
	Metric 3:	Applicability	High	The data are for pathology labs which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1999, after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by an average value and range with uncertainty was not discussed.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, and/or exposure durations.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	reproducibility was quantified as the coefficient of variation (0.02-0.03) and data from different hospitals were included to address variability between facilities., but uncertainty was not discussed.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 56714 Table: 1 of 1

...continued from previous page			
Study Citation:	Koda, S., Kumagai, S., Ohara, H. (1999). Environmental monitoring and assessment of short-term exposures to hazardous chemicals of a sterilization process in hospital working environments. Acta Medica (Hradec Králové) 53(5):217-223.		
HERO ID:	56714		
Conditions of Use:	Laboratory Use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Koda, S., Kumagai, S., Toyota, M., Yasuda, N., Ohara, H. (1998). Occupational exposure to hazardous chemicals and work environment controls in hospitals. International Congress Series 1153:1172-1177.			
HERO ID:	1321971			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.3-8 (ppm)			
Engineering control:	General ventilation system were 12.5 air changes/h (hospital A) and 18.0 air changes/h (hospital B).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by comparing 2 hospitals but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Kokotti, H., Hakkinen, E., Tapola, M., Kalliokoski, P. (1993). Control of exposure to formaldehyde during dissection work by means of local exhaust ventilation system. :151-154.			
HERO ID:	5944780			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Medical students during dissection courses.			
Exposure route:	inhalation			
Personal sampling data:	The levels of personal samples varied from 0.1 to 0.2 mg/ml in the test room and 0.4 to 1.7 mg/ml in the dissection rooms.			
Area sampling data:	The formaldehyde levels of stationary samples varied from 0.03 to 0.24 mg/ml in the test room and 0.24 to 0.56 mg/m3 in the dissection rooms.			
Engineering control:	A new exhaust system was built for this experiment. The dissection table included two platforms: inner and upper one. The edges of the removable upper platform were bent over the edges of the inner one, and there were more holes in the edges near heavy parts of a body than near the feet. The formaldehyde-containing air is sucked through these holes in the edges into the space between the upper and inner platforms. From this space, exhaust air is directed to the duct below the floor under the table. The supply air is divided from ceiling to room diffusively and slightly undertempered. The fresh airflow helps to control the disturbance flows caused by motion of 10-15 students.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL but greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by sampling in two different lab settings. Uncertainty isn’t addressed.
Overall Quality Determination		Medium		

Study Citation:	Kominsky, J. R., Stroman, R. E. (1977). Health Hazard Evaluation Determination, Report No. HHE-77-15-421, Leed and Northrup Corporation, Expendable Devices Division Ellwood City, Pennsylvania. NIOSH:77-15.			
HERO ID:	1322862			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Worker activity description:	The shell core machine personnel are concurrently exposed to multiple chemical contaminants (including formaldehyde) evolved from the curing and thermal decomposition of the synthetic based sand binder system. (Page 3 of 25)			
Exposure route:	Inhalation (Page 8 of 25), Dermal (Page 9 of 25)			
Physical form:	Gas for inhalation (Page 8 of 25), liquid solutions or solid materials or resins containing free formaldehyde for dermal (Page 9 of 25)			
Personal sampling data:	See page 10 of 25 for discussion, and Table 3 on page 20 of 24 for personal sampling results which ranged from 0.03 to 0.13 ppm			
Area sampling data:	See Table 5 (page 21 of 25) for measurements at three stationary sampling locations, the results of which ranged from 0.07 to 0.78 ppm.			
Exposure duration:	8 hour work shift (Page 2 of 25)			
Engineering control:	There are canopy hoods at the core packing station and over the two shell core machines, and an approximately 12 to 18 inch diameter fan, positioned on the core packers work table, minimized the packers exposure to the volatile effluents. (Page 12 of 25)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	In USA
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1977
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		High		

Study Citation:	Kominsky, J. R., Wilcox, T., Lucas, C. (1987). Health Hazard Evaluation Report HETA 83-015-1809, Wellman Dynamics Corporation, Creston, Iowa, July, 1987.			
HERO ID:	1271641			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Furnace tendersand molderssand mixerscore makersmetal pourersshakeoutcore knockout operatorFurnace tenderwelder			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Range in 5 coremaking areas 0.11 to 42 mg/m3 (arithmetic mean =0.26 mg/m3)The concentrations of formaldehyde measured in the furnace tenders and new core knockout operators ranged from 0.19 to 0.23 mg/m3.			
Personal protective equipment:	Respirator			
Engineering control:	General and mechanical exhaust ventilation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study P&CAM 354
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Study implemented in 1983 prior to PEL (1992).
	Metric 5:	Sample Size	High	Results from individual sampling events provided, these data can be used to generate a variety of statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, sample durations, but missing exposure durations, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Results from individual sampling events provided, these data can be used to perform an analysis of variance between sampling events, jobs and locations. Uncertainty is not addressed.
Overall Quality Determination		High		

Study Citation:	Konopinski, V.J. (1983). Formaldehyde In Office And Commercial Environments. American Industrial Hygiene Association Journal 44(3):205-208.			
HERO ID:	1316673			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	office workers			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Case A: 0.02-0.03 ppm (the report included data for each office /store room tested for different testing days.			
Number of workers:	2-20 office workers			
Engineering control:	sealing exposed fiberboard, increasing ventilation rates and cleaning with amonia			
Comments:	Subject to other regulations			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	OSHA Method VI-4 and NIOSH method 125 (chromotropic acid procedure
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for office workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were published in 1983, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	for two of the 4 locations, sampling results were provided for individual offices for multiple sampling days. one of the remaining sites provided range data and the other site had single values.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	There were data for four different sites, additionally for three of the sites range data were provided for different offices and different sampling days, that that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Koppers, (1979). Status report of industrial hygiene monitoring at the Bridgeville, Pennsylvania, plant chemical division, organic materials group.			
HERO ID:	1480906			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	Amino resin operator			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	PEAK : Amino resin operator: 2 ppm; Assistant resin operator 0.7 ppm			
Area sampling data:	PEAK: Amino resin operator: range 0.8-1 ppm;			
Personal protective equipment:	Respiratory protection must be provided when worker irritation complaints are made for specific operations in specific areas until repeat monitoring can be performed.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified. Furthermore, it is noted in the appendix that "No personal TWA (Time-Weighted Average) exposure specimens obtained due to lack of a proven. acceptable method for long-term measurement" even though breathing zone results are provided and individuals involved in the personal formaldehyde sampling are named. Instead, it is stated that area measurements performed with Drager detector tubes; (Tubes have been submitted for NIOSH certification.) Time-weighted average work area concentrations were computed from a series of random measurements.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for production of amino resin which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were published in 1979, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	For personal sampling peak values are provided while range data are provided form area sampling.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, but lacks additional metadata, such as exposure duration, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	For peak area sampling range data are provided which can be used to estimate variability, but no information is provided regarding uncertainty.

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Formaldehyde

Occupational Exposure

HERO ID: 1480906 Table: 1 of 1

...continued from previous page			
Study Citation:	Koppers, (1979). Status report of industrial hygiene monitoring at the Bridgeville, Pennsylvania, plant chemical division, organic materials group.		
HERO ID:	1480906		
Conditions of Use:	Processing as a reactant		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Korczynski, R.E. (1994). Formaldehyde exposure in the funeral industry. Applied Occupational and Environmental Hygiene 9(8):575-579.			
HERO ID:	627059			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Worker activity description:	embalming and premixing (concentrations of solutions associated with premixing given on PDF pg. 2/4)			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Personal Sampling: intact body 0.78 mg/m3 mean (range 0.12-5.64 mg/m3; SD 1.06); Autopsy 0.80 mg/m3 mean (range 0.11-4.13 mg/m3; SD 0.96) premixing 17.74 mg/m3			
Area sampling data:	Area Sampling: 0.61 mg/m3 mean (range 0.05-8.37 mg/m3; SD 1.24);			
Exposure duration:	Intact: up to 1 hr per embalming event; Autopsy 2 hours or longer; premixing: 15 min.			
Exposure frequency:	per embalming event (36)			
Personal protective equipment:	and respirators, gloves and proactive clothing, shoe covers and googles			
Engineering control:	down draft ventilation; premixing: wall exhaust fan.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH 3500 methods
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - OECD member
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after PEL - Article published in 1994
	Metric 5:	Sample Size	Medium	Monitoring data are greater than 20 years old but after PEL - Article published in 1994
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	'Metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Korhonen, K., Liukkonen, T., Ahrens, W., Astrakianakis, G., Boffetta, P., Burdorf, A., Heederik, D., Kauppinen, T., Kogevinas, M., Osvoll, P., Rix, B.A., Saalo, A., Sunyer, J., Szadkowska-Stanczyk, I., Teschke, K., Westberg, H., Widerkiewicz, K. (2004). Occupational exposure to chemical agents in the paper industry. International Archives of Occupational and Environmental Health 77(7):451-460.			
HERO ID:	1321973			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	air			
Area sampling data:	Short term samples from 5 locations (pulping, paper machines, calendering, winding, re-pulping): Pulping, refining, etc mean 0.5 ppm short term; Newsprint and uncoated paper machine mean 0.15 short term; Fine and coated paper machine mean 1.1 ppm short term; paperboard machine mean 0.52 ppm short term; Paper/paperboard machine from more than one categories mean 0.37 ppm short term; Calendering or on-machine coating mean 4.2 ppm short term; Winding, cutting, grading, etc mean 0.2 ppm short term; Re-pulping of waste paper mean 0.21 ppm short term;			
Comments:	This article summarizes the results of 3,873 measurements carried out in the production departments of paper and paperboard mills and recycling plants in 12 countries.... a team of industrial hygienists has integrated the measurements in the database with mill-specific information from the questionnaires answered by the participating companies, to create a pulp and paper department-exposure matrix (PAPDEM) for 25 major exposure agents... A description of this matrix and a summary of exposure estimates have been published elsewhere (Kauppinen et al. 2002).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from 12 countries, each are in the OECD.
	Metric 3:	Applicability	High	Data are for pulp and paper industry, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Most of the measurements were from 1980 to 1994, therefore most monitoring data were collected prior to the most recent PEL (1992). Publication 2004.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (e.g., min, max, mean, median, %not detected) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Korky, J. K., Schwarz, S. R., Lustigman, B. K. (1987). Formaldehyde concentrations in biology department teaching facilities. Bulletin of Environmental Contamination and Toxicology 38(5):907-910.			
HERO ID:	6128806			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Students and faculty in biology laboratories, and custodians who clean these laboratories.			
Exposure route:	inhalation and dermal (1/4)			
Physical form:	gas (1/4)			
Area sampling data:	"Teaching lab, trial 1: 7.0 ppm Teaching lab, trial 2: 16.5 ppm Rear stock room, trial 1: 1.97 ppm Rear stock room, trial 2: 2.62 ppm Public hallway, trial 1: <1.0 ppm Public hallway, trial 2: <1.0 ppm" (2/4)			
Engineering control:	"Airborne levels of formaldehyde vapor may be maintained below recommended exposure standards by a properly designed ventilation system. A cost effective method of removing large volumes of contaminated air from Site I would involve the installation of window exhaust fans. This would eliminate excessive chilling caused by open windows. A more effective but costly method would be to control emissions at the source by Installation of exhaust hoods. These hoods control the hazardous vapors before they reach individuals at risk, while permitting access to work. The contaminant would then be removed from the hood’s airstream by an activated charcoal filter prior to the air being vented from the building. Finally, vendors of dissection specimens should be encouraged to develop nonhazardous methods of preservation." (3/4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at three locations around a biology laboratory, and by discussing the effects of weather.
Overall Quality Determination		High		

Study Citation:	Koziel, J.A., Noah, J., Pawliszyn, J. (2001). Field sampling and determination of formaldehyde in indoor air with solid-phase microextraction and on-fiber derivatization. Environmental Science and Technology 35(7):1481-1486.			
HERO ID:	3732799			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Number of sites:	3 sites			
Physical form:	indoor air pollutant			
Area sampling data:	Chemical store main office: 33ppbv.... Paint shop in engineering shop: 59ppbv... Small office in office building: 81ppbv			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3:	Applicability	Medium	Data are for occupational and indoor settings, which is similar to the in-scope occupational scenario for use as chemical substance in products.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing data related to worker activity and exposure duration.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Kreiss, K., Cox-Ganser, J. (1997). Metalworking fluid-associated hypersensitivity pneumonitis: A workshop summary. American Journal of Industrial Medicine 32(4):423-432.			
HERO ID:	6015434			
Conditions of Use:	Metal products manufacturing			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.03-0.08 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Data were compiled by NIOSH staff; therefore, sampling/analytical methodology is assumed to be equivalent to an approved NIOSH method.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for metal product manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Sample type provided but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Kriebel, D., Myers, D., Cheng, M., Woskie, S., Cocanour, B. (2001). Short-term effects of formaldehyde on peak expiratory flow and irritant symptoms. Archives of Environmental Health 56(1):11-18.			
HERO ID:	626926			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	student			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Average exposure for duration of the study 1.1 ppm (SD 0.56 ppm median 0.97 ppm) 0.7 ppm geometric meand (GSD 2.13 ppm) peak 10.91 ppm			
Exposure duration:	2.5 hours			
Exposure frequency:	14 weeks			
Number of workers:	38			
Personal protective equipment:	followup - the lab switched to embalng fluid with lower formaldehyde concentration			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it was noted that Area B&K 1302 Miltiple Gas monitor sampling was implemented for each location every 12 minutes
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	Data are for student exposure to embalming fluids is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2001
	Metric 5:	Sample Size	Medium	Sample distribution characterized by mean , geometric mean, median, standard deviation but discrete samples not provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, geometric range median values and trends that show daily samples, but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Kriebel, D., Sama, S. R., Cocanour, B. (1993). Reversible pulmonary responses to formaldehyde. A study of clinical anatomy students. American Review of Respiratory Disease 148(6):1509-1515.			
HERO ID:	626977			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Anatomy students			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.73+/- 1.22 ppm geometric mean (range 0.49 - 0.93 ppm)			
Exposure duration:	3 hr per week			
Exposure frequency:	10 weeks			
Number of workers:	24			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH 2541 and 3500 methods were used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data from US.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after PEL - Article published in 1993
	Metric 5:	Sample Size	Medium	Sample distribution characterized by mean , geometric mean, standard deviation but discrete samples not provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing details about sampling and analysis
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, geometric range, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Kring, E.V., Ansul, G.R., Basilil, A.N., McGibney, P.D., Stephens, J.S., O’Dell, H.L. (1984). Sampling for formaldehyde in workplace and ambient air environments - additional laboratory validation and field verification of a passive air monitoring device compared with conventional sampling methods. AIHA Journal 45(5):318-324.			
HERO ID:	24662			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Large midwest chemical plant range 0.08 to 0.53 ppm; Textile mill range from 0.16 to 0.53 ppm;			
Area sampling data:	large midwest chemical plant range 0.14 to 1.32 ppm; textile mill range 0.19 to 1.54 ppm; residential 0.23 to 1.03			
Comments:	The primary goal was to demonstrate that Dupont Pro-Tek formaldehyde badges meet NIOSH and OSHA accuracy requirements, not necessarily to obtain representative samples of exposure.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	This study was to demonstrate that Dupont Pro-Tek formaldehyde badges meet NIOSH and OSHA accuracy requirements.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The primary goal was to demonstrate that Dupont Pro-Tek formaldehyde badges meet NIOSH and OSHA accuracy requirements, not necessarily to obtain representative samples of exposure.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1984, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Actual results for sampling periods were provided, but note that the primary goal was to demonstrate that Dupont Pro-Tek formaldehyde badges meet NIOSH and OSHA accuracy requirements, not necessarily to obtain representative samples of exposure.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata were provided such as worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Actual results for sampling periods were provided to allow for analysis of variability, this study was to demonstrate that Dupont Pro-Tek formaldehyde badges meet NIOSH and OSHA accuracy requirements.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 24662 Table: 1 of 1

...continued from previous page			
Study Citation:	Kring, E.V., Ansul, G.R., Basilil, A.N., McGibney, P.D., Stephens, J.S., O'Dell, H.L. (1984). Sampling for formaldehyde in workplace and ambient air environments - additional laboratory validation and field verification of a passive air monitoring device compared with conventional sampling methods. AIHA Journal 45(5):318-324.		
HERO ID:	24662		
Conditions of Use:	Multiple		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 6022586 Table: 1 of 1

Study Citation:	Krivanek, N. D., Imbus, H. R. (1992). Formaldehyde: Studies on irritation at low levels. Comments on Toxicology 4(4):315-330.			
HERO ID:	6022586			
Conditions of Use:	Various			
EXTRACTION				
Parameter	Data			
Area sampling data:	Workers in operations using hexamethylene tetramine-resorcinol adhesives: 0.5ppm... Industrial setting where acrylic wool filters impregnated with phenol-formaldehyde resin: 0.4ppm to 13.6ppm ... Workers exposed to formaldehyde and wood dust had formaldehyde levels range between 0.04ppm to 0.4ppm... Workers in Indonesian plywood manufacturing operation exposed to average formaldehyde level of 1.13ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Indonesia, a non-OECD country, or are from an unknown location.
	Metric 3:	Applicability	High	Data are for use in resins or processing wood products, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Report was 1992 and data cited was from before that date
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low		

Study Citation:	Kulle, T.J., Sauder, L.R., Hebel, J.R., Green, D.J., Chatham, M.D. (1987). Formaldehyde dose-response in healthy nonsmokers. Journal of the Air and Waste Management Association (1990-1992) 37(8):919-924.			
HERO ID:	23225			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	<0.1->5.0 ppm			
Exposure duration:	3 hours			
Exposure frequency:	5 times			
Number of workers:	19 people studied			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Low	too broad
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - 1987
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	only a range was provided for variability but nothing for uncertainty.
Overall Quality Determination		Low		

Study Citation:	Kullman, G. J. (1989). Health Hazard Evaluation Report HETA 88-269-1993, Meyersdale Manufacturing Co., Meyersdale, Pennsylvania, October 1989.			
HERO ID:	1317472			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Worker activity description:	cutting; sewing; fusing; pressing; inspections; cleaning boxing.			
Exposure route:	inhalation			
Physical form:	gas (study sampled with prefilter and with no prefilter, which resulted in similar results. Study states that this confirms formaldehyde presence as a gas and not leached from airborne cloth particulates or threads).			
Area sampling data:	Ranges below for each location, report contains discrete values in table 2Assembly Joining 0.08-0.13 ppmAssembly Felling 0.10-0.16 ppmGeometric Mean 0.12 TWA ppm / GSD 1.3 Summer Geometric Mean 0.09 TWA ppm /GSD 1.1Winter Geometric Mean 0.14 TWA ppm /GSD 1.1Small Parts Darts 0.06-015 ppmSmall Parts Collars 0.07 ppmSmall Parts Auto Band Creaser 0.10-0.17 ppmGeometric Mean 0.11 TWA ppm / GSD 0.15Summer Geometric Mean 0.08 TWA ppm /GSD 1.2Winter Geometric Mean 0.15 TWA ppm /GSD 1.1Fusing Collars 0.16-0.23 ppmFusing Creasing 0.14 ppmGeometric Mean 0.18 TWA ppm / GSD 1.3 Winter Geometric Mean 0.15 TWA ppm /GSD 1.3Spreading/cutting Cutter 0.07 ppmSpreading/cutting Spreader 0.03-0.09 ppmGeometric Mean 0.06 TWA ppm / GSD 1.6 Summer Geometric Mean 0.06 TWA ppm /GSD 1.6Folding Folder 0.04-0.10 pmGeometric Mean 0.05 TWA ppm / GSD 1.7Summer Geometric Mean 0.04 TWA ppm /GSD 1.0Winter Geometric Mean 0.10 TWA ppmPressing Presser 0.04-0.12Geometric Mean 0.07 TWA ppm / GSD 1.6Summer Geometric Mean 0.05 TWA ppm /GSD 1.1Winter Geometric Mean 0.11 TWA ppm /GSD 1.1Trim/Inspector 0.04-0.09 ppmGeometric Mean 0.07 TWA ppm / GSD 1.4Summer Geometric Mean 0.05 TWA ppm /GSD 1.4Winter Geometric Mean 0.09 TWA ppm /GSD 1.1Boxing Boxer 0.07 ppmGeometric Mean 0.07 TWA ppmSummer Geometric Mean 0.07 TWA ppm Receiving Geometric Mean 0.07 TWA ppmWinter Geometric Mean 0.07 TWA ppm			
Dermal exposure data:	nan			
Number of workers:	130			
Personal protective equipment:	Gloves or creamsLong sleeve apparel			
Engineering control:	Use of low formaldehyde fabricsExpansion of HVAC systemIncrease outside air intake3 week curing period.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (apparel manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1988-89: prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, and worker activities, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency.
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1317472 Table: 1 of 1

...continued from previous page

Study Citation:	Kullman, G. J. (1989). Health Hazard Evaluation Report HETA 88-269-1993, Meyersdale Manufacturing Co., Meyersdale, Pennsylvania, October 1989.			
HERO ID:	1317472			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. As this is a NIOSH study, it is assumed that uncertainty was considered in Method 3500.
Overall Quality Determination			High	

Study Citation:	Kullman, G. J., Stark, G. (1987). Health Hazard Evaluation Report HETA-87-0193-1865 Clarksburg Publishing Company, Clarksburg, West Virginia.			
HERO ID:	8245854			
Conditions of Use:	Ink, toner, and colorant products; Photographic supplies			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees are involved in the production of the local newspaper. In addition to normal office activities, the building contains a printing press, a photography/developing department, a photoengraving plate department, and a small print shop. (4/25)			
Exposure route:	inhalation (10/25)			
Physical form:	vapors (10/25)			
Area sampling data:	Formaldehyde concentrations were 0.003 ppm in the newsroom, display room, and circulation room, and 0.002 ppm in the ambient air. (22/25)			
Number of workers:	124 workers over two shifts. (4/25)			
Engineering control:	The HVAC system is the primary source for outside air supply. The building has five separate ventilation systems. (10/25)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for ambient air in a newspaper printing office, which is similar to the in-scope occupational scenario of ink, toner, and colorant products.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure duration, frequency and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Kurose, T., Kodera, H., Aoyama, H., Kawamata, S. (2004). Formaldehyde concentration in the air and in cadavers at the gross anatomy laboratory in Hiroshima University. Hiroshima Journal of Medical Sciences 53(3-4):33-37.		
HERO ID:	4263995		
Conditions of Use:	Laboratory use		
EXTRACTION			
Parameter	Data		
Worker activity description:	Participants in a gross anatomy course at the Faculty of Medicine of Hiroshima University.		
Area sampling data:	Atmospheric formaldehyde levels were 0.25-0.55 ppm and less than the upper limit of the guideline for formaldehyde exposure (0.5 ppm) set by the Japan Society for Occupational Health, except for one out of 10 measurements. For the first measurements when the skin of the upper limbs and trunk was removed, the formaldehyde concentration at the center of the room before and 15 min after the start of dissection was 0.05 and 0.55 ppm, respectively, and the levels at the four corners of the room were 0.37, 0.35, 0.35, and 0.3 ppm. For the second measurements, when all thoracic cavities and most abdominal cavities had been opened, the levels were 0.3 ppm at the center of the room and 0.3, 0.3, 0.3, and 0.25 ppm at the 4 corners. At the end of the day, the formaldehyde concentration was 0.15 ppm.		
Engineering control:	Dissection tables with local exhaust ventilation can markedly reduce airborne formaldehyde. Another option is use of ammonium carbonate to neutralize formaldehyde and forming harmless hexamethylenetetramine, and infusion of 2 liters of saturated ammonium carbonate solution drastically reduces formaldehyde levels in formaldehyde-prefixed cadavers.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from an OECD country. other than the U.S.
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Medium	Data are more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Monitoring study does not address uncertainty but variability addressed by measuring at different process stages.
Overall Quality Determination		Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Scientific research and development			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-1.5 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country, other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of electrical equipment			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-32.9 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S. The data are for an occupational scenario within the scope of the risk evaluation. Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old. Distribution of samples is characterized by a range with uncertain statistics.
	Metric 3:	Applicability	High	
	Metric 4:	Temporal Representativeness	Medium	
	Metric 5:	Sample Size	Medium	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of pulp, paper and paper products			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-2.384 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S. The data are for an occupational scenario within the scope of the risk evaluation. Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old. Distribution of samples is characterized by a range with uncertain statistics.
	Metric 3:	Applicability	High	
	Metric 4:	Temporal Representativeness	Medium	
	Metric 5:	Sample Size	Medium	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of rubber and plastic products			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-0.990 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S. The data are for an occupational scenario within the scope of the risk evaluation. Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old. Distribution of samples is characterized by a range with uncertain statistics.
	Metric 3:	Applicability	High	
	Metric 4:	Temporal Representativeness	Medium	
	Metric 5:	Sample Size	Medium	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of fabricated metal products, except machinery and furniture			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-2.010 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of other non-metallic mineral products			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-26.8 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Human health service			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-25.3 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S. The data are for an occupational scenario within the scope of the risk evaluation. Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old. Distribution of samples is characterized by a range with uncertain statistics.
	Metric 3:	Applicability	High	
	Metric 4:	Temporal Representativeness	Medium	
	Metric 5:	Sample Size	Medium	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of other machinery and equipment			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-7.711 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of furniture and others			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-4.152 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S. The data are for an occupational scenario within the scope of the risk evaluation. Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old. Distribution of samples is characterized by a range with uncertain statistics.
	Metric 3:	Applicability	High	
	Metric 4:	Temporal Representativeness	Medium	
	Metric 5:	Sample Size	Medium	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of textiles, except apparel			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-16.8 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S. The data are for an occupational scenario within the scope of the risk evaluation. Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old. Distribution of samples is characterized by a range with uncertain statistics.
	Metric 3:	Applicability	High	
	Metric 4:	Temporal Representativeness	Medium	
	Metric 5:	Sample Size	Medium	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of electrical components, audio, visual and communication equipment			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-1.443 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of basic metal products			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-45.706 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.	
Overall Quality Determination		Medium		

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of wood products of wood and cork; except furniture			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-62.479 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of motor vehicles, trailers and semitrailers			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-41.543 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Manufacture of chemicals and chemical products			
EXTRACTION				
Parameter	Data			
Area sampling data:	0-25.598 ppm GM (Table 2, 3/13)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S. The data are for an occupational scenario within the scope of the risk evaluation. Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old. Distribution of samples is characterized by a range with uncertain statistics.
	Metric 3:	Applicability	High	
	Metric 4:	Temporal Representativeness	Medium	
	Metric 5:	Sample Size	Medium	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Ambulatory care units at hospitals			
EXTRACTION				
Parameter	Data			
Personal sampling data:	0.001-0.258 ppm (8 hr) GM(table 3, 4/13)			
Exposure duration:	nan			
Number of workers:	62 workers at 8 units			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.				
HERO ID:	4271845				
Conditions of Use:	Furniture manufacturing				
EXTRACTION					
Parameter		Data			
Area sampling data:		2.70 ppm at 150C GM(table 3, 4/13)			
EVALUATION					
Domain		Metric	Rating	Comments	
Domain 1: Reliability		Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness		Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
		Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
		Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
		Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium		

Formaldehyde

Occupational Exposure

HERO ID: 4271845 Table: 18 of 21

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Tire manufacturing			
EXTRACTION				
Parameter	Data			
Personal sampling data:	Personal 0.029 (0.027-0.029) ppm (8 hr) GM(table 3, 4/13)			
Exposure duration:	nan			
Number of workers:	12 workers at 2 hospitals			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Endoscopy unit at hospital			
EXTRACTION				
Parameter	Data			
Personal sampling data:	0.003-0.923 ppm (8 hr); 0.103-14.773 (15 min) GM(table 3, 4/13)			
Exposure duration:	nan			
Number of workers:	48 workers at 4 hospitals			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 4271845 Table: 20 of 21

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Anatomy laboratory at a college			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.26-3.91 ppm GM(table 3, 4/13)			
Exposure duration:	nan			
Number of workers:	80 students at 1 lab			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Kwon, S.C., Kim, I., Song, J., Park, J. (2018). Does formaldehyde have a causal association with nasopharyngeal cancer and leukaemia?. Annals of occupational and environmental medicine 30:5.			
HERO ID:	4271845			
Conditions of Use:	Histological laboratories in hospitals			
EXTRACTION				
Parameter	Data			
Personal sampling data:	0.02-3.86 ppm (8 hr); 0.59-5.01 ppm (15 min) GM(table 3, 4/13)			
Area sampling data:	0.08-1.49 ppm (8 hr); 0.31-4.24 ppm (15 min)			
Exposure duration:	nan			
Number of workers:	19 workers in 9 labs			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Ladeira, C., Viegas, S., Carolino, E., Prista, J., Gomes, M.C., Brito, M. (2011). Genotoxicity biomarkers in occupational exposure to formaldehyde—the case of histopathology laboratories. Mutation Research 721(1):15-20.			
HERO ID:	1239491			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Macroscopic specimen exam; disposal of specimen and used solution; jar filling; specimen wash; biopsy exam			
Area sampling data:	0.04-0.51 (ppm); Ceiling: 0.18-2.93 (ppm)			
Number of workers:	56			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method. (NIOSH method 2541)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Portugal, an OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE, exposure frequency, exposure duration.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling multiple worker activities.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 2592890 Table: 1 of 1

Study Citation:	Laitinen, J., Mäkelä, M., Mikkola, J., Huttu, I. (2010). Fire fighting trainers’ exposure to carcinogenic agents in smoke diving simulators. Toxicology Letters 192(1):61-65.			
HERO ID:	2592890			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	firefighters			
Exposure route:	inhalation			
Area sampling data:	The emissions of formaldehyde were the highest in the gas simulator. Formaldehyde concentrations (mg/m3) in air due to burning materials were: Firehouse, chipboard – 0.7; Firehouse, conifer plywood board – 1.5; Firehouse, pure spruce and pine wood – 0.3; Gas simulator – 11. The reason for this was probably the artificial smoke, which was produced by mineral oil in the smoke generator. Pure spruce and pine wood seemed to be the best material according to these results. Formaldehyde has also been found to be a problem in wild land fires, where the highest measured formaldehyde concentrations have been over the occupational exposure limit value of 0.37mg/m3.			
Dermal exposure data:	Dermal exposure data			
Exposure duration:	nan			
Number of workers:	3 fire house simulators were used and 4 smoke diving trainers participated in each fire house simulator test. One gas simulator test was conducted and 2 smoke diving trainers participated in that test.			
Personal protective equipment:	protective clothing, including protective fire suits, fire gloves, and compressed air line breathing protectors.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	method well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 2578007 Table: 1 of 1

Study Citation:	Lakchayapakorn, K., Watchalayarn, P. (2010). Formaldehyde exposure of medical students and instructors and clinical symptoms during gross anatomy laboratory in Thammasat University. Journal of the Medical Association of Thailand 93(Suppl. 7):S92-S98.			
HERO ID:	2578007			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Dissection of organ systems and nervous systems in anatomy laboratory			
Exposure route:	Inhalation			
Personal sampling data:	0.472 to 0.848 ppm (mean 0.660 +- 0.188)			
Area sampling data:	0.401 to 0.581 ppm (mean 0.491 +- 0.090)			
Exposure duration:	3 anatomy class time			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Data collected from more than 10 years ago but less than 20 years ago.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed but variability addressed by evaluating different classes.
Overall Quality Determination		Medium		

Study Citation:	Lamplugh, A., Harries, M., Xiang, F., Trinh, J., Hecobian, A., Montoya, L.D. (2019). Occupational exposure to volatile organic compounds and health risks in Colorado nail salons. Environmental Pollution 249:518-526.			
HERO ID:	5077873			
Conditions of Use:	Personal care products (nail salons)			
EXTRACTION				
Parameter	Data			
Number of sites:	6 in study			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	8 hr averages: Table 3 (pg 5): 5.32 - 20.6 ppm (6 values presented, 1 per each salon, unsure if average of multiple samples or what)			
Exposure duration:	up to 10 hours (9 am to 7 pm business hours) (pg 2)			
Number of workers:	3-5 for each salon, 20 total (pg 2)			
Personal protective equipment:	Seventy percent of all workers reported wearing either nitrile or latex gloves, with 65% wearing latex gloves. Sixty-five percent reported wearing some type of facemask when performing nail services, with 55% wearing surgical style facemasks. No workers reported wearing N95 dust masks. (pg 5)			
Comments:	Sampling location: 1 near manicure/pedicure stations, 1 at opposite end of salon (pg 3)Analytic Method: Indoor formaldehyde levels were measured using DNPH-Silica cartridges analyzed with High-Performance Liquid Chromatography (HPLC), according to US EPA Method TO-11A (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved EPA method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Nail products for both home and salon use are regulated by the Food and Drug Administration. Under the Federal Food, Drug, and Cosmetic Act (FD&C Act), these products are generally regulated as cosmetics [FD&C Act, section 201(i)].
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (assumed mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple salons, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 2533122 Table: 1 of 1

Study Citation:	Lan, Q., Smith, M.T., Tang, X., Guo, W., Vermeulen, R., Ji, Z., Hu, W., Hubbard, A.E., Min, S., Mchale, C.M., Qiu, C., Liu, S., Reiss, B., Freeman, L.B., Blair, A., Ge, Y., Xiong, J., Li, L., Rappaport, S.M., Huang, H., Rothman, N., Zhang, L. (2015). Chromosome-wide aneuploidy study (CWAS) of cultured circulating myeloid progenitor cells from workers occupationally exposed to formaldehyde. Carcinogenesis 36(1):160-167.			
HERO ID:	2533122			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	The median (10th, 90th percentile) formaldehyde air exposure level in the 29 exposed workers was 1.38 (0.78, 2.61) ppm as an 8-h time-weighted average while in the controls the level was 0.026 (0.015, 0.026) ppm.			
Number of workers:	29 workers who were exposed to formaldehyde and 23 unexposed controls			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data collected in non-OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is less than 10 years old but data was collected more than 10 years ago.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Lavoue, J., Beaudry, C., Goyer, N., Perrault, G., Gerin, M. (2005). Investigation of determinants of past and current exposures to formaldehyde in the reconstituted wood panel industry in Quebec. Annals of Occupational Hygiene 49(7):587-602.			
HERO ID:	492149			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Table 1 provides details about worker activities in 12 sites			
Exposure route:	inhalation			
Physical form:	Vapor			
Personal sampling data:	personal measurements 0.17 ppm (GSD 2.3 ppm)(Table 3 is for personal sampling and Table 5 combines personal and area monitoring)			
Area sampling data:	Formaldehyde concentrations are provided for OSB/ MDF, and PB processes for research and government projects for specific worker designations . The geometric mean for that area measurements is 0.28 ppm (GSD 3.1ppm)			
Exposure duration:	Sampling duration for personal monitoring was 4.8 hrs median for research and 5.9 hrs for Government			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it was noted that 2-hydroxymethylpiperidine impregnated solid tubes/ extracted with carbon disulfide analysis GC - nitrogen Phosphorus detection. Earlier government studies used impinger using dinitrophenylhydrazine and perchloric acid using liquid chromatography; solid sorbent tube impregnated with n-benzylethanolamine analyzed with GC NPD were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sampling/analytical methodology is not specified.
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Published in 2005 but data range from 1984 to 2002
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Geometric mean , geometric SD and sample size was provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	The data came from multiple studies so meta data appeared to be difficult to compile. Missing: Exposure frequency, number of workers and sampling locations
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variance is discussed there was some discussion of uncertainty related to the differences between older government surprise visits vs more recent planned research visits
Overall Quality Determination		Medium		

Study Citation:	Lavoue, J., Begin, D., Beaudry, C., Gerin, M. (2007). Monte Carlo simulation to reconstruct formaldehyde exposure levels from summary parameters reported in the literature. Annals of Occupational Hygiene 51(2):161-172.			
HERO ID:	492150			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Personal measurements reported in reviewed data sources were classified into the following exposure groups: group 1 ‘Office’ includes administration and foremen; group 2 ‘Maintenance-quality control’ includes laboratory technicians, maintenance workers and cleaners; group 3 ‘Production’ includes press operators, assistant press operators, finishers, shippers; and group 4 ‘Floater’ includes floaters and press-miscellaneous tasks			
Exposure route:	inhalation			
Physical form:	Vapor			
Personal sampling data:	Personal measurements (including simulated values) had a geometric median of 0.53 mg/m3 GSD 2.8. See Also Table 2.			
Area sampling data:	Area monitoring data (including simulated values) gemetric median of 0.79 mg/m3 and GSD of 4.36 , these values varied by study year			
Exposure duration:	Sampling duration varied by study ranging from unknown to up to 6 hrs			
Comments:	The following is stated in the data source: ”more extensive simulation studies should be conducted to fully evaluate the methods presented here”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - OECD member
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Published in 2007 includes data from 13 studies that were implemented from 1965-1995
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics -Geometric mean , geometric SD and sample size provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Missing: sampling/ analysis methods, number of sites, exposure frequency, number of workers and location of the sampling sites.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	data were provided on bias and precision
Overall Quality Determination			Low	

Study Citation:	Lavoue, J., Vincent, R., Gerin, M. (2008). Formaldehyde exposure in U.S. industries from OSHA air sampling data. Journal of Occupational and Environmental Hygiene 5(9):575-587.			
HERO ID:	2600507			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers in the following industries: Agriculture, forestry, and fishing; Construction; Manufacturing; Textile mill products; Apparel and other finished products made from fabrics and similar materials; Lumber and wood products, except furniture; Furniture and fixtures; Paper and allied products; Chemicals and allied products; Rubber and miscellaneous plastics products; Stone, clay, glass, and concrete products; Primary metal industries; Fabricated metal products, except machinery and transportation equipment; Industrial and commercial machinery and computer equipment; Electronic and other electrical equipment and components, except computer equipment; Transportation equipment; Measuring, analyzing, and controlling instruments photographic, medical and optical goods; watches and clocks; Miscellaneous manufacturing industries; Transportation, communications, electric, gas, and sanitary services; Wholesale trade; Wholesale trade nondurable goods; Retail trade; Finance, insurance, and real estate; Services; Funeral service and crematories; Photofinishing laboratories; Health services; Educational services; Public administration.			
Personal sampling data:	Formaldehyde concentrations (mg/m3) for different industries are as follows: Agriculture, forestry, and fishing - 0.39 +/- 3.8; Construction - 0.39 +/- 3.6; Manufacturing - 0.70 +/- 6.0; Textile mill products - 0.20 +/- 4.4; Apparel and other finished products made from fabrics and similar materials - 0.22 +/- 3.4; Lumber and wood products, except furniture - 0.27 +/- 3.8; Furniture and fixtures - 0.32 +/- 3.5; Paper and allied products - 0.20 +/- 3.3; Chemicals and allied products - 0.45 +/- 4.6; Rubber and miscellaneous plastics products - 0.28 +/- 3.6; Stone, clay, glass, and concrete products - 0.20 +/- 3.7; Primary metal industries - 0.31 +/- 4.6; Fabricated metal products, except machinery and transportation equipment - 0.17 +/- 3.9; Industrial and commercial machinery and computer equipment - 0.33 +/- 3.2; Electronic and other electrical equipment and components, except computer equipment - 0.15 +/- 3.5; Transportation equipment - 0.17 +/- 4.3; Measuring, analyzing, and controlling instruments photographic, medical and optical goods; watches and clocks - 0.23 +/- 11.9; Miscellaneous manufacturing industries - 0.14 +/- 3.3; Transportation, communications, electric, gas, and sanitary services - 0.10 +/- 7.1; Wholesale trade - 1.05 +/- 3.1; Wholesale trade nondurable goods - 62 4.1 +/- 20; Retail trade - 0.29 +/- 5.0; Finance, insurance, and real estate - 0.16; Services - 0.11 +/- 3.7; Funeral service and crematories - 0.67 +/- 4.1; Photofinishing laboratories - 0.22 +/- 4.2; Health services - 0.43 +/- 3.9; Educational services - 0.95 +/- 3.6; Public administration - 0.25 +/- 3.7.			
Area sampling data:	data provided in this article is for personal sampling			
Comments:	See Table 2 for data			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data is over 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	Monitoring data do not include any needed metadatato understand what the data represent and are not usable in the risk evaluation.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 2600507 Table: 1 of 1

...continued from previous page

Study Citation:	Lavoue, J., Vincent, R., Gerin, M. (2008). Formaldehyde exposure in U.S. industries from OSHA air sampling data. Journal of Occupational and Environmental Hygiene 5(9):575-587.
HERO ID:	2600507
Conditions of Use:	Multiple

Domain		Metric		EVALUATION Rating	Comments
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness		High	Variability and uncertainty are addressed in many ways

Overall Quality Determination **Uninformative**

Study Citation:	Lavoué, J., Vincent, R., Gérin, M. (2006). Statistical modelling of formaldehyde occupational exposure levels in French industries, 1986-2003. Annals of Occupational Hygiene 50(3):305-321.			
HERO ID:	6247591			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in the agriculture and food industry, manufacture of wood panels (excluding plywood) and laminates, manufacture of structural wood members, rough turning and tree processing, wood carpentry work, local public administration (includes public hospitals), private health care, and medical offices. (8/17)			
Exposure route:	inhalation (1/17)			
Physical form:	gas (1/17)			
Personal sampling data:	3 pages of personal exposure measurements included for many different industries and job descriptions. (8/17)			
Area sampling data:	3 pages of area measurements included from many different industries and job descriptions. (11/17)			
Exposure duration:	"20–89 min for personal data 43–111 min for area data (3/17)"			
Exposure frequency:	Sampling took place between 1986 and 2003. (2/17)			
Engineering control:	Local Exhaust Ventilation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, percentages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at almost 700 facilities.
Overall Quality Determination		High		

Study Citation:	Lawryk, N.J., Weisel, C.P. (1996). Concentrations of volatile organic compounds in the passenger compartments of automobiles. Environmental Science and Technology 30(3):810-816.			
HERO ID:	79703			
Conditions of Use:	Unknown			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	suburban loop - low ventilation 0.3 ug/m3+/- 0.2; high ventilation 0.3 ug/m3 +/- 0.2;Turnpike 0.1 ug/m3 +/- 0.1; Lincoln tunnel 0.3 ug/m3+/- 0.2			
Comments:	formaldehyde were examined on 113 commutes throughsuburban New Jersey and 33 New Jersey/New Yorkcommutes			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Formaldehyde samples were collected on dinitrophenylhydrazine (DNPH) silica cartridges (7). Air was drawn through the cartridge. Analysis was done on a gradient high-performance liquid chromatography (HPLC) system with an ultraviolet (UV) detector at 360 nm (7).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for within a vehicle’s passenger compartment which is an occupational scenario (e.g. taxi driver) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1996, after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with standard deviation provided. The data were also presented for each vehicle and compared with other similar studies.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	The data include all associated metadata, including sample types, exposure types, sample durations, exposure durations, and worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides average values and standard deviation but no uncertainty statistics
Overall Quality Determination		Medium		

Study Citation:	LBNL (1980). Trace organics in offices.			
HERO ID:	6023126			
Conditions of Use:	Offices			
EXTRACTION				
Parameter	Data			
Area sampling data: Formaldehyde concentrations in offices range from 19 - 35 ppb (see table 2). Outdoor concentrations at these same sites is 1-3 ppb.				
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 6184520 Table: 1 of 1

Study Citation:	Lebowitz, M.D., Quackenboss, J.J. (1993). Formaldehyde: Exposure Effects on Human Health. Elsevier Elsevier(Elsevier):285-291.			
HERO ID:	6184520			
Conditions of Use:	Various			
EXTRACTION				
Parameter	Data			
Worker activity description:	Dermal: "Skin contact occurs during the use of cosmetics, household products, disinfectants, textiles (especially synthetic), orthopedic casts, and work exposure to HCHO gas or aqueous solutions." (pg 2)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	"Table 1 (pg 2) provides exposure dose (mg/d) contributions from ambient air, indoor home, indoor workplace, and smoking Wood processing plants: <0.4 mg/m3; Acrylic wool filter department: 0.5-1 mg/m3; ""In studies of batt makers [fiberglass] and histology technicians [medical samples], symptoms were greater for batt makers, especially those involved in the hot (high-exposure) areas of the process; exposure for the latter group was about 6 mg/m3, while exposure for the techs ranged from 0.5-2.3 mg/m3"""			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for multiple in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low		

Study Citation:	Lee, N., Lee, B.K., Jeong, S., Yi, G.Y., Shin, J. (2012). Work environments and exposure to hazardous substances in Korean tire manufacturing. Safety and Health at Work 3(2):130-139.			
HERO ID:	1641552			
Conditions of Use:	Rubber Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Compounding - Vulcanizing agents and accelerators in the form of powders are weighed and fed into a Banbury mixer. Curing - The green tire is placed in the mold and vulcanized under heat (150-180oC) and pressure... There is no air exhaust system.			
Exposure route:	inhalation			
Personal sampling data:	(Plant A Compounding had 3 samples ranging from 0.018-0.021 ppm with a geometric mean of 0.020) {Plant A Curing had 3 samples ranging from 0.010-0.013 ppm with a geometric mean of 0.012} [Plant B Compounding had 3 samples ranging from 0.027-0.029 ppm with a geometric mean of 0.029] (Plant B Curing had 3 samples ranging from 0.009-0.012 ppm with a geometric mean of 0.010)			
Exposure duration:	Integrated samples were sampled for more than 6 hours.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology Korea Occupational Safety and Health Agency (KOSHA) Method No.67 is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Korea, an OECD country.
	Metric 3:	Applicability	High	Data are for tire manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected in 2007 and published in 2012
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (e.g., min, max, geometric mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Some metadata provided (plant process, relative humidity, sample duration), but exposure duration was not.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Lee, S. A. (1988). Health Hazard Evaluation Report HETA 87-309-1906, Louisiana-Pacific Corporation, Missoula, Montana, June 1988.				
HERO ID:	1317215				
Conditions of Use:	Office Environment				
EXTRACTION					
Parameter	Data				
Worker activity description:	Water-based paint operatorSolvent-based paint operatorinspector that grades the productSupport staff that mix paint, clean machines, fill the machine’s pain				
Exposure route:	reservoirs.				
Physical form:	inhalation				
Area sampling data:	vapor				
Number of workers:	Grader 0.1 mg/m3Bullnose 0.2 mg/m3Water-basin fill station 0.2 mg/m3 Printer 0.3 mg/m3				
Engineering control:	8				
	increase make-up air supply				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH study using Method 3500	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	1987 Prior to the PEL (1992) and more than 20 years old	
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop summary statistics. Four area samples were taken, but sample correspond to each of the job positions discussed.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. Uncertainty was not discussed but as this is a NIOSH study, it is assumed that uncertainty was considered in Method 3500.	
Overall Quality Determination			High		

Formaldehyde

Occupational Exposure

HERO ID: 1322459 Table: 1 of 1

Study Citation:	Lee, S. A. (1988). Health Hazard Evaluation Report HETA 87-404-1893, Park County Courthouse, Fairplay, Colorado, May 1988.			
HERO ID:	1322459			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office work at a Courthouse (Page 2 of 10)			
Physical form:	vapor (Page 3 of 10)			
Area sampling data:	Five air samples were collected at various locations, with concentrations ranging from 0.02 to 0.06 ppm. (Page 4 of 10 for discussion, page 10 of 10 for table with all values).			
Number of workers:	6 (Page 2 of 10)			
Comments:	Page 8-9 of 10 has a table of "Reported Levels of Formaldehyde in the Indoor Air Classes of Private Residences".			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (office work) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1987 - Prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH method 3500.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, and worker activities, but lacks additional metadata, such as exposure durations and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in Method 3500.
Overall Quality Determination			High	

Study Citation:	Lee, S. A. (2001). Health Hazard Evaluation Report: HETA 99-0173-2856, Turnbull National Wildlife Refuge, Cheney, Washington.			
HERO ID:	4030925			
Conditions of Use:	Forestry			
EXTRACTION				
Parameter	Data			
Worker activity description:	Use of chainsaws (chainsaw exhaust) (pg 4)			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	6 samples (Full shift TWA (pg 4)) - All in ppm: 0.013, 0.014, 0.015 (twice), 0.022, 0.029 (Table 3, pg 18)			
Exposure duration:	nan			
Exposure frequency:	nan			
Number of workers:	6-8 (pg 4)			
Personal protective equipment:	Foresters wear hard hats with attached Stihl Promark ear muffs in addition to foam ear plugs, safety glasses with side shields, and cotton or leather gloves (pg 6)			
Comments:	9 hour shift, 5 hours using chainsaws per shift (pg 6). 40 hours/week (pg 7). NIOSH Method 2016 (pg 7)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for forestry, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by conducting sampling on multiple days, but uncertainty is not addressed.
Overall Quality Determination		High		

Study Citation:	Lee, S. A. (n.d.). Health Hazard Evaluation Report HETA-1984-454-1695 Mid Valley School, Trhoop, Pennsylvania.
HERO ID:	8684539
Conditions of Use:	Chemical substances in construction, paint, electrical, and metal products-Building/construction material: The major source of formaldehyde emission in the school is probably the Tripolymer® #105 foam insulation. This is a phenol polymethylol urea polymer that was sprayed into the masonry cavities of the outer walls. Other formaldehyde sources in the school could include pressed wood products used in furniture and cabinets, acoustical ceiling insulation, carpeting, and duplicating machines.

EXTRACTION

Parameter	Data
Worker activity description:	students, teachers, office personnel (page 5 of 16)
Exposure route:	inhalation (page 6 of 16)
Physical form:	vapor (page 6 of 16)
Area sampling data:	Formaldehyde air levels in the school at various locations are reported on pages 14 to 15. In August 15-16 1985 the range is from 0.02 to 0.18 ppm. In January 1986 it ranged from 0.03 to 0.06. See tables for all data points.
Number of workers:	700 students (5 of 16)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH Study Method 3500
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation (exposures in a school)
	Metric 4: Temporal Representativeness	Low	1985-86 Prior to the PEL (1992) and more than 20 years old
	Metric 5: Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, and sample durations but lacks additional metadata, such as exposure durations, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations and days. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.

Overall Quality Determination**High**

Formaldehyde

Occupational Exposure

HERO ID: 5947702 Table: 1 of 1

Study Citation:	Levin, J.O., Lindahl, R., Andersson, K. (1989). Monitoring of parts-per-billion levels of formaldehyde using a diffusive sampler. Journal of Air Pollution Control Association 39(1):44-47.			
HERO ID:	5947702			
Conditions of Use:	Use in furniture, particle board, and textile industries.			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	gas, vapor			
Area sampling data:	Occupational exposure ranges between 0.1-5 ppm FA in air. Typical conventional housing exposure is 0.01-0.1 ppm. Field testing is shown in Table I (ppb): office - 45, 40; private residence - 26, 22; Furniture industry - 43, 39, 48, 46; Particle board industry - 39, 34; Textile industry - 6, 6, 16, 14, 19, 18, 22, 24			
Comments:	See table 1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Data is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for Sweden, an OECD country.
	Metric 3:	Applicability	High	Data is applicable to multiple COUs (textile, furniture and particle board)
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1989)
	Metric 5:	Sample Size	Low	Not characterized by statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes exposure route, physical form and area sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Levine, A.J., Salvan, A., Talaska, G., Boeniger, M.F., Suruda, A., Schulte, P.A. (1997). The utility of epithelial-cell micronuclei in the assessment of intermittent exposures. Biomarkers 2(2):135-138.			
HERO ID:	1980866			
Conditions of Use:	Laboratory Use-Mortuary science students			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	15.01 ppm-hr mean (range 4.3-33.6 ppm-hr)			
Number of workers:	22			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology was not specified, but it was noted that the chromatropic acid method was used,
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The data were published in 1997, after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	High	Sampling results are provided for each student for each day of the study.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	The study data included sample type and exposure type, butlacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided results for each student and each day of the study that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Levine, R.J., Andjelkovich, D.A., Shaw, L.K. (1984). The mortality of Ontario undertakers and a review of formaldehyde-related mortality studies. Journal of Occupational and Environmental Medicine 26(10):740-746.			
HERO ID:	21251			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Worker activity description:	disinfect, preserve, and restore bodies in preparation for funeral			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	assuming these are area samples: emblaming intact bodies 0.3 ppm; and autopsied bodies 0.9 ppm			
Number of workers:	cohort study of 1477			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - OECD member
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1984 based on data compiled in 1978, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Some metadata were provided such as duration of embalming events, worker activities, and exposure frequency. No additional metadata were provided such as sampling and analytic methods, number of sites, and worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Li, J. F. (2017). Health Hazard Evaluation Report: HHE-2016-0145-3292, October 2017. Evaluation of Employee Exposures at a Plastic Bag Sealing Plant.			
HERO ID:	4794766			
Conditions of Use:	Heating of polyethylene bags			
EXTRACTION				
Parameter	Data			
Worker activity description:	The wicketers unwound and drew in rolls of polyethylene film and folded them. Depending on the customer’s order, zippers or tear perforations were attached to some films prior to sealing. The wicketer added two holes at the top of the film and then heat-sealed and thermally cut the film. This formed two sides and one end of the bag and left the other end of the bag unsealed. The bags were stacked on wire wickets (Figures 1 and 2) and then manually removed by the wicketer operator and packaged into cardboard boxes for shipment. During the site visit, two of the three wicketers were operating, and one wicketer operator was working nearby folding and packaging bags. Employees stated that typically all three wicketers were in operation. The flatbed bagger produced various sizes of bags by unwinding and drawing rolls of polyethylene film, folding the film, and heat-sealing and thermally cutting the edges to form bags. No wickets were used at the flatbed bagger, and the operator was responsible for placing finished bags into boxes for shipment. Only two of the three flatbed baggers were operational, and only one was running during our site visit.			
Exposure route:	inhalation			
Physical form:	vapor, gas			
Personal sampling data:	Table 2 provides short term (15 minutes) in ppm: Flatbed bagger operator: 0.068, 0.024, 0.025; Wicketer operator: 0.028, 0.016, 0.0046, 0.024, 0.015, 0.030, 0.023, 0.019, 0.026			
Engineering control:	The company had installed LEV at the wicketer machines in 2016 that consisted of a slot hood mounted next to the wicketer heat-sealer (Figure 5). Flexible duct connected the slot hood to a fan that exhausted the air through the ceiling to the outdoors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source contains high quality data by following and abiding NIOSH and OSHA safety rules.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is directly applicable to exposure to FA from heating of polyethylene bags.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2017)
	Metric 5:	Sample Size	Medium	Characterized by range of data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes worker activity, physical form, exposure route, personal sampling data, and engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty not addressed.
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 5431864 Table: 1 of 1

Study Citation:	Li, T., Cheng, Y., Liu, Z., Bai, Y. (2009). Human cancer risk assessment of formaldehyde in different office environments in Guiyang City, China. :1032-1036.			
HERO ID:	5431864			
Conditions of Use:	Commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office workers			
Exposure route:	inhalation			
Area sampling data:	”Site A: 0.17+-0.06 mg/m3 Site B: 0.06+-0.03 mg/m3 Site C: 0.05+-0.03 mg/m3 Site D: 0.07+-0.02 mg/m3 Site E: 0.06+-0.01 mg/m3 Site F: 0.06+-0.02 mg/m3 Site G: 0.38+-0.05 mg/m3 Site H: 0.25+-0.05 mg/m3 Site I: 0.07+-0.01 mg/m3 Site J: 0.02+-0.01 mg/m3 Site K: 0.03+-0.04 mg/m3 Total: 0.09+-0.08 mg/m3”			
Exposure duration:	8 hours/day			
Exposure frequency:	40 years			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	Low	Data are for ambient air, which is similar to the in-scope occupational scenario disposal of formaldehyde.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at 11 sites.
Overall Quality Determination		Medium		

Study Citation:	Liang, X., Zhang, J., Song, W., Wang, K., Zhang, B. (2018). Formaldehyde exposure in indoor air from public places and its associated health risks in Kunshan City, China. Asia-Pacific Journal of Public Health 30(6):551-560.			
HERO ID:	5956005			
Conditions of Use:	General population - Background exposure			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees working in 4 categories of public places in Kunshan City in China: (1) cultural and entertainment places (including theaters, KTV, game hall, and dance hall); (2) hotel and social interaction places (including hotels, restaurants, cafes, bars, and teahouse); (3) bathing and beauty places (including barber shop, SPA club, bath center, fitness center, and beauty shop); and (4) shopping places (including supermarkets, shopping malls, and bookstores).			
Exposure route:	Inhalation			
Physical form:	Gas			
Area sampling data:	Concentrations (mg/m3) of formaldehyde as measured: (1) cultural and entertainment places: average - 0.055+/-0.046, median - 0.042, range - 0.001 to 0.260; (2) hotel and social interaction places: average - 0.062+/-0.034, median - 0.062, range - 0.002 to 0.420; (3) bathing and beauty places: average - 0.068+/-0.078, median - 0.05, range - 0.001 to 0.820; (4) shopping places: average - 0.045+/-0.057, median - 0.031, range - 0.001 to 0.760. Hotel and social interaction places had the most number of test samples, followed by bathing and beauty, cultural and entertainment, and shopping places			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology is well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	Medium	data relate to background exposure that exists in public areas where employees may be working, may be useful for risk evaluation
	Metric 4:	Temporal Representativeness	High	data less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	no discussion on uncertainties
Overall Quality Determination		Medium		

Study Citation:	Liebling, T., Rosenman, K.D., Pastides, H., Griffith, R.G., Lemeshow, S. (1984). Cancer mortality among workers exposed to formaldehyde. American Journal of Industrial Medicine 5(6):423-428.			
HERO ID:	21249			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	Chemical workers: phenol formaldehyde molding powders and liquids, urea formaldehyde resins, melamine, hexamethylene, tetramine and resorcinol			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.05 to 5.00 ppm (peak value of 273 ppm)			
Number of workers:	24			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from a plant in Western Massachusetts and maybe representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for chemical worker which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1984, and covers the period from 1976 to 1980; before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range, but ncertain statistics were not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided such as sampling and analytic methods, sample durations, exposure durations, worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Lillienberg, L., Burdorf, A., Mathiasson, L., Thörneby, L. (2008). Exposure to metalworking fluid aerosols and determinants of exposure. Annals of Occupational Hygiene 52(7):597-605.		
HERO ID:	1313606		
Conditions of Use:	Use of Metalworking fluid		
EXTRACTION			
Parameter	Data		
Worker activity description:	Most machines were highly automated and (almost) fully enclosed. In most shops, more than one type of MWF was used during the production of metal pieces, varying from small to medium pieces of about 0.2–10 kg except where bearings were made up to 1 ton, with machining times from a few minutes to several hours. Most of the operators worked in the direct vicinity of the machines during the whole shift. When not machining, the operators programmed the machine, performed quality measurements, changed tools or products, used compressed air for cleaning and conducted repairs. A limited time was spent away from the machines, e.g. transporting product and doing administrative tasks. During most shifts, operators performed the same routine activities on the same machines.		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	From Table 3: Company 1: 0.128 mg/m3 mean, 0.125 mg/m3 geometric mean, GSD 1.29 (range 0.087-0.154 mg/m3) - note elevated values may be due to use of recirculated air.; Company 2: 0.012 mg/m3 mean, 0.009 mg/m3 geometric mean, GSD 2.24 (range 0.001 - 0.042 mg/m3); Company 3: 0.003 mg/m3 mean, 0.003 mg/m3 geometric mean, GSD 1.57 (range 0.001-0.007 mg/m3) Assumed units based on units noted in the text summary		
Exposure duration:	6 - 8 hours ("Full shift")		
Number of workers:	21		
Engineering control:	In all shops, general ventilation and exhaust ventilation systems were present. The general ventilation varied from 2.5 to 5.2 turnovers per hour..		
Comments:	This study noted the use of compressed air is the most important factor in peak concentrations.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified, though it was noted that samples using activated carbon were analyzed with high-performance liquid chromatography with ultravioletdetection.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden - an OECD member
	Metric 3: Applicability	High	The data are for metal shop workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The data were published in 2008, after the most recent PEL (1992) and more than 10 but less than 20 years old.
	Metric 5: Sample Size	High	Descriptive statistics were used to calculate means (arithmetic and geometric) and geo-metric standard deviations (GSDs)
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and much more.
Domain 4: Variability and Uncertainty			
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Formaldehyde

Occupational Exposure

HERO ID: 1313606 Table: 1 of 1

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Study Citation:	Lillienberg, L., Burdorf, A., Mathiasson, L., Thörneby, L. (2008). Exposure to metalworking fluid aerosols and determinants of exposure. Annals of Occupational Hygiene 52(7):597-605.		
HERO ID:	1313606		
Conditions of Use:	Use of Metalworking fluid		
Domain		EVALUATION	
Metric		Rating	Comments
Metric 7:	Metadata Completeness	Medium	The study provided range data, geometric standard deviation, and variance ratios for 3 different companies, these elements can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		High	

Study Citation:	Lin, N., Rosenberg, M. A., Li, W., Meza-Wilson, E., Godwin, C., Batterman, S. (2021). Occupational exposure and health risks of volatile organic compounds of hotel housekeepers: Field measurements of exposure and health risks. Indoor Air 31(1):26-39.			
HERO ID:	7311740			
Conditions of Use:	fabric, textile, and leather products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Hotel housekeepers in four groups: room cleaners, laundry workers, maintenance, and office workers. (2/14)			
Exposure route:	inhalation (2/14)			
Physical form:	gas (9/14)			
Area sampling data:	Formaldehyde, a toxic aldehyde, averaged 10 ± 6 and 14 ± 6 µg/ m3 in the break and laundry rooms, respectively. (6/14) Supplemental Table S6-> US Hotel (exhaust air) 28 µg/m3; China Hotels: 10, 140, 114 µg/m3 [mean values]; These are from other published studies: 2015003, 2214101, 626839 5956712, 1978790.			
Exposure duration:	Housekeepers work for 3-8 hours/day. (4/14)			
Number of workers:	There are 1.8 million hotel housekeepers in the U.S. (1/14)			
Engineering control:	All spaces, including lobby, office, break, laundry, and guest rooms, were mechanically ventilated and used separate and independent unit ventilators that provided heating, cooling, and exchange with outdoor air. (4/14)			
Comments:	Authors do not know the source of formaldehyde, they note that it could come from building materials, furnishings, beddings, towels, or as a byproduct of terpenes and ozone. "Additional studies are needed to verify formaldehyde sources in hotels."(9/14)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for commercial use of fabric and textile products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (average, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at multiple hotels during different seasons.
Overall Quality Determination			High	

Study Citation:	Lindskov, R. (1982). Contact urticaria to formaldehyde. Contact Dermatitis 8(5):333-334.			
HERO ID:	1314820			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	fixation of tissues in fume cupboard in the laboratory of a pathology department using 10% and 20% solutions of buffered formaldehyde			
Exposure route:	dermal			
Physical form:	vapor			
Area sampling data:	The values varied between 0.7 and 1 ppm in the fume cupboard.			
Dermal exposure data:	Dermal exposure data			
Number of workers:	1			
Engineering control:	Use of fume hood			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified though it was noted that formaldehyde concertation at the fume hood wasmeasured with a Drager Tubes.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Denmark - and OECD country
	Metric 3:	Applicability	High	The data are for a pathology worker which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were published in 1982 before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Range data provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, and worker activities, but lacks additional metadata, such as sample durations, exposure durations, and exposure frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Lippmann, M., Melville, R. (2001). Influence of data elements in OSHA air sampling database on occupational exposure levels. Applied Occupational and Environmental Hygiene 16(9):884.			
HERO ID:	6020747			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Embalmers in funeral homes			
Exposure route:	inhalation			
Physical form:	vapor, gas			
Personal sampling data:	The average 8-hr TWA formaldehyde exposure among embalmers comprising this exposure group was 0.44 ppm and the standard deviation was 0.66 ppm. The geometric mean and standard deviation were 0.19 ppm and 4.18, respectively. Seventeen (15%) of the individual concentrations were above the current OSHA PEL-TWA of 0.75 ppm and 12 (11%) were at or above the PEL-TWA in effect at the time of inspection.In a study of formaldehyde exposure in the funeral industry in Manitoba, Canada, Korczinski (34) reported the results of 48 personal breathing zone samples collected during embalming of intact and autopsied bodies. Airborne formaldehyde concentrations ranged from 0.11–5.64 mg/m3 ; none of the measurements were below the limit of detection.			
Area sampling data:	In a study of formaldehyde and paraformaldehyde, Kerfoot and Mooney (57) collected 187 measurements for determination of airborne formaldehyde levels in the embalming rooms of six Detroit, Michigan-area funeral homes. Airborne formaldehyde concentrations ranged from 0.09–5.26 ppm with no sampling results below the analytical limit of detection.			
Exposure duration:	8-hr TWA			
Number of workers:	A total of 111 measurements collected during 68 inspections were included in this case study.			
Engineering control:	Local exhaust ventilation			
Comments:	Data from OSHA database so likely a common source.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is from OSHA so it is for U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	High	Full characterized by statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes worker activity, exposure route, physical form, area sampling and exposure duration.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
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Formaldehyde

Occupational Exposure

HERO ID: 6020747 Table: 1 of 1

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Study Citation:		Lippmann, M., Melville, R. (2001). Influence of data elements in OSHA air sampling database on occupational exposure levels. Applied Occupational and Environmental Hygiene 16(9):884.		
HERO ID:		6020747		
Conditions of Use:		Laboratory Chemical		
Domain		Metric	EVALUATION Rating	Comments
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 2444324 Table: 1 of 1

Study Citation:	Liu, J., Zhai, J.Z., Pei, J., Li, Y. (2007). Measurement and assessment of VOC and formaldehyde contamination during the construction of a new museum in China. ASHRAE Transactions 113(2):355-361.				
HERO ID:	2444324				
Conditions of Use:	Installation/Demolition of Building Materials				
EXTRACTION					
Parameter	Data				
Worker activity description:	construction workers and museum workers during construction				
Exposure route:	inhalation				
Area sampling data:	Per Table 2: Formaldehyde Concentration (mg/m3) by location: Hall (1st floor) – 0.1; East exhibition hall (2nd floor) – 0.05; West exhibition hall (2nd floor) – 0.05				
Engineering control:	ventilation is an effective method to remove indoor VOCs during construction				
EVALUATION					
Domain		Metric	Rating		Comments
Domain 1: Reliability		Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness		Metric 2:	Geographic Scope	Low	The data is from China, a non-OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Medium	data collected between 10 and 20 years old	
	Metric 5:	Sample Size	Low	no statistics	
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Low	no other metadata
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low		

Study Citation:	Loh, M.M., Houseman, E.A., Gray, G.M., Levy, J.I., Spengler, J.D., Bennett, D.H. (2006). Measured concentrations of VOCs in several non-residential microenvironments in the United States. Environmental Science and Technology 40(22):6903-6911.			
HERO ID:	2442846			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Personal sampling data:	Formaldehyde geometric mean concentrations ranged from 5.96 ug/m3 in electronics stores to 53 ug/m3 in housewares stores. Formaldehyde was highest in housewares and furniture stores, most likely due to the sale of pressed wood products known to emit formaldehyde. Overall, formaldehyde geometric mean concentrations in stores was found to be 19.6 ug/m3 while in diners the geometric mean was reported as 14.3 ug/m3. Formaldehyde showed significantly higher levels in summer in both types of stores.			
Exposure duration:	Varied; 1-3 hrs sampling durations- Field staff mimic general population/consumer exposure			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	Low	The data are for microenvironments for commercial buildings but sampling was done to mimic general population/consumer, not workers within these environments, which would be an occupational scenario. Therefore data is similar to an occupational scenario. In addition, microenvironments may include sources within and outside of the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	data is between 10 and 20 years
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, but lacks additional metadata, such as source attribution or more detailed environment information.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability by considering different types of environments and seasons. Uncertainty is discussed in limitations section.
Overall Quality Determination			Medium	

Study Citation:	Lorenzoni, D.C., Pinheiro, L.P., Nascimento, H.S., Menegardo, C.S., Silva, R.G., Bautz, W.G., Henriques, J.F., Almeida-Coburn, K.L., Gama-De-Souza, L.N. (2017). Could formaldehyde induce mutagenic and cytotoxic effects in buccal epithelial cells during anatomy classes?. Medicina Oral, Patologia Oral y Cirugia Bucal 22(1):e58-e63.			
HERO ID:	4480836			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Anatomy students participating in practical anatomy classes			
Exposure route:	Inhalation			
Physical form:	Liquid			
Area sampling data:	0.73 (ppm)			
Number of workers:	17			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data no more than 10 years old
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1314720 Table: 1 of 1

Study Citation:	Low, I., Mitchell, C. (1985). Respiratory disease in foundry workers. British Journal of Industrial Medicine 42(2):101-105.			
HERO ID:	1314720			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Worker activity description:	Aftercast, general foundry, core sop, line and core shop/line			
Exposure route:	Inhalation			
Physical form:	vapor			
Personal sampling data:	Furane process-Core shop non detect; general foundry 2 to 4 ppm; Shell process- 1 ppm			
Number of workers:	17 in Aftercast; 15 general foundry; 17 core shop; 6 line; 8 core shop/line			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but Formaldehyde concentrations were measured using the chromotropic acid visible absorption spectrometer and Drager tubes.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Australia - an OECD member
	Metric 3:	Applicability	High	The data are for foundry workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were published in 1985, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	A range was provided for the Furane process and the lower limit of detection of 1 ppm for the Shell process.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	The study include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Lu, H., Tian, J., Cai, Q.Y., Wen, S., Liu, Y., Li, N. (2016). Levels and Health Risk of Carbonyl Compounds in Air of the Library in Guangzhou, South China. Aerosol and Air Quality Research 16(5):1234-1243.			
HERO ID:	3259031			
Conditions of Use:	Use of Paper Products			
EXTRACTION				
Parameter	Data			
Area sampling data:	Mean (arithmetic) formaldehyde concentrations were measured in three rooms in a library in Guangzhou, China: L1, stack room (with an area of 520 m2); L2, electronic reading room (with an area of 320 m2); L3, compact stack room (with an area of 476 m2). Formaldehyde concentrations (ug/m3) were as follows: L1 - 3.12 ±1.00 (morning), 3.84 ±1.11 (afternoon), 4.36 ±1.37 (night); L2 - 6.97 ±6.12 (morning), 5.82 ±3.78 (afternoon), 7.59 ± 3.08 (night); L3 - 2.61 ±0.58 (morning), 2.73 ±0.46 (afternoon), 3.83 ±0.95 (night). Outdoor formaldehyde concentrations (ug/m3) were 2.25 ±1.93 (morning), 3.64 ±1.56 (afternoon), 8.56 ±7.98 (night). Indoor/outdoor (I/O) concentration ratios of formaldehyde in the library is 1.21 (mean), 0.80 (SD), 0.45 (min.), 3.09 (max.).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	monitoring data is no more than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainty
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	6 Plants: Plant 3- Manufacture glue for plywood, sample taken over glue vat, Plant 4&5- UF Resin production/drumming/drum washing/ foam agent blending;			
Exposure route:	Plant 6 Resin II Cooks, drum washing/foam agent blending			
Physical form:	inhalation			
Personal sampling data:	vapor			
Area sampling data:	[ppm] Plant 1- Production workers: 1.39 (mean); Plant 6- Cooks: mean=0.9, range=0.12-5.4, Drum washer: mean=0.39 range=0.2-0.74, Foaming agent blender: mean=0.19, range=0.06-0.34			
Exposure duration:	Plant 2- Resin plant worker (range 0.05-0.37 ppm) 0.24 ppm (mean); Plant 3- Resin plant worker II (0.09-0.17ppm) 0.13 ppm (mean); Plant 4&5- Production(0.12-0.55), Drumming(0.18-5.4), Drum washing(0.2-0.74), Foam agent blending(0.6-0.34)			
Exposure frequency:	Production Operators(Plant 1)-4 hr TWA; Resin plant 3 405 minutes			
Number of workers:	Plant 3- intermittent			
Comments:	Total Full time workers exposed 4,728; Total part time workers exposed 1,272			
	Report is a secondary source(review paper). Original sources: Plant 1 is NIOSH, 1980. Walk-through survey report of Georgia Pacific Chemical and Resin Div., Crossett, Arkansas. NIOSHTIC No.=00095215; Plant 2 is from HERO ID: 1317290; Plant 3 is NIOSH HHE Nos.76-79, 80-543.Weyerhaeuser Co.,Longview,WA; Plant 4&5 is NIOSH Technical Report 83-108. Industrial hygiene characterization of urea-formaldehyde and polyurethane foam insulation.,Washington,DC,1983.; Plant 6 is NIOSH. An industrial hygiene survey of urea-formaldehyde foam insulation manufacturing at Rapco Foam, Inc.EnviroControl,Inc., Rockville,MD, NIOSH Contract No.210-78-0081,1980.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is for Production worker Charcoal Tubes/Ion Chromatography was used; Resin Plant I Bisulfite impingers/Colorimetric analysis UF resin I Solute sorbent/Ion Chromatography; UF resin II Bisulfite Impingers/Chromotropic Acid
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States; Based on references Plant 1 is Georgia Pacific plant in AR,US; Plant 2 is Formica, Cincinnati, OH; Plant 3 is in Longview, WA; Plant 4&5 is in the US but specific city, state not specified; Plant 6 is in Rockville, MD
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but the production data are from 1976- 1983
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided except for UF I which is only range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata but missing worker activities, Exposure frequency, sampling sites and location

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Formaldehyde

Occupational Exposure

HERO ID: 21849 Table: 1 of 30

...continued from previous page			
Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.		
HERO ID:	21849		
Conditions of Use:	Processing as a reactant		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	range provided to access variability but no discussion of uncertainty
Overall Quality Determination		Medium	

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Production workers 1.4 ppm (mean) and lab Tech 1.31			
Exposure duration:	4 hr TWA			
Number of workers:	Total Full time workers exposed 271-913; Total part time workers exposed 145-487			
Comments:	Data is cited from NIOSH, 1980. Walk-through survey report of Georgia Pacific Chemical and Resin Div., Crossett, Arkansas. NIOSHTIC No.=00095215			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is noted that Charcoal Tubes were used to collect samples and Ion Chromotography used for analysis. Associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Cited reference indicates data from Georgia Pacific plant in US
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but the data are from 1980
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - only mean provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	number of samples, descriptive worker activities, site location, exposure frequency not provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	only mean provided no information about variability nor any indication of uncertainty
Overall Quality Determination			Medium	

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.
HERO ID:	21849
Conditions of Use:	Textile Finishing

EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	area and personal sampling: Textiles warehouses source 1 0.31 ppm mean (range 0.04-0.73 ppm); source 2 0.25 ppm mean (range 0.08-0.51 ppm); textile facilities source 1 0.8 ppm median (range <0.1-1.3 ppm); source 2 0.7 ppm median (range <0.1-1.4 ppm); PERSONAL :textile manufacture 0.69 ppm mean 0.64 median (range 0.11-1.33)
Area sampling data:	textile manufacture 0.53 mean 0.45 median (0.15-1.2 ppm).
Exposure duration:	Textile Manu 1 3 hr sampling, 8 hr exposure duration; textile manu 2 is grab sampling
Number of workers:	Total Full time workers exposed 17,800; Total part time workers exposed 2,200
Comments:	Primary sources of the referenced data are (15-17). 15. NIOSH. Health Hazard Evaluation Determination Report No. HE-78-116-557. Commonwealth Trading Co. NIOSH, Washing-ton, DC, 1979. 16. NIOSH. Industry selection for determination of extent of exposure. Memo from Larry Elliott, NIOSH Center for Disease Control, Cincinnati, OH, to NIOSH, Washington,DC, 1979. 17. NIOSH. Health Hazard Evaluation Determination Report No.80-192-828. Rock Hill Printing and Finishing Co., RockHill, NC,1981.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not extensively discussed though it was noted that for textile activities charcoal tubes were used along with Spectrophotometric procedures; warehouse Bisulfite Impinger/Spectrophotometric
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United State.
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but the Textiles/warehouse, Textile I/facilities data were from 1979; Textile II and Manufacturing were from 1981
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample distribution characterized by limited statistics - Range and mean provided except for Textiles/warehouse, range and median provided for textile I/facilities; and range, mean and median were provided for textile II/manufacturing
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata missing exposure duration, sampling location, worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	range provided to quantify variability but no indication of uncertainty

Overall Quality Determination

Medium

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 21849 Table: 3 of 30

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Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.		
HERO ID:	21849		
Conditions of Use:	Textile Finishing		
		EVALUATION	
Domain	Metric	Rating	Comments

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.		
HERO ID:	21849		
Conditions of Use:	Use of fabric, textile and leather products		
EXTRACTION			
Parameter	Data		
Worker activity description:	permanent press work room for cutting pressing, sewing and storage areas. The others are unknown		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	Warehouse 0.39 ppm mean, 0.37 ppm median (range 0.11-0.57 ppm); Sewing machine operators I 0.72 ppm mean, 0.71 ppm (range 0.51-0.91 ppm); Sewing machine operators II 1.2 ppm mean and median (range 0.3-1.8 ppm); pressers 0.07 ppm mean, 0.054 median (range 0.05-0.95 ppm)		
Area sampling data:	permanent press I 0.31 ppm mean (range 0.15-0.38 ppm); permanent press II 0.74 ppm mean (range 0-2.7 ppm); Warehouse 0.12 ppm mean, 0.15 median (range 0.04-0.19 ppm)		
Exposure duration:	warehouse I 30-45 min personnel sampling and 164-341 min area sampling; sewing machine operators I 7-8 hrs; sewing machine operators II 30 minute sampling; cloths pressers 3-4 hrs. Exposure duration reported at 8 hrs for warehouse, sewing machine operators, and clothing pressers		
Number of workers:	771,420 (full), 125,580 (part)		
Comments:	Primary sources are (18)USDHEW Report on a study of formaldehyde exposures, Perfection Garment Manufacturing, Martinsburg, WV, U.S. Department of Health, Education and Welfare, Washington,DC, 1966. (19) USDHEW Formaldehyde emissions in the permanent-press fabrics industry. TR-52, Consumer Protection and Environmental Health Service, Cincinnati,OH, 1968. (20) NIOSH. Health Hazard Evaluation Determination Report No. 75-143-333, UnitogCo., Warrensburg, MO. NIOSH, Washington, DC, 1976. (15) NIOSH. Health Hazard Evaluation Determination Report No.HE-78-116-557 .Commonwealth Trading Co. NIOSH, Washington,DC,1979.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified for some of the dataa though it was noted that for permanent press operations Bisulfite Impingers were used for sampling and analysis was performed using Ion Chromatography; others are unknown
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but Permanent Press I was published in 1966; permanent press II 1968; warehouse and sewing in 1979 and pressers in 1976.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided for permanent press; range, mean, median provided for all others, no uncertainty estimates
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata but missing sampling location, exposure frequency and number of sites
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Range provided for variability but nothing for uncertainty
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Formaldehyde

Occupational Exposure

HERO ID: 21849 Table: 4 of 30

...continued from previous page			
Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.		
HERO ID:	21849		
Conditions of Use:	Use of fabric, textile and leather products		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	all workers 1-2.5 ppm			
Number of workers:	Total Full time workers exposed 15,000			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario but lacks clarity to determine if it refers to data that would be out of scope.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data from 1979 study
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Only Range
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	missing sampling and analytic method, exposure duration and frequency, sampling locations, worker activity, Types of measurement and number of samples
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided to get a sense of variability but no indication of uncertainty
Overall Quality Determination			Medium	

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Injection mold operators 0.037 ppm mean (range 0.01-0.1 ppm); Operators <2 (range <2 ppm); Sand mold production 0.31ppm mean, 0.2 median (0.1-0.7)			
Area sampling data:	Area 0.2 ppm mean (range 0.01-0.53 ppm); Near grinder hopper 3 ppm mean, 3 ppm median (2-4 ppm); Sand mold 0.17 ppm mean, 0.1 ppm median (range ND-1.1 ppm)			
Exposure duration:	Exposure duration: sand mold production 8 hr/day Sampling period: injection mold 100-350 min sampling; Area samples 55-425 min; sand mold production 4 hr sampling			
Number of workers:	Total Full time workers exposed 15,073; part time 1,527			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology was not specified for all data thought it was noted that for area and and injection mold sampling Chromotropic Acid was used and for others Draeger Tubes
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data (Warren MI and Louisville, KY)
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but the Warren MI study was from 1973 and the Louisville, KY study ws from 1976
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but missing sampling location and worker activity
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	range quantifies variability, but no discussion of uncertainty
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Paper treatment resin impregnated:filter treating of paper, press; Treated paper products			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	paper treatment dataset 1 0.08 ppm mean (range 0.04-0.16 ppm); dataset 2 0.05 ppm mean (range 0.01-0.23 ppm); dataset 3 0.05ppm mean (0.02-0.28); Treated paper products 0.34 median (0.14-0.9))			
Area sampling data:	resin area 0.06 ppm mean (range 0.03-0.07 ppm);treated paper products area 0.59 ppm median (range 0.14-0.99 ppm);			
Exposure duration:	Sampling 4 hours for treatment and resin. Coating 30 second sampling 20 times per day			
Exposure frequency:	8 hrs/day			
Number of workers:	Total Full time workers exposed 6,000-45,000			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it was noted that Bisulfite Impinger/Charcoal Tubes and Chromotropic Acid was used for Paper treatment and resin, others unknown
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US Cincinnati, OH and Buckport ME others are believed in the US
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - mean and range provided for paper treatment and resin; median and range provided for treated paper, and mean, median and range provided for coating
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	missing sampling location and worker activity
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided to access variability but no indication of uncertainty
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Rubber Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.04 ppm mean (range ND-0.04 ppm)			
Number of workers:	Total Full time workers exposed 6,128-27,586			
Comments:	Formaldehyde used as a preservative			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is missing details on sampling period and worker activities though it was noted that samples were collected using bisulfite impinger and Colorimetric Analysis was used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States (Denver, CO)
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data were from 1977
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata but missing worker activities, sampling location exposure and duration
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides no discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 21849 Table: 9 of 30

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	vapor			
Area sampling data:	Area samples near process machinery: 0.05ppm mean & median (0.03-0.07)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is missing details on sampling period though it was noted that Bisulfite Impinger/Colorimetric Analysis were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States (Vernon CA)
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data is from 1978
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - mean, median and range provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata but missing sampling location , exposure duration and frequency, number of workers and their activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty
Overall Quality Determination			Medium	

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Worker activity description:	Installers; Rapid worker turnover rate reported, with most employees leaving within 6 months			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.023 ppm TWA, 0.019 ppm Median (range 0.007-0.033 ppm)			
Exposure duration:	8 hrs/day			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US Portland OR	
	Metric 3: Applicability	High	Data are for an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data from 1978	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics - TWA, median and range provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata but missing type of measurement and method, descriptive worker activities, sampling location exposure duration	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring data does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Worker activity description:	dealers and installers; application of UF foam to commercial and residential buildings; exposures for applicators, laborers, trucking, and warehouse area;			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	total supply chain range 0.07-2.0 ppm, suburban shopping center I 1.05 mean (range 0.8-1.6 ppm); shopping center II 1.44 ppm mean (range 0.3-3.1 ppm); Shopping center III 1.56 ppm mean (range <0.5-3.0 ppm)			
Number of workers:	Total Full time workers exposed 2,000- 15,000			
Comments:	Primary sources are (1)Herrick, H.F. et al, 1983. Industrial hygiene characterization of urea-formaldehyde and polyurethane insulation. NIOSH Technical Report 83-108; NIOSH. (2) Industry selection for determination of extent of exposure. Memo from Larry Elliot, NIOSH Center for Disease Control, Cincinnati, OH to NIOSH, Washington, DC, 1979.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is missing details on sampling time though it was noted that supply chain IC; Shopping I Bisulfite Impinger/Colorimetric Annalysis; Shopping II Charcoal Tubes/Ion Chromatography; shopping III Draeger tubes were used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Article published in 1984 but the supply chain data were from 1983 and the others were from 1979
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - mean and range provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	missing number of sites, sampling location, exposure duration and frequency and worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	range can be used to assess variability but no indication of uncertainty
Overall Quality Determination			Medium	

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	aggregates area and personal sampling 0.9 ppm mean (range 0.2-1.9 ppm)			
Area sampling data:	aggregates area and personal sampling 0.9 ppm mean (range 0.2-1.9 ppm)			
Number of workers:	Total Full time workers exposed 500-900			
Comments:	Primary sources are Industry selection for determination of extent of exposure. Memo from Larry Elliot, NIOSH Center for Disease Control, Cincinnati, OH to NIOSH, Washington, DC, 1979.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	High	Data are for an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data were from 1983	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics - mean and range provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, but missing worker activities, type of measurement and method, number of sites sampling location, exposure duration and frequency.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Range provided for very limited discussion on variability but no indication of uncertainty	
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Non-TSCA			
EXTRACTION				
Parameter	Data			
Worker activity description:	exposure at mushroom farm			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	personal range ND-2.7 ppm			
Area sampling data:	Area I 2.68 ppm (range <0.51-10+ ppm); Area II range ND-4.93 ppm			
Exposure duration:	Personal sampling was short-term sampling			
Exposure frequency:	Intermittent			
Comments:	Primary source of exposure data: NIOSH. Walk-through survey report: Report no. 125.10 Butler County Mushroom Farm, Inc. Worthington, PA. NIOSH, Washington, DC 1980			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is missing sampling duration though it was noted that for Area I Draeger Tubes; all others Charcoal Tubes/Ion Chromatography were used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US Worthington, PA
	Metric 3:	Applicability	Uninformative	Data are for use as a fumigant/disinfectant, which is a non-TSCA use
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided for Area I the others were just range of values
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	missing: sampling location, number of workers, exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Data does not address variability or uncertainty except range is provided to appreciate variability but no indication of uncertainty.
Overall Quality Determination		Uninformative		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	pathologists			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Study I 4.8 ppm median (range 0.06-7.9 ppm); Study II 4.35 ppm (range 2.2-7.9 ppm)			
Exposure duration:	Intermittent			
Number of workers:	Total parttime workers exposed 12,400			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified for all data though it was noted that Hopkins Bisulfite Impinger / Chromotropic Acid was used the other locations were unknown
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1979 studies
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	missing exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range and different studies provided to appreciate variability but no indication of uncertainty
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Study I 2.25 ppm (range 2.2-2.3 ppm); II 1.9 ppm,			
Area sampling data:	Study III 2.0 ppm (range 2.0-2.0 ppm)			
Comments:	Primary source is Blade, L. M. Occupational exposure to formaldehyde-recent NIOSH involvement. In: Formaldehyde: Toxicology-Epidemiology-Mechanisms, 1983, pp1-23.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not fully specified though it was noted that for Study I Bisulfite Impinger; Study II & III Charcoal Tubes were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Unknown but assume in the US
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1983
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided for Study I the others do not make sense
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	missing: analytical methods, number of workers and sites, worker activities, sampling location, exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	2.4 ppm			
Area sampling data:	0.8 ppm			
Comments:	Primary source is Blade, L. M. Occupational exposure to formaldehyde-recent NIOSH involvement. In: Formaldehyde: Toxicology-Epidemiology-Mechanisms, 1983, pp1-23.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified though it was noted that Charcoal Tubes were used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Unknown but assume in the US
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1983
	Metric 5:	Sample Size	Low	Sample distribution characterized by limited statistics - Range provided but does not make sense
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	missing: sampling and analytical methods,number of workers and activities, exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	no indication of variability or uncertainty
Overall Quality Determination		Low		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Study II 0.41 ppm mean (range 0.27-0.63 ppm)			
Area sampling data:	Study I 0.42 ppm mean (range ND - 0.90 ppm); Study III 0.51 mean (range 0.04-0.5 ppm)			
Comments:	Primary source is Blade, L. M. Occupational exposure to formaldehyde-recent NIOSH involvement. In: Formaldehyde: Toxicology-Epidemiology-Mechanisms, 1983, pp1-23.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling is partially specified for Study I & II Charcoal Tubes; Study 3 CEA instrument Model 555 were used, but analytical methodology is not specified
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Unknown but assume in the US
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1983
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing: sampling and analytical methods, sampling locations, exposure duration and frequency, number of sites, workers and their activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	vapor			
Personal sampling data:	Study I 0.55 ppm mean (range 0.04-1.6 ppm)			
Area sampling data:	Study II 0.17 ppm mean (range 0.03-0.43 ppm)			
Number of workers:	Total Full time workers exposed 2,680; Total part time workers exposed 2,220			
Comments:	Primary source is Blade, L. M. Occupational exposure to formaldehyde-recent NIOSH involvement. In: Formaldehyde: Toxicology-Epidemiology-Mechanisms, 1983, pp1-23.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not fully specified though it was noted that Bisulfite Impingers were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Unknown but assume in the US
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1983
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	missing sampling and analytical methods, number of sites, worker activities, sampling location, exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.		
HERO ID:	21849		
Conditions of Use:	Laboratory Use		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	0.55 ppm mean (range 0.37-0.73 ppm)		
Comments:	Primary source is Blade, L. M. Occupational exposure to formaldehyde-recent NIOSH involvement. In: Formaldehyde: Toxicology-Epidemiology-Mechanisms, 1983, pp1-23.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not fully specified though it was noted that Bisulfite Impingers were used
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Unknown but assume in the US
	Metric 3: Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1983
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Missing: sampling and analytic methods, number of sites, number of workers and their activities, sampling location, exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty
Overall Quality Determination		Medium	

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Study I 0.56 ppm mean (range <0.25-0.85 ppm)			
Area sampling data:	Study II 1.17 ppm mean (range 0.28-3.4 ppm)			
Comments:	Primary source is Blade, L. M. Occupational exposure to formaldehyde-recent NIOSH involvement. In: Formaldehyde: Toxicology-Epidemiology-Mechanisms, 1983, pp1-23.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not fully specified though it was noted that for Study I Chromotropic Acid; Study II CEA instrument Model 555 were used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Unknown but assume in the US
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1983
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	missing: sampling and analytical methods, number of sites, number and activity of workers, sampling location, exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 21849 Table: 21 of 30

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.		
HERO ID:	21849		
Conditions of Use:	Office Environment		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	Area 0.06 mean (range 0.02-0.12 ppm); <0.04 mean (<0.04)		
Comments:	Primary source is Blade, L. M. Occupational exposure to formaldehyde-recent NIOSH involvement. In: Formaldehyde: Toxicology-Epidemiology-Mechanisms, 1983, pp1-23.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not fully specified though it was noted that for Study I Bisulfte Impinger; Study II Charcoal Tubes were used
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Unknown but assume in the US
	Metric 3: Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1983
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics - mean and range provided but the data for Study II does not make sense
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Missing: sampling and analytical methods, worker numbers and activities, sampling location, exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty
Overall Quality Determination		Medium	

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.
HERO ID:	21849
Conditions of Use:	Laboratory Use

EXTRACTION	
Parameter	Data
Worker activity description:	Resident, Pathologist, Technician, Assistants
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	Resident 1.58 ppm mean; Pathologist 1.24 ppm; Technician 0.57 ppm; Assistant 0.16 ppm,
Area sampling data:	Area 0.72 (range 0.13-13.57 ppm)
Number of workers:	Total part time workers exposed 12,400
Comments:	Primary source is Makar et al., 1975 Formatte assays in body fluids application in methanol poisoning Biochem. Med. 13:117-126.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not fully specified though it was noted that Chromotropic Acid analysis was used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Unknown but assume in the US
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1983
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Mean provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing sampling and analytical methods, number of sites, worker activities, sampling locations, exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided for area samples to appreciate variability but no indication of uncertainty

Overall Quality Determination	Medium

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	By mix and storage tanks; data indicated no exposure in work area where majority of work time spent			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	coating preparation 1 ppm mean, 0.01 median (range <0.01-3 ppm); coating preparation 0.51 ppm mean 0.42 ppm median(range 0.8-42)**			
Exposure duration:	Sampling period grab, 30-200 min. Exposure duration ca. 30 sec			
Exposure frequency:	20 times/day			
Comments:	** Range provided for Coating preparation indicates error in provided range.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Uninformative	No sampling or analytical methodology not specified and provided data indicates error in reporting.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study does not provide discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Uninformative		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Study I 0.42 ppm			
Area sampling data:	Study II 0.54 ppm mean (range 0.45-0.64 ppm)			
Comments:	Primary source is Blade, L. M. Occupational exposure to formaldehyde-recent NIOSH involvement. In: Formaldehyde: Toxicology-Epidemiology-Mechanisms, 1983, pp1-23.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified though it was noted that charcoal tubes were used for sampling
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Unknown but assume in the US
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1983
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided though Study I range does not make sense
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing: sampling and analytical methodology, number of sites, worker activities, sampling location, exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Worker activity description:	: Bronze foundry and coring; Iron foundry and coring; Molding			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Bronze personal 0.53 ppm mean 0.55 ppm median (range 0.24-0.80); Iron foundry I 0.43 ppm median (range <0.02-18.3 ppm); Iron foundry II 0.16 ppm mean (range 0.07-0.33 ppm); Molding personal 0.09 ppm mean (0.03-0.13 ppm)			
Area sampling data:	Bronze area 0.39 ppm mean and median (range 0.12-0.69 ppm) Molding area 0.21 ppm mean (range 0.07-0.78)			
Exposure duration:	only bronze area sampling was for 2 hours and personal sampling was for 3-4 hrs			
Exposure frequency:	Bronz foundry and Iron Foundry was 8 hrs/day			
Number of workers:	Total Full time workers exposed 28,638			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not fully specified though it was noted that Bisulfite Impinger/Chromotropic Acid/Colorimetric analysis were used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Unknown but assume in the US
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but study was for 1974
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - mean, median and range provided for Bronz foundries; median and range provided for Iron foundries, all others were mean and range
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing sample location and worker activity
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range could be used to understand variability, no indication of uncertainty
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Study I 0.23 -0.33 ppm mean (range <0.14-0.63 ppm)			
Area sampling data:	Study II 0.19-0.26 ppm mean (range <0.03-0.40 ppm); Study III 0.21 ppm mean (range 0.03-0.40 ppm); Study IV 0.46 ppm (range 0.05-1.12 ppm)			
Number of workers:	Total Full time workers exposed 771,420; Total part time workers exposed 125,580			
Comments:	Primary source is Blade, L. M. Occupational exposure to formaldehyde-recent NIOSH involvement. In: Formaldehyde: Toxicology-Epidemiology-Mechanisms, 1983, pp1-23.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is only partially specified though for Study I Chromotropic acid; Study II Bisulfite Impinger; Study III CEA instrument Model 555 were used	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Unknown but assume in the US	
	Metric 3: Applicability	High	Data are for an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1983	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Missing sampling and analytical methods, worker activities, sampling location, exposure duration and frequency	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty	
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Study I range <0.38-1.04 ppm			
Area sampling data:	Study II 0.15 ppm mean (range 0.05-0.4 ppm); Study III 0.18 ppm mean (range 0.11-0.29 ppm)			
Comments:	Primary source is Blade, L. M. Occupational exposure to formaldehyde-recent NIOSH involvement. In: Formaldehyde: Toxicology-Epidemiology-Mechanisms, 1983, pp1-23.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not fully specified though it was noted that for Study I Chromotropic acid; Study II Bisulfite Impinger; Study III CEA instrument Model 555 were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Unknown but believe in the US
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1983
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing sampling and analytical methods, number of sites, number of workers and their activities, sampling locations, exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty
Overall Quality Determination			Medium	

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.		
HERO ID:	21849		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	veneer press, veneer core press, veneer adhesives		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	Plant 0.12 ppm mean (range 0.008-0.25ppm); veneer press 2.75 ppm mean (range 0.9-6.4 ppm); veneer core press 0.40 ppm mean (range 0.2-055 ppm); core veneer adhesives 0.70 ppm mean (range 0.25-2.5)		
Number of workers:	Total Full time workers exposed 47,322		
Comments:	Herrick, H.F. et al, 1983. Industrial hygiene characterization of urea-formaldehyde and polyurethane insulation. NIOSH Technical Report 83-108		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology provided was bisulfite impingers and chromotropic acid procedure.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data.
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data from 1983 study
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics - Mean, range, but no standard deviation.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but missing number of sites, sampling location, exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Range provided for variability but no indication of uncertainty
Overall Quality Determination		Medium	

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Worker activity description:	embalming			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	both area and personal sampling:Study II 1.1 mean 0.54 ppm median (range 0.20-3.99 ppm); Study III 2.7 ppm mean 2.49 ppm median (range 1.3-3.93 ppm)			
Area sampling data:	Study I 0.74 ppm mean (range 0.09-5.26 ppm); Study II 1.1 mean 0.54 ppm median (range 0.20-3.99 ppm); Study III 2.7 ppm mean 2.49 ppm median (range 1.3-3.93 ppm)			
Exposure duration:	Study II sampling period 70-190 min; Study III 300 min			
Number of workers:	Total partime workers exposed 52,000-70,200			
Comments:	Primary sources for the data are: (1) Kerfoot et al., 1975. Formaldehyde and paraformaldehyde study in funeral homes. Am Ind. Hyg. Assoc. J. 36: 533-537. (2) NIOSH. Health Hazard Evaluation Determination Report HE-76-146-670, Cincinnati College of Mortuary Science, Cincinnati, OH. NIOSH, Washington, DC.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is missing sample duration though it was noted that for Study I Chromotropic Acid and for the others charcoal tubes were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data from two studies dated 1975 and 1980
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - mean and range provided for Study I, other included mean median and range
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Missing sampling location and exposure frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty
Overall Quality Determination		Medium		

Study Citation:	Lucier, G.W., Hook, G.E. (1984). Report on the consensus workshop on formaldehyde. Environmental Health Perspectives 58(12):323-381.			
HERO ID:	21849			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Dissection of cats saturated in formalin			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	8.3 ppm mean (range 2.75-14.8 ppm)			
Exposure duration:	Intermittent			
Number of workers:	Total partime workers exposed 35,000			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is noted that Bisulfite Impinger /Chromotropic Acid analysis were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Article published in 1984 but data are from 1981
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Range and mean provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	missing : number of sites, exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range provided to appreciate variability but no indication of uncertainty
Overall Quality Determination		Medium		

Study Citation:	Lukcsó, D., Guidotti, T.L., Franklin, D.E., Burt, A. (2014). Indoor Environmental and Air Quality Characteristics, Building-Related Health Symptoms, and Worker Productivity in a Federal Government Building Complex. Archives of Environmental and Occupational Health 71(2):0.			
HERO ID:	2534854			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	0.01 ppm geometric mean, standard deviation 0.008 ppm; Maximum 0.046 ppm			
Particle size characterization:	PM10 0.012 mg/m3 geometric mean max 95th percentile 0.04 mg/m3			
Number of workers:	15,704 occupants (NSA employees) Of the 15,704 qualified employees, 7,637 (48.6%) responded to the survey.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Based on NIOSH study - Passive sampling dosimeters, usually 3/study area: SKC (Eighty Four, PA) UMEX-100 first 2 rounds, 3M (Minneapolis, MN); model 3720 third round
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Uninformative	Office exposure may be subject to other regulations
	Metric 4:	Temporal Representativeness	Medium	The study was published in 2014 using data from a 2005 survey, after the most recent PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Medium	Geometric mean, standard deviation and maximum value
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Data included sample type and exposure type, butlacks additional metadata, such as sample durations, exposure durations, exposure frequency, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The study provided standard deviation data that can be used to evaluate variability. As the data for this report is based on a NIOSH study uncertainty was likely considered in the sampling and analysis methodology used.
Overall Quality Determination		Uninformative		

Study Citation:	Luker, M.A., Vanhouten, R.W. (1990). Control of formaldehyde in a garment sewing plant. American Industrial Hygiene Association Journal 51(10):541-544.		
HERO ID:	5951421		
Conditions of Use:	Processing for incorporation into an article		
EXTRACTION			
Parameter	Data		
Worker activity description:	Sewing pants in industrial setting with machine; steam pressing pants; resin curing in oven ; packing/shipping pants after curing		
Physical form:	Off-gas from use in resin system that has 350 to 400ppm formaldehyde (and transition to resin with 160 ppm formaldehyde)		
Personal sampling data:	Worker formaldehyde exposure ranged from 0.46 ppm to 1.13 ppm (Mean of 0.82 ppm) for 400 ppm formaldehyde fabric; Worker formaldehyde exposure ranged from 0.09 ppm to 0.24 ppm (Mean of 0.13 ppm) for 160 ppm formaldehyde fabric;		
Area sampling data:	Area formaldehyde exposure ranged from 0.42 ppm to 1.40 ppm (Mean 0.92 ppm in A.M. and 1.05 ppm in P.M.) for 400 ppm formaldehyde fabric; Area formaldehyde exposure ranged from 0.11 ppm to 0.47 ppm (Mean 0.20 ppm in A.M. and 0.38 ppm in P.M.) for 160 ppm formaldehyde fabric;		
Number of workers:	Sewing: 270, Steam Pressing: 30, Resin Curing: 2, Packing/Shipping: 15		
Engineering control:	Decrease from 400 ppm resin system to 160 ppm resin system caused reduction of 80-85% in formaldehyde concentrations; suggests need for exhaust ventilation and not 100% recirculation of air		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for incorporation into article, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	High	The sample is well characterized (separate data for each occupation and also A.M. and P.M. data).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by changing process parameters and temporal changes for various areas, but uncertainty is not addressed.
Overall Quality Determination		High	

Study Citation:	Lyapina, M., Zhelezova, G., Petrova, E., Boev, M. (2004). Flow cytometric determination of neutrophil respiratory burst activity in workers exposed to formaldehyde. International Archives of Occupational and Environmental Health 77(5):335-340.			
HERO ID:	626727			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	gluing			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	mean values for the average shift concentrations were 0.87 +/-0.39 mg/m3 (min 0.64 mg/m3; max 1.92 mg/m3)			
Exposure duration:	12.7+/- 9.6 yeas			
Number of workers:	29			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it was noted that infrared gas analyzer Miran 1B2 was used
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Bulgaria - not an OECD member
	Metric 3:	Applicability	High	Data are for glue application is in-scope occupational scenario
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2004.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, min, max) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type not provided nor were other metadata such as sampling location, number of samples, employee activities, sampling and analytic methods, exposure frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by providing mean, min and max values, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Löfstedt, H., Westberg, H., Seldén, A.I., Bryngelsson, I.L., Svartengren, M. (2011). Respiratory symptoms and lung function in foundry workers using the hot box method: A 4-year follow-up. Journal of Occupational and Environmental Medicine 53(12):1425-1429.			
HERO ID:	1313413			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers who are exposed to fumes emanating from the Hot Box method.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	2001: 98 ug/m3 mean, SD 94 ug/m3, geometric mean 66 ug/m3 GSD 1.1 ug/m3 (range 14-440 ug/m3); 2005: 45 ug/m3 mean, SD 43 ug/m3, geometric mean 35 ug/m3 GSD 1.0 ug/m3 (range 10-190 ug/m3)			
Exposure duration:	full shift			
Number of workers:	25			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified but a source containing the method is cited.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - an OECD member
	Metric 3:	Applicability	High	The data are for brass foundry workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The study was derived from data compiled in 2005 after the PEL (1992) and more than 10 but less than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized with mean and standard deviation, geometric means and geometric standard deviation and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	most meta data was provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Löfstedt, H., Westberg, H., Seldén, A.I., Lundholm, C., Svartengren, M. (2009). Respiratory symptoms and lung function in foundry workers exposed to low molecular weight isocyanates. American Journal of Industrial Medicine 52(6):455-463.			
HERO ID:	1313574			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Worker activity description:	Coremakers, die casters, and other exposed			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	aggregated total exposure: 190 ug/m3 mean, SD 250 ug/m3, geometric mean 120 ug/m3, GSD 2.8 ug/m3 (range 14-1600 ug/m3); Core makers: 280 ug/m3 mean, SD 290 ug/m3, geometric mean 200 ug/m3 GSD 2.1 ug/m3 (range 50-1600 ug/m3); die casters: 80 ug/m3 mean, SD 58 ug/m3, geometric mean 63 ug/m3 GSD 2.1 ug/m3 (range 21-220 ug/m3); Other exposed: 46 ug/m3, SD 50 ug/m3, geometric mean 32 ug/m3 GSD 2.2 ug/m3 (range 14-170 ug/m3)			
Exposure duration:	measurement was for a full 8-hour shift.			
Number of workers:	64			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - an OECD member
	Metric 3:	Applicability	High	The data are for foundry workers, which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report was published in 2009, after the most recent PEL (1992) and more than 10 and less than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	The study includes all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided standard deviation and range data for three different exposure groups that can be used to evaluate variability in the data. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Löfstedt, H., Westberg, H., Seldén, A.I., Rudblad, S., Bryngelsson, I.L., Ngo, Y., Svartengren, M. (2011). Nasal and ocular effects in foundry workers using the hot box method. Journal of Occupational and Environmental Medicine 53(1):43-48.
HERO ID:	1313473
Conditions of Use:	Foundries

EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	type of sampling not provided assumed it was area. Short duration sampling: 51 ug/m3 mean, SD 49 ug/m3, geometric mean 37 ug/m3 GSD 2.1 ug/m3 (range 13-190 ug/m3)
Particle size characterization:	Short duration sampling- total dust: 510 ug/m3 mean, SD 500 ug/m3, geometric mean 360 ug/m3 GSD 2.3 ug/m3 (range 62-2900 ug/m3)
Exposure duration:	8 hrs
Number of workers:	48
Comments:	the data pertain to workers who were exposed to emissions arising from the thermal degradation of the chemical binders used in the Hot Box method

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified, but all analyses were performed in the laboratory of the Department of Occupational and Environmental Medicine, Orebro University Hospital. The laboratory is accredited by the Swedish Board for Accreditation and Conformity Assessment.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - an OECD member
	Metric 3:	Applicability	High	The data are for bronze foundry workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The study was published in 2011 after the latest PEL (1992) and less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized with mean and standard deviation, geometric means and geometric standard deviation and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.

Overall Quality Determination

Medium

Study Citation:	Malaka, T., Kodama, A.M. (1990). Respiratory health of plywood workers occupationally exposed to formaldehyde. Archives of Environmental Health 45(5):288-294.			
HERO ID:	61242			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	plywood workers			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	1.13 ppm mean			
Area sampling data:	range 0.28-3.48 ppm; Plywood: 0.64 ppm mean (range 0.22-2.3 ppm); Particle board 2.36 ppm mean (range 1.16-3.48 ppm); 0.50 ppm mean (range 0.38-0.61 ppm); logistic warehouse 0.07 ppm mean; sawmill 0.02 ppm mean; log pond 0.07 ppm mean; woodworking 0.003 ppm mean.			
Particle size characterization:	plywood 0.47 mg/m3 respirable dust 0.77 mg/m3 total dust; particle board 1.30 mg/m3 respirable dust 5.78 mg/m3 total dust; block board 0.62 mg/m3 respirable dust 1.28 mg/m3 total dust; sawmill 0.73 mg/m3 respirable dust 2.16 mg/m3 total dust; logistic warehouse 0.17 mg/m3 respirable dust 0.28 mg/m3 total dust; Average 0.60 mg/m3 respirable dust 1.35 mg/m3			
Number of workers:	186 male worker			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not an approved OSHA or NIOSH method. Differences in methods are not expected to lead to lower quality data. Sampling was implemented using a passive bubbler and a compact dedicted colorimeter using 3-methyl-2-benzothiazoline hydrazone hydrochloride as recommended by the American Public Health Association
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	location for data was Indonesia - not an OECD member
	Metric 3:	Applicability	High	The data are for plywood manufacture which is an occupational scenario within the scope of the risk evaluation. Though it may be excluded as it may be subject to other regulations
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1990, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average values and range for different wood products; uncertain statistics not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) and type of wood product, but no other metadata.
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 61242 Table: 1 of 1

...continued from previous page

Study Citation:		Malaka, T., Kodama, A.M. (1990). Respiratory health of plywood workers occupationally exposed to formaldehyde. Archives of Environmental Health 45(5):288-294.		
HERO ID:		61242		
Conditions of Use:		Compressed Wood Product Manufacturing		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	Medium	The study provided range values for each wood product which can be used to assess variability. The study did not provide a discussion of the uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 5947051 Table: 1 of 1

Study Citation:	Maniscalco, M., Paris, D., Melck, D., Chiariello, N., Napoli, F.D., Manno, M., Iavicoli, I., Motta, A. (2018). Biomonitoring of workers using nuclear magnetic resonance-based metabolomics of exhaled breath condensate: A pilot study. Toxicology Letters 298:4-12.			
HERO ID:	5947051			
Conditions of Use:	Uncertain			
EXTRACTION				
Parameter	Data			
Worker activity description:	20 blue-collar workers of a friction system plant			
Exposure route:	inhalation			
Personal sampling data:	Formaldehyde concentrations from personal sampling of the blue collars: airborne levels in the investigated workplace - <0.002 mg/m3; TLV-TWA – 0.37 mg/m3.			
Area sampling data:	no information available for area sampling			
Number of workers:	20 blue-collar workers and 10 white-collared workers as controls			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Low	The data are for an occupational scenario that is uncertain but may be similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Manufactured Housing Inst, (1985). Letter from manufactured housing institute to US EPA commenting on the two ICF draft reports with attachments.			
HERO ID:	5901016			
Conditions of Use:	Building and construction materials (manufactured homes)			
EXTRACTION				
Parameter	Data			
Worker activity description:	particleboard/plywood in manufactured homes (pg 3); 663 homes sampled; 60% <4 years old, 92% <15 years old (pg 3)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	pg 3: mean for older homes: 0.061 ppm; mean for newer model homes (1981-84): 0.08 ppm; mean for all homes: 0.072 ppm; range for all homes: 0.01-0.464 ppm; median for homes <1 year old: 0.153 ppm; media for homes >1 year old: 0.073 ppm; average 0.1 ppm for new homes and for homes >16 years old: 0.03 ppm			
Comments:	week-long concentrations via passive sampling (pg 3) Width of floor board provided (pg 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Full Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, medians, range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by presenting statistics for newer and older manufactured homes. Uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Manville Serv Corp, (1987). Summary of industrial hygiene monitoring data representing studies taken at four Manville Corp manufacturing locations relative to five chemicals with cover letter dated 070887.			
HERO ID:	4158385			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Personal sampling data:	0.00- 20.0 ppm is the range of annual averages from 1962 to 1985, including personal and area samples. Individual yearly averages are available on page 7.			
Area sampling data:	0.00- 20.0 ppm is the range of annual averages from 1962 to 1985, including personal and area samples. Individual yearly averages are available on page 7.			
Number of workers:	45 sampled in this study			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are form the U.S.
	Metric 3:	Applicability	Low	It is unclear what the scope of the report is, as it only includes sample data.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means and ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Exposure concentrations provided but missing most other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	Manville Serv Corp, (1987). Industrial hygiene monitoring data representing studies taken at four manville corp manufacturing locations.			
HERO ID:	5466871			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Personal sampling data:	In a plant in Waterville, OH, annual mean formaldehyde concentrations ranged between 0.09 and 3.52 ppm between 1962 and 1985. Number of personal samples were 21 and number of area samples were 202. Between 1962 and 1980, only area samples were collected. The highest average value was observed in 1977 as 3.52 ppm, while the lowest was 0.1 ppm in 1976. The average values shown between 1981 and 1985 are averages of personal sampling and area sampling, and the highest average value was observed in 1985 as 0.24 ppm.			
Area sampling data:	In a plant in Waterville, OH, annual mean formaldehyde concentrations ranged between 0.09 and 3.52 ppm between 1962 and 1985. Number of personal samples were 21 and number of area samples were 202. Between 1962 and 1980, only area samples were collected. The highest average value was observed in 1977 as 3.52 ppm, while the lowest was 0.1 ppm in 1976. The average values shown between 1981 and 1985 are averages of personal sampling and area sampling, and the highest average value was observed in 1985 as 0.24 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	Medium	characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Markel, H. L. (1985). Health hazard evaluation report: HETA-84-337-1611 - Federal building, Dallas, Texas.			
HERO ID:	1322650			
Conditions of Use:	Use of Cleaning and Furniture Care Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	employees performing duties at various locations within the Federal building (Page 4 of 11)			
Area sampling data:	non-detectable levels of formaldehyde (Page 8 of 11)			
Comments:	[in general] Building-related illness episodes have been reported more frequently in recent years as buildings have been made more air-tight to conserve energy and reduce air conditioning costs. (Page 5 of 11) Formaldehyde and other aldehydes may be released from foam plastics, carbonless paper, particle board, plywood and textile fabrics. (Page 6 of 11)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	USA
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	From 1984
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1317814 Table: 1 of 1

Study Citation:	Marlow, D. A. (1995). Health hazard evaluation report HETA 94-0309-2514, Homecrest Industries Incorporated, Wadena, Minnesota.				
HERO ID:	1317814				
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product				
EXTRACTION					
Parameter	Data				
Worker activity description:	Workers in the soft goods department have the job title of Cutter, Sewer, or Cushion Finisher. A Cutter rolls out fabric in layers on long tables and cuts the layered fabric using a Greber fabric cutter. A Sewer sews the cut fabric into cushions and coverings, sometimes using a PVC coated polyester yarn backing called Phifertex®. A Cushion Finisher cuts polyester filler, places the filler into the cushions, and then completes the sewing.				
Exposure route:	Inhalation				
Physical form:	Vapor				
Personal sampling data:	Sewer nondetectableSewer nondetectableSewer nondetectableSewer nondetectableCushion Finisher nondetectableSewer nondetectable				
Area sampling data:	In Soft Goods Dept 0.01 ppmIn Fabric storage 0.14 ppmNext to Greber nondetectableFabric storage 0.12 ppm				
Number of workers:	45				
Engineering control:	Improve ventilation in Fabric Storage area				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH study- Methods 3500 and 2539		
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US		
	Metric 3: Applicability	High	The data are for an occupational scenario (home goods products) within the scope of the risk evaluation.		
	Metric 4: Temporal Representativeness	Medium	1994 - After the PEL (1992) but more than 20 years old		
	Metric 5: Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed, but assumed addressed in the NIOSH methods used		
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, exposure durations, and worker activities, but lacked exposure frequency.		
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in Methods 3500 and 2539.		
Overall Quality Determination		High			

Study Citation:	Marsh, G., Youk, A., Stone, R., Buchanich, J., Gula, M., Smith, T., Quinn, M. (2001). Historical cohort study of US man-made vitreous fiber production workers: I. 1992 fiberglass cohort follow-up: Initial findings. Journal of Occupational and Environmental Medicine 43(9):741-756.			
HERO ID:	706911			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Calculated median mean and coefficient of variation provided for each plant included in Table 4 of supplemental information (all plants Median 0.066 ppm, mean 0.076 ppm and CV 0.928) also provided was cumulative exposure for each plant (Median 0.173 ppm-yrs, Mean 0.546 ppm-yrs; CV 1.710 ppm-yrs)			
Exposure duration:	See Table 4 of Supplemental information			
Number of workers:	17558 (1992)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	Data are for fiberglass productions which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years and after the PEL- Article published in 2001 but the monitoring data was from 1992
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (median, mean, and Coefficient of Variance) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type and exposure type not provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by the coefficient of variance and data for 10 plants, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Marsh, G.M., Morfeld, P., Zimmerman, S.D., Liu, Y., Balmert, L.C. (2016). An updated re-analysis of the mortality risk from nasopharyngeal cancer in the National Cancer Institute formaldehyde worker cohort study. Journal of Occupational Medicine and Toxicology 11:8.			
HERO ID:	3129860			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Area sampling data:	Data from 10 manufacturing plants were presented in this report. The median average intensity of exposure (AIE) for these plants ranged between 0.080 ppm (Plant 7) and 2.799 (Plant 2).			
Number of workers:	25,619 worker			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	Data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data collected more than 20 years ago.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Study does address variability by comparing exposure from different plants but does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Marsh, G.M., Stone, R.A., Esmen, N.A., Henderson, V.L., Lee, K.Y. (1996). Mortality among chemical workers in a factory where formaldehyde was used. Occupational and Environmental Medicine 53(9):613-627.			
HERO ID:	82659			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Chemical plant workers			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	exposure <0.01 - >5 ppm was based on job classification- the underlying data were not provided.			
Number of workers:	7359 workers accessed for health effects			
Comments:	long term workers (employed > 1 y)short term workers (employed < 1 y)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US CT
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after the PEL- -Published 1996
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	actual sampling data not included in this paper, missing: sampling and analysis methodology, number of samples, number of sites, worker activities, type of sampling, exposure concentrations, exposure frequency, and number of workers.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Uninformative	no concentration data were provided
Overall Quality Determination		Uninformative		

Study Citation:	Marsh, G.M., Youk, A.O. (2004). Reevaluation of mortality risks from leukemia in the formaldehyde cohort study of the National Cancer Institute. Regulatory Toxicology and Pharmacology 40(2):113-124.			
HERO ID:	56914			
Conditions of Use:	Industrial/commercial use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Personal sampling data:	For highest peak exposure, the authors observed statistically significant 50–63% deficits in leukemia mortality for unexposed subjects and subjects in the lowest exposure category (>0–1.9 ppm), which NCI used as the baseline category for RRs. US and regional SMRs in NCI’s middle exposure category (2.0–3.9 ppm) are essentially null (SMRs = 1.00 and 1.04, respectively) and only moderately elevated in the highest exposure category (4.0+ ppm) (SMRs = 1.24 and 1.31, respectively). For all leukemia, we observed slightly smaller 29–30% deficits in deaths among subjects in NCI’s RR baseline category (>0–0.4 ppm), but these deficits remain statistically significant or nearly significant.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology is an approved method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	the data is more than 10 years and less than 20 years
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Adequate discussion on variability but limited discussion on uncertainty
Overall Quality Determination		High		

Study Citation:	Marsh, G.M., Youk, A.O. (2005). Reevaluation of mortality risks from nasopharyngeal cancer in the formaldehyde cohort study of the National Cancer Institute. Regulatory Toxicology and Pharmacology 42(3):275-283.			
HERO ID:	86683			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Median Average intensity of formaldehyde exposure: plant 1 1.023 ppm; plant 2 2.799 ppm; plant 3 0.112 ppm; plant 4 0.234 ppm; plant 5 0.196 ppm; plant 6 0.233 ppm; plant 7 0.080ppm; plant 8 0.382 ppm; plant 9 0.400 ppm; plant 10 0.543 ppm;			
Exposure duration:	median duration in years provided for each plant (see supplemental tab)			
Exposure frequency:	median cumulative ppm- years provided for each plant (see supplemental tab)			
Number of workers:	details at each 10 plant are provided in Table 1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Low	unclear what industry the plants represent
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - published 2005
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - mean average values were provided along with 5-95 tile value
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing: sampling and analysis methods, number of samples, sampling locations, and worker activity,
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	some information on variance was provided but nothing about uncertainty
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 626531 Table: 1 of 1

Study Citation:	Marsh, G.M., Youk, A.O., Buchanich, J.M., Cassidy, L.D., Lucas, L.J., Esmen, N.A., Gathuru, I.M. (2002). Pharyngeal cancer mortality among chemical plant workers exposed to formaldehyde. Toxicology and Industrial Health 18(6):257-268.			
HERO ID:	626531			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	average intensity of exposure 0.138 ppm for this cohort study exposure was grouped into 3 bins (< 0.03 ppm, 0.03-0.159 ppm > 0.16 ppm)			
Number of workers:	7328 (that worked at a plastics plant from 1941 -1984)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for plastic product manufacture, an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (published 2002) after the most recent PEL establishment (1992), and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata were provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Marsh, G.M., Youk, A.O., Buchanich, J.M., Erdal, S., Esmen, N.A. (2007). Work in the metal industry and nasopharyngeal cancer mortality among formaldehyde-exposed workers. Regulatory Toxicology and Pharmacology 48(3):308-319.			
HERO ID:	626530			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	plastics-producing workers			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	used historical exposure reconstruction methods: average intensity of exposure was 0.138 ppm (short term 0.079 and long term 0.168 ppm)			
Number of workers:	7345			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for plastic product manufacture an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 2007, after the most recent PEL (1992) more than 10 years but not more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 6116836 Table: 1 of 1

Study Citation:	Marshall, E. (1987). EPA indicts formaldehyde, 7 years later. Science 236(4800):381.			
HERO ID:	6116836			
Conditions of Use:	Garment industry			
EXTRACTION				
Parameter	Data			
Area sampling data:	<0.5 ppm			
Number of workers:	777,000			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 626188 Table: 1 of 1

Study Citation: Matanoski, G. M. (1989). Risks of pathologists exposed to formaldehyde (final report).
HERO ID: 626188
Conditions of Use: Laboratory Use

EXTRACTION

Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Number of workers:	6411 physicians who would have had occupational exposure to formaldehyde because of their membership in pathology societies...It assumes all members of these societies are likely exposed (not sure about bacteriologists). Some the societies include clinical staff who may not be involved in pathology.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	no sampling involved
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for an occupational scenario (pathologist) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Published in 1989, 3 years prior to the PEL (1992).
	Metric 5: Sample Size	Low	Data was limited to mortality data, no other exposure or engineering data provided.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Data was limited to mortality data, no other exposure or engineering data provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Uninformative	Data was limited to mortality data, no other exposure or engineering data provided.

Overall Quality Determination **Uninformative**

Study Citation:	Materna, B.L., Jones, J.R., Sutton, P.M., Rothman, N., Harrison, R.J. (1992). Occupational exposures in California wildland fire fighting. AIHA Journal 53(1):69-76.		
HERO ID:	13709		
Conditions of Use:	Firefighting		
EXTRACTION			
Parameter	Data		
Worker activity description:	waiting at base camp; fireline mopping up and prescribed burning.		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	0.16 mg/m3 mean (range 0.048-0.42 mg/m3)		
Particle size characterization:	base camp 3.27 mg/m3 mean (range 1.8-4.4 mg/m3); Fireline mop up 9.46 mg/m3 (range 2.7-37.4 mg/m3); fireline mop up respirable 1.75 mg/m3 mean (range 0.327-5.14 mg/m3); prescribed burning respirable 1.15 mg/m3 mean (range 0.235-2.71 mg/m3)		
Number of workers:	80,000 firefighters involved in 70,000 fires burning a total of 2 millions acres		
Personal protective equipment:	Recommended use of appropriate respirators		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling / analytical methodology was implemented using NIOSH method 2539 for 10% of the samples, all samples were analyzed using appropriate NIOSH methods used by NIOSH chemists at the Methods Research and Support Branch, Cincinnati, Ohio.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from California and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The data are for wild fire fighters which is a scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The data were from three fire seasons from 1987 to 1989, prior to the most recent PEL (1992) and was more than 20 years old.
	Metric 5: Sample Size	High	Distribution of samples is characterized by a mean and range uncertain was assumed to be considered in the use of NIOSH methods.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	The monitoring data were for personal sampling for mountainous locations at elevations up to 7800 ft, but no additional metadata were provided such as sampling and analytic methods, number of sites, sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study provides data ranges for different firefighting activities which can be helpful in evaluating variability. Uncertainty was included in the NIOSH methods used.
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 13709 Table: 1 of 1

...continued from previous page

Study Citation:	Materna, B.L., Jones, J.R., Sutton, P.M., Rothman, N., Harrison, R.J. (1992). Occupational exposures in California wildland fire fighting. AIHA Journal 53(1):69-76.		
HERO ID:	13709		
Conditions of Use:	Firefighting		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Mathur, N., Rastogi, S. K. (2007). Respiratory effects due to occupational exposure to formaldehyde: Systematic review with meta-analysis. Indian Journal of Occupational and Environmental Medicine 11(1):26-31.			
HERO ID:	1313679			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	not clear but likely area sampling: Alexanderson (1984) 0.62 ppm mean; follow up study Nunn (1990) range 0.1-2.0 ppm			
Number of workers:	Number of workers studied: Alexanderson (1984) 109; follow up study Nunn (1990) 164			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown	
	Metric 3: Applicability	High	The data are for particle board workers which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The studies were published in 1984 & 1990, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Low	only a mean was provided for the Alexanderson study and range data provided for the Nunn study.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no meta data were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The Nunn study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1313679 Table: 2 of 8

Study Citation:	Mathur, N., Rastogi, S. K. (2007). Respiratory effects due to occupational exposure to formaldehyde: Systematic review with meta-analysis. Indian Journal of Occupational and Environmental Medicine 11(1):26-31.				
HERO ID:	1313679				
Conditions of Use:	Construction Manufacturing				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	not clear but likely area sampling: Alexanderson (1984) 0.47 ppm mean				
Number of workers:	Alexanderson (1984) 47				
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown	
	Metric 3:	Applicability	High	The data are for woodworkers which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	The study was published in 1984, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5:	Sample Size	Low	only a mean was provided	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination			Low		

Formaldehyde

Occupational Exposure

HERO ID: 1313679 Table: 3 of 8

Study Citation:	Mathur, N., Rastogi, S. K. (2007). Respiratory effects due to occupational exposure to formaldehyde: Systematic review with meta-analysis. Indian Journal of Occupational and Environmental Medicine 11(1):26-31.			
HERO ID:	1313679			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	not clear but likely area sampling: Malaka (1982) 1.13 ppm mean			
Number of workers:	Malaka (1982) 156			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown	
	Metric 3: Applicability	High	The data are for plywood workers which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The study was published in 1982, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Low	only a average was provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no meta data were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1313679 Table: 4 of 8

Study Citation:	Mathur, N., Rastogi, S. K. (2007). Respiratory effects due to occupational exposure to formaldehyde: Systematic review with meta-analysis. Indian Journal of Occupational and Environmental Medicine 11(1):26-31.			
HERO ID:	1313679			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	spray painters exposed to acid-hardening lacquers [16] containing formaldehyde			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	not clear but likely area sampling: Alexanderson (1988) 0.48 mg/m3 mean (range 0.14-2.60 mg/m3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for workers involved with spray painting acid lacquers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1988, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	an average and range data were provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1313679 Table: 5 of 8

Study Citation:	Mathur, N., Rastogi, S. K. (2007). Respiratory effects due to occupational exposure to formaldehyde: Systematic review with meta-analysis. Indian Journal of Occupational and Environmental Medicine 11(1):26-31.				
HERO ID:	1313679				
Conditions of Use:	Laboratory Use				
EXTRACTION					
Parameter	Data				
Worker activity description:	medical students				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	not clear but likely area sampling: Chia (1992) 0.74 ppm mean, peak 1.2 ppm				
EVALUATION					
Domain	Metric	Rating			Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown	
	Metric 3:	Applicability	High	The data are for medical students which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	The study was published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.	
	Metric 5:	Sample Size	Low	only an average and peak value were provided	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty.	
Overall Quality Determination			Low		

Study Citation:	Mathur, N., Rastogi, S. K. (2007). Respiratory effects due to occupational exposure to formaldehyde: Systematic review with meta-analysis. Indian Journal of Occupational and Environmental Medicine 11(1):26-31.			
HERO ID:	1313679			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Anatomy and histology workers			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	not clear but likely area sampling: Khamgaonkar (1991) 1 ppm average			
Number of workers:	148			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for anatomy and histopathology workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1991, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	only an average was provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Mathur, N., Rastogi, S. K. (2007). Respiratory effects due to occupational exposure to formaldehyde: Systematic review with meta-analysis. Indian Journal of Occupational and Environmental Medicine 11(1):26-31.			
HERO ID:	1313679			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	medical students			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	not clear but likely area sampling: Akbar (1994) 1.24 ppm mean (range 0.1 - 2.94 ppm)			
Number of workers:	34			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for medical students which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1994, after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	an average and range data were provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Low		

Study Citation:	Mathur, N., Rastogi, S. K. (2007). Respiratory effects due to occupational exposure to formaldehyde: Systematic review with meta-analysis. Indian Journal of Occupational and Environmental Medicine 11(1):26-31.			
HERO ID:	1313679			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Funeral service workers			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	not clear but likely area sampling: Holness (1989) 0.36 ppm mean (range 0.08-0.84 ppm)			
Number of workers:	84			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The study was published in 1989, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	an average and range data were provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Low		

Study Citation:	Matthews, T.G., Fung, K.W., Tromberg, B.J., Hawthorne, A.R. (1986). Surface emission monitoring of pressed-wood products containing urea-formaldehyde resins. Environment International 12(1-4):301-309.		
HERO ID:	22183		
Conditions of Use:	Installation/Demolition of Building Materials		
EXTRACTION			
Parameter	Data		
Worker activity description:	Consumer- Indoor air of residential homes		
Exposure route:	Inhalation		
Physical form:	Vapor		
Area sampling data:	measurement ranged from 0.09 mg/m3 to 0.31 mg/m3, each measurement is done at different combination of temperature, relative humidty, and air exchange.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling /analytical methods does not referenced a NIOSH/OSHA method, but the study used Formaldehyde Surface Emission Monitor (FSEM) is a short tubular monitor constructed from a 20-cm mechanical sieve that seals with a compressible flange to a flat test surface. Emissions specific from the measurement site are sorbed inside the FSEM on a planar distribution of 13 X molecular sieve. The sorbent is analyzed for formaldehyde using a water-rinse desorption and calorimetric analysis procedure.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated product emission compared to current manufactured products. The data were published in 1986, before the most recent PEL (1992) as well as the formaldehyde wood product rule and more than 20 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Average emission rates and variance were provided for six different wood products from three different manufacturers.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata which also included temperature and humidity levels, but lack other metadata for exposure.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Data were provided showing variability between different types of wood products from 3 different manufacturers - not a formal one-way analysis of variance was performed. Additionally, the Formaldehyde Surface Emission Monitor (FSEM) which were compared to measured emission rates to evaluate uncertainty in the analysis.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 22183 Table: 1 of 1

...continued from previous page			
Study Citation:	Matthews, T.G., Fung, K.W., Tromberg, B.J., Hawthorne, A.R. (1986). Surface emission monitoring of pressed-wood products containing urea-formaldehyde resins. Environment International 12(1-4):301-309.		
HERO ID:	22183		
Conditions of Use:	Installation/Demolition of Building Materials		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Mauer, M. P., Cook, C. K. (1999). Health hazard evaluation report HETA 97-0242-2725, Delphi Chassis Systems, Dayton, Ohio, February 1999.			
HERO ID:	1317810			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	HEIM operator Dept 37 0.03 ppmHEIM operator Dept 37 0.03 ppmHEIM operator Dept 37 0.02 ppmQuality operator Dept 37 0.03 ppmHEIM operator Dept 2 0.02 ppmFork truck operator 0.03 ppm			
Area sampling data:	Curing oven #2 0.02 ppmAdjacent to curing oven #6 0.02 ppmCuring oven #1 0.04 ppmPaint line #2 0.01 ppmPaint line #3 0.02 ppm			
Exposure duration:	8 to 10 hrs per day			
Number of workers:	Approximately 280 workers (assemblers, machine operators, and quality operators) are employed in these departments over three shifts.			
Personal protective equipment:	Respirator use, including the use of dust-mist masks was reported by only a few employees. The MSDS for the epoxy powder paint recommends the use of appropriate NIOSH listed respiratory devices for particulates and fumes. The MSDS for the glass beads recommends the use of a NIOSH approved dust respirator. The MSDS for the metallic disk brake lining compound states that respiratory protection is not generally needed, as long as localexhaust and general ventilation maintain acceptable exposure levels. Exposure levels for all these substances should be minimized due to the complex composition of the dust and the uncertain health effects potentially related to it.Safety glasses should be used in all work areas. Dust-proof goggles are recommended for exposures to the epoxy powder paint dust,particularly when working directly with the paint application apparatus.Employees working with the epoxy powder paint should use protective coveralls, sleeve protectors, and permeation resistant gloves to minimize contact with skin and personal clothing.Machine operators who work with metalworking fluids should discontinue using latex rubber gloves for skin protection. Instead,gloves made of nitrile rubber material should be used. This material is more effective against permeation by metalworking fluids.			
Engineering control:	Due to the potential health effects associated with exposure to brake dust, epoxy resins, formaldehyde, and HMTA (at unspecifiedconcentrations), exposure to these air contaminants should be minimized to their lowest feasible concentrations. One way tofurther reduce exposures would be to improve the exhaust ventilation effectiveness by providing an adequate supply of replacement air, thus eliminating excessive negative pressure. Inaddition, exhaust ventilation systems serving HEIM machines, unloader bins, paint lines, and cure ovens should be further evaluated and modified by a qualified industrial ventilation engineer to assure optimum service and performance.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study - Method 2016
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (brake part manufacturer) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1997 - after PEL (1992) but more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1317810 Table: 1 of 1

...continued from previous page

Study Citation:		Mauer, M. P., Cook, C. K. (1999). Health hazard evaluation report HETA 97-0242-2725, Delphi Chassis Systems, Dayton, Ohio, February 1999.		
HERO ID:		1317810		
Conditions of Use:		Construction Manufacturing		
Domain		Metric	EVALUATION Rating	Comments
Metric 6:		Metadata Completeness	Medium	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations thought worker activities and exposure frequency were not provided
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	High	Data were provided for different locations which could be used to assess variability. Uncertainty was not discussed but assumed that it was considered in NIOSH method 2016.
Overall Quality Determination			High	

Study Citation:	McCammon, C. (1998). Health hazard evaluation report 97-0138-2677 Shindoni, Inc. Tesuque, New Mexico February 1998.			
HERO ID:	8048635			
Conditions of Use:	Use of Adhesive (Binder) in Foundry			
EXTRACTION				
Parameter	Data			
Worker activity description:	Bronze Foundry operation: Sand is mixed with an isocyanate-based binder system (Pep Set I & II, Ashland chemical Corporation) and then packed around wax (or fiberglass) shapes to make a mold. Once the binder has set, the mold is poured. The predominant metal used is bronze. The bronze is melted from ingots in a furnace adjacent to the sand mixing/mold preparation area. Once the bronze reaches the appropriate temperature, the ladle is moved via a ceiling crane to the pour area, and the mold is poured. The actual pour takes only a few minutes per mold (usually two molds are poured at once). When the heated bronze contacts the molds, great quantities of irritating smoke are produced			
Exposure route:	inhalation			
Personal sampling data:	Personal, Operating sand mixer 2.9 mg/m3			
Area sampling data:	Mixing Pep Set with sand 1.7 mg/m3, During pour, on wall left of mold <0.10 mg/m3, During pour, to right of mold <0.10 mg/m3, During pour, center of exhaust face (0.5 mg/m3), During pour, left of mold 1.5 mg/m3 Analytical Limit of Detection -micrograms per sample 0.3() Analysis is between the Limit of Detection and the Limit of Quantitation and is considered only semi-quantitative< below limit of detection			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site. The uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Mccammon, C. S., Tubbs, R. L., Reh, B. D., Reh, C. M. (1997). Health Hazard Evaluation Report HETA 97-0084-2669, Woodward Governor Company, Fort Collins, Colorado.			
HERO ID:	3042078			
Conditions of Use:	Use of Metalworking fluid			
EXTRACTION				
Parameter	Data			
Worker activity description:	Plating room operators: add fresh formaldehyde solution to mix.			
Exposure route:	inhalation, dermal			
Physical form:	colorless gas			
Area sampling data:	All 4 area air samples collected for formaldehyde in the Plating Room were below the LOD (0.4 micrograms/sample) or <0.1 ppm			
Exposure duration:	exposure duration of 10 hours per day, 40 hours per week for a working lifetime			
Exposure frequency:	40 hrs/week			
Number of workers:	800			
Personal protective equipment:	Some employees wear respirators or lab hoods when working in the Assembly area and painting areas.			
Engineering control:	Some areas have local exhaust ventilation but machines do not have them present immediately surrounding them.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is not peer reviewed but study requested and conducted by NIOSH and follows various NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1997)
	Metric 5:	Sample Size	Medium	Characterized by a range of data with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Includes worker activities, exposure route, physical form, personal and area samples, exposure duration and frequency, PPE and engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Addresses variability by stating the different areas tested for formaldehyde. Addresses uncertainty by providing LOD.
Overall Quality Determination			High	

Study Citation:	Mccammon, C., Daniels, W., Lee, S. (1997). Health hazard evaluation report No. HETA-97-0062-2662, New Alaska Native Medical Center, Anchorage, Alaska.			
HERO ID:	6558306			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in Pathology and the Autopsy Room in Alaska Native Medical Center in Anchorage, Alaska			
Exposure route:	inhalation			
Physical form:	Formaldehyde is a colorless gas with a strong odor			
Personal sampling data:	All samples collected from the Pathology Laboratory and the Autopsy Room were below the limit of detection for the analytical method (0.6 ug/sample).			
Area sampling data:	All samples collected from the Pathology Laboratory and the Autopsy Room were below the limit of detection for the analytical method (0.6 ug/sample).			
Comments:	Table 5. Summary of Air Sampling Results for Formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1944517 Table: 1 of 1

Study Citation:	McCammon, C.S., Robinson, C., Waxweiler, R.J., Roscoe, R. (1985). Industrial hygiene characterization of automotive wood model shops. American Industrial Hygiene Association Journal 46(7):343-349.			
HERO ID:	1944517			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description: Area sampling data:	Workers in wood working shops. Job categories included model makers, sweepers, machine operators, workers in plastic shop, and multi-axis machine operators. Formaldehyde concentrations were between 0.1 and 0.3 ppm above routing and shaping operations. However, one of the blind blank samples showed to be one of the highest concentrations. Therefore, these data were discounted.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data greater than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Mccleery, R. E. (2000). Health Hazard Evaluation Report: HETA 99-0185-2787, Wonder Industries, Wyoming, Minnesota.		
HERO ID:	4678855		
Conditions of Use:	Other- Thermal degradants in Plastic Product Manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	Injection molding machine operators; Plastic injection molding for corner guards, handles, pallet legs and diaper pales.		
Exposure route:	inhalation		
Physical form:	colorless gas/vapor		
Area sampling data:	Concentrations ranged between 0.01 to 0.015 ppm. Highest FA concentration (0.015 ppm) was located on injection-molding machine #7 (white mattress corner guard, HDPE). All air sample results were lower than relevant evaluation criteria. Full table of samples provided in Table 2 (p.16)		
Exposure duration:	Exposure duration is 3 shifts per day period with 5 to 6 people per shift. Week starts Sunday night at 11pm and ends on Friday night at 11pm. Most workers are exposure up to 10 hours a day, 40 hours per week.		
Number of workers:	15-18 per day period.		
Personal protective equipment:	Workers not required to wear hearing protection while in the injection molding area of the facility. They are offered 3M® 1100 Foam Ear Plugs. The Noise Reduction Rating (NRR) for these plugs is 29 decibels (dB). There are also 3M 8500 respirators (single strap respirators for nuisance dust) offered. However, these respirators are not NIOSH approved under the current regulation, 42 CFR Part 84. NIOSH investigators did not observe any employees wearing any personal protective equipment (PPE) during the site visit. Recommendations suggest PPE should be stored in one area, respirators (N95) should be worn.		
Engineering control:	Heating system exists for the facility but is rarely operated in the injection molding area due to the heat generated by the process. During the site visit, the rear overhead door leading ot the docking area was open throughout the day as well as the front entrance door. Does not have a local exhaust ventilation for the injection molding machines. A wall exhaust fan was in operation in the southwest corner of the production area. Employees indicated those exhaust fans are not typically in operation but they were during the NIOSH site visit. Recommendations suggest exhaust fans should be in continuous operation to enhance air movement.		
Comments:	Analyzed by NIOSH method 2016, 2549, 1501, 1550 and 1552		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data is for US.
	Metric 3: Applicability	Uninformative	Data is applicable to the emission of formaldehyde as a decomposition for polypropylene and polyethylene (byproduct formation), therefore it does not appear to be applicable for use of formaldehyde in plastic product manufacturing.
	Metric 4: Temporal Representativeness	Low	Source is over 20 years old.
	Metric 5: Sample Size	High	Individual samples are provided.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Includes worker activity, exposure route, physical form, area sampling data. exposure duration, PPE, and engineering control.
Domain 4: Variability and Uncertainty			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 4678855 Table: 1 of 1

...continued from previous page

Study Citation:	Mccleery, R. E. (2000). Health Hazard Evaluation Report: HETA 99-0185-2787, Wonder Industries, Wyoming, Minnesota.
HERO ID:	4678855
Conditions of Use:	Other- Thermal degradants in Plastic Product Manufacturing

		EVALUATION	
Domain	Metric	Rating	Comments
	Metric 7: Metadata Completeness	Low	Limited discussions on variability and uncertainty.

Overall Quality Determination	Uninformative

Study Citation:	Mcmanus, K. P. (1992). Health Hazard Evaluation Report HETA 91-251-2218, New Hampshire Ball Bearing, Laconia, New Hampshire. 4(HETA-91-251-2218):91-251.
HERO ID:	2780125
Conditions of Use:	Use of Adhesives and Sealants

EXTRACTION

Parameter	Data
Worker activity description:	Employees worked in the Teflon Room, where teflon cloth is adhered to the inside of bushings to provide lubrication of the bearings; adhesive "AD", which contains a phenolic resin, free phenol, ethylalcohol, and free formaldehyde. Teflon fabric pieces, measuring 18 x 24 inches, are roll coated with adhesive and allowed to cure in a drying room. Curing times vary from 7-14 days. One side of the fabric is roll coated with adhesive and allowed to cure before the other side is coated and allowed to cure. Sometimes a third coat is required to meet certain specifications.
Exposure route:	inhalation and dermal
Physical form:	gas
Area sampling data:	The following concentrations of formaldehyde were noted: Drying Rm - 0.08 ppm, Cloth Rm - 0.03 ppm, Teflon Rm Cab - ND.
Exposure duration:	The plant operates 2 shifts: between 7A.M. and Midnight, with staggering start and stop times.
Number of workers:	New Hampshire Ball Bearing, Inc. employs approximately 490 workers in the manufacture of self-lubricating bearings. The majority of the workforce is employed in the machine shop. Approximately 40 employees work in the Teflon Department, where teflon cloth is adhered to the inside of bushings to provide lubrication of the bearings.
Personal protective equipment:	air supplied respirators, which are only used when applying certain adhesives. However, the air supply was not monitored to warn against carbon monoxide or oil mist contamination. Additionally, there was no respirator program to indicate proper use, storage, cleaning and limitations of these respirators, nor were employees medically cleared to wear respirators; NIOSH recommends use of respirators. The air supply to the respirators in the Cloth Room must be equipped with high temperature and carbon monoxide warning systems. Gloves made of the appropriate material to protect against exposure to specific chemicals in use need to be selected and provided.
Engineering control:	dedicated ventilation system that provides 10 air changes per hour. The air is exhausted directly to the outside; NIOSH recommended substitution of adhesives to eliminate the potential for exposure to formaldehyde.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Methodology is approved by NIOSH (NIOSH Method 3500)
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include all associated metadata except exposure frequency.
Domain 4: Variability and Uncertainty			

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Study Citation:	Mcmanus, K. P. (1992). Health Hazard Evaluation Report HETA 91-251-2218, New Hampshire Ball Bearing, Laconia, New Hampshire. 4(HETA-91-251-2218):91-251.		
HERO ID:	2780125		
Conditions of Use:	Use of Adhesives and Sealants		
Domain		EVALUATION	
Metric		Rating	Comments
Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site. Uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		High	

Study Citation:	McNary, J.E., Jackson, E.M. (2007). Inhalation exposure to formaldehyde and toluene in the same occupational and consumer setting. Inhalation Toxicology 19(6-7):573-576.			
HERO ID:	5946737			
Conditions of Use:	Personal care products (nail salons)			
EXTRACTION				
Parameter	Data			
Number of sites:	30 salons in CA sampled (pg 3)			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Table 1 (pg 3) presents mean, SD, median, and geometric mean for technicians, clients, and area samples Table 2 (pg 4) presents data in ppm (assumed mean) for each salon, including some overnight, outside, and background samples			
Area sampling data:	Area samples taken 10 ft away from workstation: Table 1 (pg 3) presents mean, SD, median, and geometric mean for technicians, clients, and area samples Table 2 (pg 4) presents data in ppm (assumed mean) for each salon, including some overnight, outside, and background samples			
Comments:	Analytic Method: EPA method T0-11 (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved EPA method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for personal care products (nail salons), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, media, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple salons, but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Mehta, M., Jenkins, J., Liveright, T. (1987). Health Hazard Evaluation Report HETA-86-0486-1799 New Jersey Education Associaton, Trenton, New Jersey.			
HERO ID:	8198273			
Conditions of Use:	Commercial Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office workers in an education building. (3/19)			
Exposure route:	inhalation (4/19)			
Physical form:	gas (4/19)			
Area sampling data:	Formaldehyde was not detected in the area sampling with a LOD of 0.5ppm. (10/19)			
Number of workers:	140 people (4/19)			
Engineering control:	The air for the NJEA Building is supplied and exhausted through a Heating Ventilation and Air Conditioning (HVAC) system. The air distribution on floors 4, 5 and 6 was from the Air Handling Unit (AHU) located in the penthouse and that of floors 1, 2, and the basement was from the AHU located in the basement. The air was distributed on each floor through diffusers located on the ceiling and exhausted through return air grills located on the side walls. Some of the air was distributed through grills provided on the periphery of each floor approximately 2 feet above floor level. (7/19)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for ambient air in an office, which is similar to the in-scope occupational scenario use of furniture products.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure frequency, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Mehta, M., Liveright, T., Dawkins, S. (1987). Health Hazard Evaluation Report HETA-87-0171-1840 New Jersey Department of Transportation, Trenton, New Jersey.
HERO ID:	8245069
Conditions of Use:	Furniture and furnishings not covered elsewhere

EXTRACTION	
Parameter	Data
Worker activity description:	"Source of exposure is thought to be upholstered partitions, chairs and carpeted floors. (4/30)"
Exposure route:	inhalation, dermal (3/30)
Physical form:	vapor (8/30)
Area sampling data:	The average air concentration for all 12 samples was 0.054 ppm, with a range of 0.035 to 0.094 ppm. (15/30)
Exposure duration:	8-10 hours (7/30)
Number of workers:	1200 people (4/30)
Engineering control:	The North Wing and South Wing on each floor have separate air handling units (AHUs). The air is supplied through the AHU to the work areas of each wing via a Variable Air Volume (VAV) unit or box. Each VAV box is connected by ducts to a number of air inlet registers located on the false ceiling with a closed plenum. VAV boxes are provided with dampers. The movement of the dampers is controlled by thermostats located on the side walls which detect room temperature. (4/30)

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for commercial use of furniture and furnishings, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure frequency and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at many locations at different temperatures and humidities.

Overall Quality Determination	High

Study Citation:	Menziez, D., Tamblyn, R.M., Nunes, F., Hanley, J., Tamblyn, R.T. (1996). Exposure to varying levels of contaminants and symptoms among workers in two office buildings. American Journal of Public Health 86(11):1629-1633.			
HERO ID:	3391045			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	Buildings were sampled with increased and decreased ventilation as described in Table 1: Ventilation increased: 0.034, 0.012 ppm; Ventilation decreased: 0.038, 0.048;			
Exposure duration:	Workers are full-time and exposed 8 hours a day, 40 hours a week			
Number of workers:	Of 840 eligible workers in the twobuildings, 702 (84%) participated.			
Engineering control:	Building’s HVAC system had 30% efficient pre-filter and 80-90% efficient bag-filters.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for Canada, an OECD country.
	Metric 3:	Applicability	Low	Data is for general office space workers.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1996).
	Metric 5:	Sample Size	Low	Data characterized by a range of data but no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes engineering controls, exposure route, sampling data, exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Address variability by looking at different building with different ventilation rates. Address uncertainty by looking at attributes for formaldehyde levels and accounting for unknown/unexplained sources.
Overall Quality Determination		Medium		

Study Citation:	Merkle, S.E. (1985). Ambient concentrations of formaldehyde and ammonia in a screwworm fly rearing facility. American Industrial Hygiene Association Journal 46(6):336-340.			
HERO ID:	1318482			
Conditions of Use:	Non-TSCA			
EXTRACTION				
Parameter	Data			
Worker activity description:	Transfer flies to oviposition room, remove eggs and transfer to petri dishes and transferred to larvae rearing area. Larvae strain testing. media preparation which is where formaldehyde is an additive. Periodically vacuum larvae waste products from vat and replenish food. operate hot room where materials an equipment are held to kill any remaining larvae.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1981 Media preparation 340 ug/m3 mean (range 240-440 ug/m3); larvae rearing 46 ug/m3 mean (range 23-82 ug/m3);1983 Media preparation 426 ug/m3 mean (range 425-427 ug/m3); larvae rearing 73 ug/m3 mean (range 10-190 ug/m3); Centrifuge 35 ug/m3 mean (range 18-52 ug/m3); 1984 larvae rearing 44 ug/m3 mean (range 22-77 ug/m3); Total for all years media preparation 383 ug/m3 mean; larvae rearing 58 ug/m3 mean; centrifuge 35 ug/m3 mean			
Number of workers:	1000			
Engineering control:	recommended use of enclose piping system to transfer formalin into media prep mixers; dilution ventilation was used			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Appears NIOSH methods were used - used two glass bubbler in series. Each bubbler contained sodium bisulfite absorbing solution, Samples were analyzed using the chromotropic acid-spectrophotometric method (P&CAM no. 125) recommended by NIOSH.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Mexico - not an OECD member
	Metric 3:	Applicability	Uninformative	The data are for formaldehyde used as a bactericide and fungicide which is an occupational scenario not within the scope of the risk evaluation (non-TSCA).
	Metric 4:	Temporal Representativeness	Low	This study was published in 1985 using data from 1981-84, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	mean and range values were provided for three different production areas and the different sampling years
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include critical metadata, such as sample type and exposure type, sample durations, and worker activities butlacks additional metadata, such as exposure durations, and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Range data were provided for 3 different production areas and three different years; these data can be used to evaluate variability. Uncertainty is addressed in the NIOSH methods.

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Formaldehyde

Occupational Exposure

HERO ID: 1318482 Table: 1 of 1

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Study Citation:	Merkle, S.E. (1985). Ambient concentrations of formaldehyde and ammonia in a screwworm fly rearing facility. American Industrial Hygiene Association Journal 46(6):336-340.
HERO ID:	1318482
Conditions of Use:	Non-TSCA

Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Uninformative	

Study Citation:	Methner, M. M., Tapp, L., Ramsey, J. (2014). Health Hazard Evaluation Report: HETA-2012-0025-3207, May 2014. Evaluation of Metals, Solvents, Formaldehyde, Ventilation, and Ergonomic Risks During the Manufacture of Electrical Cable Accessories.			
HERO ID:	2452612			
Conditions of Use:	Use of Plastic and Rubber Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees at a plant that produced underground electrical power distribution cable accessories			
Exposure route:	Inhalation			
Physical form:	Vapo/gas			
Personal sampling data:	Formaldehyde concentration in personal air ranged between 0.0032 to 0.0058 ppm.			
Area sampling data:	Formaldehyde concentration in area air ranged between 0.0011 to 0.0063 ppm for longer duration and 0.051 ppm for short duration			
Exposure duration:	production employees worked 8-hour shifts, except for paintdepartment employees who normally worked 12-hour shifts.			
Number of workers:	The 41 interviewed employees included 20 molders, 6 assemblers, 5 material preparers in the paint department, 3 testers, 2 material handlers, 2 maintenance staff, 2 quality assurance staff, and 1 production operator.			
Personal protective equipment:	Recommended PPE - gloves			
Engineering control:	local exhaust ventilation system was not operating. Recommended engineering controls – 1) Repair the local exhaust ventilation system. 2) Provide adjustable workstations for assembly tasks. Parts bins that support the assembly process should be in front of the employee at a vertical height of 24"–70" and a forward reach ≤ 16". 3) Provide foldup steps on the platforms that support the molding machines. 4) Lower paint booths or provide a raised platform to allow employees to use the spray gun with their elbow at a 90° angle. 5) Locate the parts drying racks in the paint department at heights of 27"–62" to eliminate reaching overhead or bending at the back. 6) Continue to evaluate ways to eliminate excessive reaching and bending when working on the deflasher. Provide employees with a retrieval tool such as a rake or hoe to pull parts from the machine into the bin. 7) Provide rotating lift tables or load levelers for stackable parts and boxes. Do not use pallets placed directly on the floor. 8) Provide antifatigue mats at all standing workstations. 9) Choose a tool (e.g., hammer) of the right size and shape for the task and the user.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH methods
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
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Formaldehyde

Occupational Exposure

HERO ID: 2452612 Table: 1 of 1

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Study Citation:		Methner, M. M., Tapp, L., Ramsey, J. (2014). Health Hazard Evaluation Report: HETA-2012-0025-3207, May 2014. Evaluation of Metals, Solvents, Formaldehyde, Ventilation, and Ergonomic Risks During the Manufacture of Electrical Cable Accessories.		
HERO ID:		2452612		
Conditions of Use:		Use of Plastic and Rubber Products		
Domain		Metric		Comments
Overall Quality Determination		EVALUATION Rating Medium		

Study Citation: Meyer, B. (1986). Occupational and indoor air formaldehyde exposure: Regulations and guidelines. :217-229.
HERO ID: 5947989
Conditions of Use: Various

EXTRACTION

Parameter	Data
Exposure route:	inhalation
Physical form:	liquid
Area sampling data:	From Table 2 (mean): 0.24 ppm - UF Resin Mfg, 0.25 ppm - Textile industry, 0.35 ppm - Plywood Mfg, 0.41 ppm - US Funeral Homes, 0.94 - Acid cure varnishes. Table 2 also provides maximum levels as well.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The data are for occupational scenarios within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics (mean and max provided for most COU's)
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Unclear if samples are personal or area, article does provide the references used which may still be useful.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination **Uninformative**

Study Citation:	Meyer, B., Hermanns, K. (1986). Formaldehyde release from wood products - an overview. ACS Symposium Series 316:1-16.			
HERO ID:	5946044			
Conditions of Use:	Mobile homes and furniture made with wood products containing formaldehyde resins			
EXTRACTION				
Parameter	Data			
Area sampling data:	Mobile homes: See figure 1 - 2 and Table 2. Air concentration in a mobile home ranges from 0.25 - 1.25 ppm and depends on ventilation rates and types of boards.			
Comments:	// Furniture: See Figure 3-4. Air concentration from chamber study shows 0-0.7 ppm. This article talks about the factors considered when modeling air concentrations and emissions.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Study Citation:	Meyers, A.R., Pinkerton, L.E., Hein, M.J. (2013). Cohort mortality study of garment industry workers exposed to formaldehyde: Update and internal comparisons. American Journal of Industrial Medicine 56(9):1027-1039.			
HERO ID:	1998382			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Worker activity description:	At the garment manufacturing facilities, shirts were made from fabrics treated with formaldehyde resins to impart crease resistance and other desirable properties.			
Exposure route:	inhalation			
Personal sampling data:	Formaldehyde levels across all departments and facilities were similar with an overall geometric mean concentration of 0.15 ppm (geometric standard deviation = 1.90).			
Area sampling data:	Average levels of formaldehyde in the garment industry were characterized as 0.3–2.7 ppm among eight US garment plants in 1966 and industry average levels in the 1970s and 1980s were characterized as 0.2–2 ppm			
Number of workers:	549 workers (12 - 73 within each department)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	the data presented is from 1980s
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Milton, D.K., Walters, M.D., Hammond, K., Evans, J.S. (1996). Worker exposure to endotoxin, phenolic compounds, and formaldehyde in a fiberglass insulation manufacturing plant. American Industrial Hygiene Association Journal 57(10):889-896.			
HERO ID:	1314170			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Production workers and maintenance workers.			
Exposure route:	Inhalation			
Physical form:	Liquid			
Personal sampling data:	18.1-67.4 (ug/m^3)			
Area sampling data:	22-414 (ug/m^3)			
Exposure duration:	nan			
Number of workers:	Thirty-seven workers, 19 production workers from 2 of the 4 shift rotation groups and 18 maintenance employees.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plasticizer, additive and impurity in adhesives, sealants and lubricants, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1996)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by both personal breathing zone and area sampling, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Milton, D.K., Wypij, D., Kriebel, D., Walters, M.D., Hammond, S.K., Evans, J.S. (1996). Endotoxin exposure-response in a fiberglass manufacturing facility. American Journal of Industrial Medicine 29(1):3-13.			
HERO ID:	1314209			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Personal sampling data:	Exposure categories: Low 8.1 ug/m3 8-hr TWA mean, 6.4 ug/m3 geometric mean (range 1.2-16.6 ug/m3); Medium 34.8 ug/m3 8-hr TWA mean, 31.8 ug/m3 geometric mean (range 16.8-60.3 ug/m3); High 107 ug/m3 8-hr TWA mean, 100 ug/m3 geometric mean (range 61.1-265 ug/m3)			
Exposure frequency:	187 days at work with concurrent personal exposure monitoring			
Number of workers:	37			
Comments:	Note the study was sponsored by Owen Corning Fiberglass and the National Institute of Health.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified, though it was noted that dinitrophenylhydrazine-coated glass filters were analyzed for formaldehyde using the HPLC.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for Fiberglass manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1996, after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized with 8 hr TWA mean values, geometric means and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample duration, and exposure durations but lacks additional metadata, such as exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Mirabelli, M.C., Holt, S.M., Cope, J.M. (2011). Anatomy laboratory instruction and occupational exposure to formaldehyde. Occupational and Environmental Medicine 68(5):375-378.			
HERO ID:	5955573			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Students working with formaldehyde-preserved tissues and instructors demonstrating or observing students as they perform specific dissection or prosection activities. (1/4)			
Exposure route:	""""routes by which formaldehyde exposure may occur include (1)absorption by the respiratory tract via inhalation through the nose or mouth, (2) absorption through the skin following dermal contact, (3) absorption through the digestive tract via ingestion, including splashes into the mouth or by eating or smoking using the hands or (4) injection directly into the bloodstream (e.g., through cuts and puncture wounds)"" (2/4)"			
Physical form:	aqueous solution, vapors (2/4)			
Personal sampling data:	"Samples collected in the breathing zones of anatomy students have been reported as high as 1.79-3.78 ppm." (2/4)			
Area sampling data:	"Ambient air sample concentrations ranging from 0.2 to 2.4 ppm were reported at times when an autopsy was being performed, and from 1.70 to 2.44 ppm when samples were collected from an anatomy laboratory classroom with opened windows but no mechanical ventilation system." (2/4)			
Personal protective equipment:	PPE includes aprons or lab coats, protective eyewear, face masks and gloves. (1/4)			
Engineering control:	""""The use of properly functioning general mechanical ventilation and local exhaust ventilation, including downdraft tables, reduces exposures mainly to the nasal and respiratory tracts and the eyes"" (3/4)"			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Monsanto Research Corp, (1983). Detailed industrial hygiene survey: formaldehyde production, Georgia-Pacific Corporation, Albany, Oregon.
HERO ID:	8728033
Conditions of Use:	Manufacture

EXTRACTION	
Parameter	Data
Worker activity description:	Operators are responsible for operating the formaldehyde production process, unloading methanol from tank cars, loading formaldehyde into rail cars and trucks, sampling the process, and prevention and clean-up of spills. Operators also change the catalyst in tubes during shut-down periods. Maintenance personnel, working day shifts, Monday through Friday, are responsible for maintenance of the entire facility, including the resin plant. Specific maintenance requests are recorded by the unit operators on a board in the maintenance shop. Maintenance personnel keep a log on all maintenance to be performed during the day shift and may be called in at any time during the evening shifts to repair serious mechanical problems that require immediate attention. Lunches are eaten on-the-Job, inside the control/lab room or shop. Approximately two trucks are loaded with formaldehyde per day. It takes approximately 30 minutes to load a truck. The operator supervises the loading, which is performed by the truck driver who is not an employee of the plant. The truck driver initially opens the tank top hatch (Figure 4) and places the loading spout into the tank (Figure 5). The operator sets the required load for the tank on the automatic delivery control device (Figure 6) located at the loading area. He remains in the vicinity of the loading area for most of the loading period, often talking to the operator. On occasion, he may get involved in starting automatic delivery of resin to a truck a short distance away while formaldehyde loading is proceeding. The operator remains in the resin loading area for a very short time, either to start or stop automatic delivery of the resin. Consequently, it is not believed that exposure to formaldehyde vapors resulting from resin loading is of any significance, and it is not expected to add to the exposure resulting from formaldehyde loading. Approximately 16 rail cars are loaded per month. The operator performs all required duties. He initially opens the top hatch and then attaches a reinforced flexible line to the bottom of the tank car for bottom delivery. The operator starts automatic delivery by setting the load on the automatic delivery control device located at the loading area. The operator then usually leaves the area because loading usually takes 1.5 to 1.75 hours. Again, the operator may be involved in loading the resin. The operator withdraws 50-51 percent formaldehyde solution from the absorber four times per shift by opening a ball valve and filling a 100-mL graduated cylinder (Figure 10). A catch basin, located below the sample point, is used to collect the purge of the sample line (Figure 11) and any excess solution or water to rinse. A formaldehyde gas sample is drawn by an operator or the quality control supervisor into a syringe through a sample valve in the aftercooler inlet. This sample is then injected by an operator or quality control supervisor into the gas chromatograph in the control/lab room and analyzed. This is usually done once every third shift, or more often, up to three-four times per shift, if process changes such as catalyst adjustment are involved.
Exposure route:	Inhalation
Physical form:	Gas
Personal sampling data:	Long-term sampling Operator 1: 0.11-0.70 (ppm) Operator 2: BDL-0.28 (ppm) Operator 3: 0.13-0.31 (ppm) Operator 4: 0.02-0.20 (ppm) Maintenance worker 1: 0.02-0.46 (ppm) Maintenance worker 2: 0.15-2.22 (ppm) Short-term sampling [formaldehyde process sampling] Operator 1: 0.07-0.62 (ppm) Operator 2: BDL-0.64 (ppm) Operator 3: 0.29 (ppm) Short-term sampling [formaldehyde loading supervision] Operator 2: 1.04 (ppm) Operator 3: 0.86-1.07 (ppm) Short-term sampling [gas sample at aftercooler] Supervisor 3: 1.34 (ppm)
Area sampling data:	Adjacent to east downer knock out tank: 0.13-0.31 (ppm) Adjacent to center tank: BDL-0.05 (ppm) Above north adsorber sample point: 0.09-0.36 (ppm) West side of east converter electrical outlet: 0.10-0.64 (ppm) East side of west converter electrical outlet: 0.08-0.20 (ppm) Formaldehyde storage area: 0.56-1.06 (ppm) Methanol storage area: 0.32-0.55 (ppm) Formaldehyde Source Sampling Side agitator - Tank F8: >92.83 (ppm) * Side agitator - Tank F10: >83.65 (ppm) * Absorber pump #2: 14.78->33.15 (ppm) * Loading pump: >54.69 (ppm) * Adsorber Pump #1: 6.05 (ppm) * Tube analysis indicated breakthrough; slightly off calibration-extrapolated value.
Exposure duration:	Operators work in 8-hour shifts. Truck loading operations take approximately 30-minutes. Rail car loading takes 1.5-1.75 hours.
Exposure frequency:	The plant operates 7 days/week.
Number of workers:	The total plant employs approximately 40 employees, which include approximately 15 production operators.

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Study Citation:	Monsanto Research Corp, (1983). Detailed industrial hygiene survey: formaldehyde production, Georgia-Pacific Corporation, Albany, Oregon.
HERO ID:	8728033
Conditions of Use:	Manufacture

Domain	Metric	EVALUATION		Comments
		Rating		
Personal protective equipment:	Rain gear, face shields, gloves, helmets, safety glasses, disposable dust masks, and protective clothing are available as needed, or on request. Safety shoes and respirators are provided. An MSA self-contained breathing apparatus is available in the control room. Several supplied-air respirators are available, and the plant compressed air is monitored and meets the criteria for breathing air. An emergency eyewash and shower unit is located on the ground level of the production unit in the vicinity of the tank truck and rail car HCHO loading areas, and at the resin loading area which is near the formaldehyde loading area. All employees are required to wear hard hats and safety glasses with side shields while working in production areas. Specific PPE requirements are: Formaldehyde Loading: half-face organic vapor cartridge respirator, rubber gloves. Formaldehyde solution sample withdrawal: rubber gloves. Sample removal of HCHO gas from aftercooler inlet: half-face respirator and rubber gloves. Formaldehyde storage tank entry: full protective suit, boots, gloves, air-supplied respirator. Maintenance formaldehyde leak repair: Gloves, half-face respirator.			
Engineering control:	Pump seals were used on pumps along with natural ventilation.			

Domain	Metric	EVALUATION		Comments
		Rating		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling and analytical method was approved by the NIOSH project officer.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL update and are more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Site-specific assessment so variability was addressed by different workers and uncertainty can be determined from the sampling and analytical method.

Overall Quality Determination**High**

Study Citation:	Monsanto Research Corp, (1982). Preliminary plant visit industrial hygiene report: Formaldehyde production facility, E. I. DuPont de Nemours and Company, Grasselli Plant, Linden, New Jersey.			
HERO ID:	8728036			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	The formaldehyde operators’ duties include turning valves and other general operational duties as well as loading tank trucks. The service operators are involved in miscellaneous service work and clean-up. Service operators spend most of their time on duties with the sulfuric acid plant.			
Exposure route:	Inhalation.			
Physical form:	Gas.			
Personal sampling data:	8-hr TWA Loader: 0.02-1.02 (ppm)HCHO Operator: 0.12-0.50 (ppm)Shipper: 0.01-0.06 (ppm)Chief operator: 0.01-0.13 (ppm)15-min TWA HCHO operator: 0.05-0.68 (ppm)Chief Operator: not detectedHCHO operator startup: 4.1-22.4 (ppm)			
Area sampling data:	Start up (4-hr TWA): 0.32 (ppm)Start up (3-hr TWA): 0.89 (ppm)Tank truck loading (5-hr TWA): 0.71 (ppm)Sump (5-hr TWA): 0.56 (ppm)			
Exposure duration:	Most tasks take 3-5 hours per day.			
Exposure frequency:	Operating days 7 days a week			
Number of workers:	The workforce covers two production areas (formaldehyde and sulfuric acid) consists of seventeen employees: two supervisors, five chief operators, four formaldehyde operators, five service operators, and one shipper. Formaldehyde operators devote 100 percent of their time, and service operators about 20 percent, to formaldehyde production. In addition, the area has a shipper who is a clerk with minimal field (outside) responsibility in formaldehyde. The shipper, as the service operator, is shared with the sulfuric acid plant. The maintenance group consists of a supervisor and 8 to 10 persons. They cover a large area and are estimated to spend no more than 20 percent of their time in the formaldehyde area.			
Personal protective equipment:	Training in use of respirators is an integral part of the overall training program. The safety department is responsible for cleaning and maintenance of the respirators. All full-face respirator users are fit-tested (qualitative) once a year. Specific PPE requirements are as follows All formaldehyde operations: hard hats and side-shield safety glasses. Startup operations: full-face respirators. Loading operations: rubber gloves, coverall goggles, full-face respirator during hookup. Opening blocked piping: supplied air mask. Operating overhead valves: overall goggles.			
Engineering control:	Vent-scrubber system. A laboratory hood was recently added to the control laboratory. Samples are stored and analyzed in this hood. When the analysis is completed, samples are grouped outside the hood while awaiting disposal (sample containers are closed). The loading area and delivery arm have a vapor collector and exhaust ventilation to minimize exposure			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario (manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment or update
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 8728036 Table: 1 of 1

...continued from previous page			
Study Citation:	Monsanto Research Corp, (1982). Preliminary plant visit industrial hygiene report: Formaldehyde production facility, E. I. DuPont de Nemours and Company, Grasselli Plant, Linden, New Jersey.		
HERO ID:	8728036		
Conditions of Use:	Manufacture		
Domain	Metric	EVALUATION Rating	Comments
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by sampling multiple worker activities and areas.
Overall Quality Determination		High	

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.			
HERO ID:	67399			
Conditions of Use:	Consumer Use- Residential Home			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.01-0.10 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for homes with out urea-formaldehyde which is an occupational scenario within the scope of the risk evaluation, but may be excluded as it is subject to other regulations.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 67399 Table: 2 of 14

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.			
HERO ID:	67399			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.37-0.73 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for hospitals which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 67399 Table: 3 of 14

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.			
HERO ID:	67399			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.27-0.63 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for dialysis units which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.
Overall Quality Determination			Low	

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.				
HERO ID:	67399				
Conditions of Use:	Consumer Use- Residential Home				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	0.0-1.77 ppm				
EVALUATION					
Domain	Metric	Rating		Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown	
	Metric 3:	Applicability	High	The data are for residential mobile home exposure which is an occupational scenario within the scope of the risk evaluation, but may be excluded as it is subject to other regulations.	
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.	
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.	
Overall Quality Determination			Low		

Formaldehyde

Occupational Exposure

HERO ID: 67399 Table: 5 of 14

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.			
HERO ID:	67399			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.2-0.74 ppm			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for a urea-formaldehyde resin plant which is an occupational scenario within the scope of the risk evaluation, but may be excluded as it is subject to other regulations.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 67399 Table: 6 of 14

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.			
HERO ID:	67399			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.9-3.30 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown	
	Metric 3: Applicability	High	The data are for clothing store which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.	
Overall Quality Determination		Low		

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.			
HERO ID:	67399			
Conditions of Use:	Consumer Use- Residential Home			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.01-40.0 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown	
	Metric 3: Applicability	High	The data are for residential exposure which is an occupational scenario within the scope of the risk evaluation. But may be excluded as subject to other regulations	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.	
Overall Quality Determination		Low		

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.			
HERO ID:	67399			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.1-58.0 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown	
	Metric 3: Applicability	High	The data are for dye production which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 67399 Table: 9 of 14

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.			
HERO ID:	67399			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.04-10.9 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for laminating which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 67399 Table: 10 of 14

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.			
HERO ID:	67399			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.20-0.12 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for office exposure which is an occupational scenario within the scope of the risk evaluation, but may be excluded as it is subject to other regulations.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 67399 Table: 11 of 14

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.			
HERO ID:	67399			
Conditions of Use:	commercial uses			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	2.75-14.8 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for biology labs which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 67399 Table: 12 of 14

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.				
HERO ID:	67399				
Conditions of Use:	Foundries				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	0.02-18.3 ppm				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.		
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown		
	Metric 3: Applicability	High	The data are for iron foundry workers which is an occupational scenario within the scope of the risk evaluation.		
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.		
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided		
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata provided.		
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.		
Overall Quality Determination		Low			

Formaldehyde

Occupational Exposure

HERO ID: 67399 Table: 13 of 14

Study Citation: Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.			
HERO ID: 67399			
Conditions of Use: Embalming			
		EXTRACTION	
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	0.09-5.26 ppm		
		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.
Overall Quality Determination		Low	

Formaldehyde

Occupational Exposure

HERO ID: 67399 Table: 14 of 14

Study Citation:	Montanaro, A. (1992). Occupational asthma associated with low molecular weight antigens. Immunology and Allergy Clinics of North America 12(4):779-793.			
HERO ID:	67399			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.06-79.0 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range values for different uses that could be used to assess variability; but the study did not provide any data on uncertainty.
Overall Quality Determination		Low		

Study Citation:	Moore, L.L., Ogrodnik, E.C. (1986). Occupational exposure to formaldehyde in mortuaries. Journal of Environmental Health 49(1):32-35.			
HERO ID:	626334			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Personal Sampling: 1.1 ppm TWA (range 0.03-3.15 ppm) for embalming episode			
Area sampling data:	for full work shift Area: 0.45 ppm (range nd-0.84 ppm)			
Exposure duration:	45-75 minutes for an embalming event			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved OSHA method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL - Published in 1986
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics TWA average and range but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type provided but no other metadata; missing: number of samples, exposure frequency, and number of workers
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability addressed by providing data for individual labs and range, uncertainty addressed in the sampling methodology
Overall Quality Determination		Medium		

Study Citation:	Mortimer, V. (1981). Preliminary survey report: Particleboard and plywood plants, Springfield Wood Products Facility, Weyerhaeuser, Inc., Springfield, Oregon.			
HERO ID:	6558524			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Production workers in a plywood plant. (5/13)			
Exposure route:	inhalation (5/13)			
Physical form:	vapor from adhesive sprays (6/13)			
Personal sampling data:	In a survey in Oregon, 9 area samples and 1 personal sample ranged from 0.21-4.39 ppm. In another survey that year, 2 area and 2 personal samples ranged from 0.83-2.92 ppm. (8/13)			
Area sampling data:	Area close to particleboard press: <0.5 ppm Area above caul plate separator: 1 ppm Area along plywood press: <0.5 ppm Area along loading platform: <0.5 ppm (7/13) In a survey in Oregon, 9 area samples and 1 personal sample ranged from 0.21-4.39 ppm. In another survey that year, 2 area and 2 personal samples ranged from 0.83-2.92 ppm. (8/13)			
Number of workers:	250 (5/13)			
Personal protective equipment:	Hearing protectors and safety glasses are required for some jobs. Respirators are available if workers want to use one. (9/13)			
Engineering control:	Curtains are hung around the particleboard press to contain heated rising emissions , and roof fans remove them. Control rooms have been built for press operators. An air conditioner has been installed in each control room. The board cooler and cooling tunnel have been built onto the outside of the plant so that the cooling air doesn't enter the building. In the plywood plant there are roof fans above the presses.(8/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Report is published by NIOSH, so sampling/analytical methodology is an approved method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesives and sealant chemicals in wood product manufacturing, am in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Mortimer, V. (1982). Preliminary survey report: Particleboard plant, Timber Products Company, Medford, Oregon.
HERO ID:	6558525
Conditions of Use:	Processing: Wood Product Manufacturing

EXTRACTION	
Parameter	Data
Worker activity description:	Workers in a wood product manufacturing plant
Exposure route:	inhalation
Personal sampling data:	On October 5, 1977, 10 personal samples were taken, averaging 30 minutes in duration, were taken by the Oregon Workers' Compensation Department. The calculated concentrations ranged from approximately 1.0 to 3.2 ppm, with a mean (+ standard deviation) of 1.4(+ 0.6) ppm.
Area sampling data:	No values were greater than 2 parts formaldehyde per million parts of air (ppm); however, some were in the area of 1 ppm.
Exposure duration:	Average of 30 minutes for the personal samples
Number of workers:	70
Personal protective equipment:	No single personal protective equipment item is required for every worker. Hearing protectors and safety glasses are required for some jobs; respirators are not mandatory for any worker.
Engineering control:	Local exhaust ventilation is used over the cooling wheel. A canopy hood covers the boards as they make a 1800 pass over a supply of air from underneath. Smoke tube analysis showed fairly good capture by the hood, although there was an interfering flow of air horizontally across the boards. A detector tube (Drager 0.5/a) sample taken at floor level required 13 pump strokes, indicating less than one part formaldehyde per million parts of air. The sampling site was about 5 to 15 feet below the boards, close to both the cooling wheel and the unloaded stack of boards. Two roof fans located above the press remove much of the heated air from the press. although there is not much air flow observable at the level of the platform which provides worker access to all points of the production line. A detector tube sample taken close to the press showed less than 1.5 ppm (8 strokes), and this location is not usually occupied by any employee. Around 1973, control rooms were built for the press operator and for the former-operator who controls the layering of particles on the caul plates. Now only a few workers involved in maintenance and clean-up regularly work outside these booths. An air conditioner has been installed in each control room for cooling during hot weather. The units are small, commercially available, window models which are vented to the indoor workplace air just outside the booth. They were not operating on the day of the survey, and it is not known what effect, if any, they would have on formaldehyde levels in the control rooms.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data from more than 20 years ago.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty				

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 6558525 Table: 1 of 1

... continued from previous page				
Study Citation:		Mortimer, V. (1982). Preliminary survey report: Particleboard plant, Timber Products Company, Medford, Oregon.		
HERO ID:		6558525		
Conditions of Use:		Processing: Wood Product Manufacturing		
Domain		Metric		EVALUATION
				Rating
				Comments
	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination				

Study Citation:	Mortimer, V.D. (1984). In-depth survey report: Control technology for formaldehyde emissions at Hillcrest Veneer Plant, High Point, North Carolina.			
HERO ID:	6019678			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Manufacturing veneered panels for furniture			
Exposure route:	Inhalation			
Physical form:	Gas			
Personal sampling data:	Average personal concentrations for formaldehyde in press room for loaders were 0.17+/- 0.06 ppm and for unloaders were 0.35 +/-0.15 ppm. Average personal concentrations for formaldehyde in multiple-opening press for loaders were 0.17+/- 0.06 ppm and for unloaders were 0.31 +/-0.16 ppm. Average personal concentrations for formaldehyde in shuttle-press for west-side operator were 0.31+/- 0.01 ppm and for east-side operator were 0.39 +/-0.17 ppm. Average personal concentrations for formaldehyde in feed-through press for loaders were 0.13+/- 0.07 ppm and for unloaders were 0.35 +/-0.23 ppm.			
Area sampling data:	Average area concentration for formaldehyde in general plant was <0.18 +/- 0.02 ppm and in the press room was 0.25 +/- 0.07 ppm. Average area concentration during glue spreading and mixing was <0.19 +/- 0.02 ppm, in press room – west was 0.19 +/- 0.08, in press room center was 0.23 +/- 0.04 ppm, press room east was 0.30 +/- 0.09, and during cold press/finishing was <0.19 +/- 0.02 ppm.			
Exposure duration:	nan			
Exposure frequency:	nan			
Number of workers:	100 to 150 employees			
Engineering control:	Combination of area and local exhaust ventilation, exhausting a total of less than 100,000 cfm from the press room, and supply-air ventilation, infusing approximately 18,000 cfm into the primary work area of the press workers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data is more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Moseley, C. L. (1979). Hazard Evaluation and Technical Assistance Report No. TA 79-16, Johnson Memorial Hospital, Stafford Springs, Connecticut.			
HERO ID:	4223253			
Conditions of Use:	Chemical substances in products not described by other codes-Laboratory Chemicals (e.g.,mortuary science)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Administrative and health care functions of Johnson Memorial Hospital...no clearly identifiable source for formaldehyde in CSS other than that brought in by soiled equipment from themorgue/autopsy area (pdf pg 3) It was postulated at one time that chemicals from the autopsy area beneath the Administration Area vi~re the cause of the reported symptoms. The most likely chemical is formaldehyde...the Administration Aera value probably represents normal background level in the hospital and may be indicative of poor handling or storage of formaldehyde in areas where it is normally used. The CSS value may be due to residual formaldehyde on incoming soiled equipment. (pdf pg 9)			
Exposure route:	inhalation			
Area sampling data:	The results of area samples for aldehydes taken in the Administration and CSS Areas are presented in Table II. Two compounds were identified–formaldehyde and furfural.Recommended personal exposure level§ are 1.2 mg/m3 ~NIOSH, 15 minute ceiling exposure limit) and 20 mg/m (ACGIH, TWA Limit) , respectively. Inspection of Table II indicates all values were below these criteria. (pdf pg 8)Environmental sampling in the Administration Area indicated a concentration of °326 mg/m3 (one sample). Formaldehyde was also detected in CSS at 0.61 mg/m (pdf pg 9)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH methods used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3:	Applicability	Medium	Source of formaldehyde was not confirmed, so occupational scenario may not be within scope, though it likely is, given the hospital setting.
	Metric 4:	Temporal Representativeness	Low	Data are from 1979 and occupational scenario has likely changed.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sam-pled site or sector.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 4058540 Table: 1 of 1

Study Citation:	Moseley, C. L., McConnell, R. (1985). Health hazard evaluation report: HETA-85-108-1593 - Carey Plastics Division, Toledo Molding and Die Corporation, Carey, Ohio.			
HERO ID:	4058540			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Press operators, floor help, hopper fillers, inspectors, assistant foremen, foremen, and indirect laborers (4/25)			
Exposure route:	inhalation (3/25)			
Personal sampling data:	All area and personal samples were below the limit of quantitation of 0.08 mg/m3. (12/25)			
Area sampling data:	All area and personal samples were below the limit of quantitation of 0.08 mg/m3. (12/25)			
Exposure duration:	8 hours/day (4/25)			
Exposure frequency:	5 days/week of operation, weeks/yr not specified (4/25)			
Number of workers:	approximately 200 workers (4/25)			
Engineering control:	The workplace is ventilated by numerous passive ceiling vents and ceiling and wall exhaust fans. The controls to both open the vents and start/stop the fans are accessible to everyone. Molds must be changed when the product changes. (5/25)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for use as an intermediate in the manufacture of plastic and resin materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination			High	

Study Citation:	Moseley, C. L., Singal, M., Murphy, L. (1979). Health Hazard Evaluation Determination, Report No. HHE-78-116-557, Commonwealth Trading Company, Stoughton, Massachusetts.
HERO ID:	1318499
Conditions of Use:	Use of fabric, textile and leather products

EXTRACTION	
Parameter	Data
Worker activity description:	Three areas of the warehouse were the center of employee complaints; the area where clothing is unpacked and placed on hangers and placed in the conveyer system (aka "T" area), the aisle area between the "B" and "C" areas where clothing is arranged by size and ticketed, and the Ticket area which is adjacent to the "B" and "C" areas and where the stamping of tickets is done. (Page 4 out of 23). These three areas were where personal and area samples were taken.
Exposure route:	inhalation and dermal were tested in this study
Physical form:	vapor (page 2 of 23)
Personal sampling data:	Seven personal breathing zone samples were taken, all below the NIOSH recommended criteria for 1ppm on the day of sampling, with concentrations ranging from 0.16 ppm to 0.73 (see Table 1, page 18 of 23, for all the personal sample results). However some of these levels were above the "action level" of 0.5ppm for formaldehyde, which required steps to be taken to reduce exposure. (Page 7 of 23).
Area sampling data:	General area samples were all below the NIOSH recommended criteria for 1ppm. (Page 7 of 23) This includes samples taken where an unopened box of clothing from India Imports (one of the brands associated with the illness) was obtained, and a hole large enough to withdraw an air sample was made. This sample was analyzed for formaldehyde. (Page 4 of 23)See Table 1 (Page 18 of 23) for all the area sample results (which ranged between 0.4 and 0.19) and results of formaldehyde levels within a box of newly arrived clothing (concentrations of 0.16 and 0.15 were observed).
Dermal exposure data:	nan
Exposure duration:	8-10 hours/day (Page 6 of 23)
Number of workers:	225 affected employees (Page 2 of 23)
Engineering control:	The warehouse area is ventilated by a centrally located, 86,000 cubic feet per minute (cfm) intake rooftop fan and by whatever air exchange that takes place when the shipping and receiving doors are open. There are no windows in the warehouse. There are also four 10,000 cfm exhaust fans located along one side of the roof to help relieve the positive pressure buildup. The warehouse is not air conditioned and is heated by a city gas-fire furnace. Figure 1 (on page 21 of 23) shows the general layout of the building and the ventilation system. In addition, after the first episode [where many employees reported illness] management rented and installed 12 pedestal fans to help eliminate areas of stagnant air. (Page 3 of 23). However, this was not adequate at moving air through the warehouse, and it was believed that racks of hanging clothes on upper levels act as a barrier to air exchange in the lower level. The air in aisles where this is not fan directed may become stale and with noticeable odors from hanging clothes. (Page 7 of 23)
Comments:	Symptoms were associated with certain brands of clothing (Outlander, India Imports, Organically Grown). These brands were not being handled at the time of the investigation, though an unopened box of India Imports clothing was obtained to test for formaldehyde. (Page 4 of 23)

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	From the US
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Study more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.

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Study Citation:	Moseley, C. L., Singal, M., Murphy, L. (1979). Health Hazard Evaluation Determination, Report No. HHE-78-116-557, Commonwealth Trading Company, Stoughton, Massachusetts.		
HERO ID:	1318499		
Conditions of Use:	Use of fabric, textile and leather products		
Domain	Metric	EVALUATION Rating	Comments
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations, worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations/jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods
Overall Quality Determination		High	

Study Citation:	Moss, C. E., Bryant, C., Stewart, J., Whong, W. Z., Fleegeer, A. (1990). Health Hazard Evaluation Report HETA 88-101-2008, University of Utah Health Sciences Center, Salt Lake City, Utah.				
HERO ID:	1322411				
Conditions of Use:	Unknown				
EXTRACTION					
Parameter	Data				
Worker activity description:	laser surgery and animal research procedures (page 2 of 40)				
Exposure route:	inhalation of smoke generated by medical lasers (page 2 of 40)				
Physical form:	vapor (page 2 of 40)				
Personal sampling data:	Equipment was positioned as close as possible to the active surgical site(hand held in the employees breathing zone) without interfering with the medical procedure. (Page 2 of 40) This is assumed as personal sampling data. For the Medical Center and Animal Evaluations, Formaldehyde was detected from trace amounts to 0.44 (though noted that some sampling took place over over very short procedures). See discussion on page 8 of 40. See Tables IX-X on page 22-23 of 40 for more data points. Personal sampling data is also provided for the first and second preliminary evaluations in Table IV on page 17 (brief discussion on page 7), and Table VII on page 20 (brief discussion on page 7).				
Area sampling data:	See discussion on page 8 of 40. See Tables IX-X on page 22-23 of 40 for more data points. Data ranged from trace to 0.013				
Exposure duration:	range from a few minutes to an hour or more (see page 22 for some sample durations, which represent how long exposure would be per event)				
Exposure frequency:	most of the operating room personnel were involved in more than one laser surgery procedure daily. (Page 8 of 40)				
Personal protective equipment:	All personnel involved with these operations were required to wear operating room clothing, including masks, head covers, laser goggles, shoe covers, and surgical gloves. (Page 2 out of 40)				
Engineering control:	Filtered vacuum system to suction away the laser-produced smoke (page 2 of 40)				
EVALUATION					
Domain	Metric	Rating		Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study Method 3500	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities. (laser surgery)	
	Metric 4:	Temporal Representativeness	Medium	1998 - after PEL (1992) but more than 20 years old	
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH method 3500.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.	
Domain 4: Variability and Uncertainty					
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Formaldehyde

Occupational Exposure

HERO ID: 1322411 Table: 1 of 1

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Study Citation:		Moss, C. E., Bryant, C., Stewart, J., Whong, W. Z., Fleegeer, A. (1990). Health Hazard Evaluation Report HETA 88-101-2008, University of Utah Health Sciences Center, Salt Lake City, Utah.		
HERO ID:		1322411		
Conditions of Use:		Unknown		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between different laser types and locations. Uncertainty was not discussed but assumed that it was addressed in NIOSH method 3500.
Overall Quality Determination			High	

Study Citation:	Mui, K.W., Wong, L.T., Hui, P.S., Chan, W.Y. (2009). Formaldehyde exposure risk in air-conditioned offices of Hong Kong. Building Services Engineering Research & Technology: An International Journal 30(4):279-286.		
HERO ID:	2574572		
Conditions of Use:	Office Environment		
EXTRACTION			
Parameter	Data		
Worker activity description:	office workers in Hong Kong		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	Formaldehyde concentrations in one group of offices were between 2 and 1,300 ug/m3 with an arithmetic mean of 54 +/- 113 ug/m3 and a geometric mean of 32 +/- 2.7 ug/m3. Formaldehyde concentrations in the second group of offices were between 4 and 208 ug/m3 with an arithmetic mean of 41 +/- 41 ug/m3 and a geometric mean of 29.3 +/- 2.1 ug/m3.		
Exposure duration:	Data were taken on an 8-hour basis		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4: Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected after the most recent PEL establishment or update but are generally more than 10 years old. If no PEL is established, the data are more than 10 years but generally, no more than 20 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data includes most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium	

Study Citation:	Mundt, K.A., Gallagher, A.E., Dell, L.D., Natelson, E.A., Boffetta, P., Gentry, P.R. (2017). Does occupational exposure to formaldehyde cause hematotoxicity and leukemia-specific chromosome changes in cultured myeloid progenitor cells?. Critical Reviews in Toxicology 47(7):1-11.			
HERO ID:	3827184			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	Majority (41 out of 43 samples) worked in factories that produced or used formaldehyde-melamine resin			
Personal sampling data:	Exposure ranged from 0.318 ppm to 5.61 ppm as 8hr TWA			
Exposure duration:	full shift			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for production/use of formaldehyde resins, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data from another report cited in the article. The report was published in 2010.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing specific worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Mäkinen, M., Kalliokoski, P., Kangas, J. (1999). Assessment of total exposure to phenol-formaldehyde resin glue in plywood manufacturing. International Archives of Occupational and Environmental Health 72(5):309-314.			
HERO ID:	1314048			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Patching, feeding of drying machine, forklift driving, scaring, assembly, hot pressing, glue preparation, finishing (puttying), finishing (sanding), carrying plywood piles			
Exposure route:	Inhalation, dermal			
Physical form:	Liquid			
Personal sampling data:	0.05-0.30 (mg/m^3)			
Area sampling data:	0.03-0.31 (mg/m^3)			
Dermal exposure data:	Dermal exposure data			
Number of workers:	11			
Personal protective equipment:	Cotton and nitrile gloves, bib overalls, protective shoes, protective coveralls			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for use as a plasticizer, additive and impurity in adhesives, sealants and lubricants, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1999)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple facility areas and multiple worker activities, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Mølhave, L. (1980). The effect of a chemical surface-treatment on formaldehyde emission from particleboards. <i>Holzforschung und Holzverwertung</i> 32(6):137-138.			
HERO ID:	22889			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Inside Chamber(1m3 stainless steel box): Treated (formaldehyde absorbent coating) 0.33 mg/m3 average, standard Deviation 0.02 (range 0.31- 0.36 mg/m3; n=4); untreated 0.57 mg/m3 average, standard deviation 0.04 (range 0.53-.60 mg/m3 n=4 but one sample excluded due to analytical error)			
Comments:	Chamber Experiment			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	The sampling method appears acceptable and does not indicate flaws or quality issues. Analysis methods are noted to follow chromatropic acid method, which is then cited but specifics are not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Denmark - an OECD member
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1980, using data form 1978 which is before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Naddafi, K., Nabizadeh, R., Rostami, R., Ghaffari, H.R., Fazlzadeh, M. (2019). Formaldehyde and acetaldehyde in the indoor air of waterpipe cafes: Measuring exposures and assessing health effects.			
HERO ID:	6144283			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees in waterpipe cafes			
Exposure route:	Inhalation			
Personal sampling data:	Formaldehyde Concentration (ug/m3) in personal breathing zone were: Fruit-flavored tobacco – ranges between 34.80 and 277.23; Regular tobacco – mean - 60.25 +/- 21.90; Total – ranges between 28.16 and 303.79.			
Area sampling data:	Formaldehyde concentrations (ug/m3) in indoor air were 151.1 +/- 67 (between 40.7 and 265.8) and 60 +/- 21.4 (between 31 and 265.8) in cafés with fruit flavored tobacco and regular tobacco, respectively.			
Number of workers:	Employees in 40 cafes selected			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	used NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	limited discussion on uncertainties and variabilities
Overall Quality Determination		High		

Study Citation:	Nakazawa, H., Ikeda, H., Yamashita, T., Hara, I., Kumai, Y., Endo, G., Endo, Y. (2005). A case of sick building syndrome in a Japanese office worker. Industrial Health 43(2):341-345.			
HERO ID:	1313747			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office workers			
Exposure route:	Inhalation			
Area sampling data:	0.017-0.053 (ppm)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3:	Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old. (2005)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE, exposure frequency, exposure duration.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Namiesnik, J., Zygmunt, B., Kozdron-Zabiegala, B. (1994). Some aspects of indoor air pollution and analysis. Polish Journal of Environmental Studies 3(4):5-19.			
HERO ID:	6021395			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation (2/15)			
Physical form:	vapor (2/15)			
Area sampling data:	Average concentration of formaldehyde over 315 indoor sites was 49.4 ppb. (5/15)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Poland, an OECD country.
	Metric 3:	Applicability	Low	Data are for ambient air, which is similar to the in-scope occupational scenario use of furniture and furnishing products
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at many facilities.
Overall Quality Determination		Medium		

Study Citation:	(2004). Summary of Health Hazard Evaluation: Issues Related to Occupational Exposure to Fire Fighters, 1990 to 2001.
HERO ID:	1317224
Conditions of Use:	Firefighting

EXTRACTION

Parameter	Data
Worker activity description:	fire fighters' exposures to chemical contaminants during wildland fire suppression operations
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	[see area]
Area sampling data:	up to 0.10ppm

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	The sampling/analytical methodology is not specified, however, NIOSH HHEs generally use approved NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Uninformative	The data is occupational however forest fires are outside the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is published in 2004, however, the cited information is from an HETA from 1992 (HETA-92-0045-2260), which is before the most recent PEL.
	Metric 5: Sample Size	Medium	Maximum value provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Report states that personal breathing zone and area samples were collected but does not specified for 0.10ppm if its for area or personal.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report does not address variability or uncertainty.

Overall Quality Determination**Uninformative**

Study Citation:	(1989). Formaldehyde. AMA Council on Scientific Affairs. Connecticut Medicine 53(4):229-235.			
HERO ID:	1986544			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Area sampling data:	One study indicated that white male morticians in West Virginia were exposed to low levels of formaldehyde (at least a timeweighted average not exceeding 1.2 ppm or a half-hour peak of 2.1 ppm). Another study showed that 76 female histology technicians were exposed daily to formaldehyde at concentrations of 0.2 to 1.0 ppm. One of the earliest surveys of environmental levels of formaldehyde in funeral homes was an evaluation of ventilation systems (essentially wall-mounted exhaust fans) in six funeral homes. Ambient levels of formaldehyde ranged from 0.75 to 2.50 ppm {without ventilation} and 0.25 to 1.39 ppm (with ventilation). Another survey of seven funeral homes in 1980, involving both area and personal sampling, determined that embalmers were exposed to 0.1 to 0.4 ppm of formaldehyde when working with intact bodies and 0.5 to 1.2 ppm of formaldehyde when working with autopsied bodies. Ambient air samples during class in eight gross anatomy laboratories of a major medical school over a 12-week period were evaluated. Only 11% of the ambient air samples exceeded 1.0 ppm whereas 44% of the personal samples were above 1.0 ppm. Most (62%) of the daily mean exposures varied between 1.0 and 2.0 ppm, and half were between 0.6 and 1.0 ppm; the lowest was 0.3 ppm and the highest was 2.63 ppm. In one medical center autopsy service, weekly time-weighted average exposures for pathologists, residents, and technicians were between 0.61 and 1.32 ppm.			
Number of workers:	See Table 2 for estimations of exposed groups			
Engineering control:	ventilation system			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., area) but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability and uncertainty are addressed by looking at multiple settings
Overall Quality Determination		Medium		

Study Citation:	(1989). Formaldehyde. Council on Scientific Affairs. JAMA: Journal of the American Medical Association 261(8):1183-1187.			
HERO ID:	1986547			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Personal sampling data:	Table 1: 0.4-3.0 (ppm)Table 2: 0.1-0.5 (ppm)In one medical center autopsy service, weekly time-weighted average exposures for pathologists, residents, and technicians were between 0.61 and 1.32 ppm.			
Area sampling data:	Seventy-six female histology technicians who were exposed daily to formaldehyde (ambient levels, 0.2 to 1.9 ppm). Ambient levels of formaldehyde in funeral homes ranged from 0.75 to 2.50 ppm (without ventilation) to 0.25 to 1.39 ppm (with ventilation).Another survey of seven funeral homes in 1980, involving both area and personal sampling, determined that embalmers were exposed to 0.1 to 0.4 ppm of formaldehyde when working with intact bodies and 0.5 to 1.2 ppm of formaldehyde when working with autopsied bodies.In laboratories of a major medical school over a 12-week period daily mean exposures varied between 1.0 and 2.0 ppm, and half were between 0.6 and 1.0 ppm; the lowest was 0.3 ppm and the highest was 2.63 ppm.			
Engineering control:	Engineering controls come under the purview of the professional industrial hygienist and ventilation engineer, who should be competent to survey the work environment, to design an adequate ventilation system, and to monitor and maintain exposurelevels to meet the OSHA standard.			
Comments:	In few cases no distinction was made between area sampling and personal sampling. In this form, those data were extracted as area sampling data.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu- ated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data from the 1980s.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling workers in multiple job types but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	(1983). Historical prospective mortality study of past and present employees of the celanese chemical and plastics plant located in bishop texas.			
HERO ID:	3648021			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees separated into work groups: administrative/supervisory (secretaries, managers, etc), Support (chemists, engineers, technicians), Operations - shift supervisors, Maintenance - foremen			
Exposure route:	inhalation			
Physical form:	gas/vapor			
Area sampling data:	Administrative - 0.0-0.10 ppm; Support - 0.1 - 1.00 ppm; Operations: 0.1-0.5 ppm, 0.5 to 1.5 ppm; Maintenance - 0.10-0.50 ppm, 0.10-1.00 ppm, 1.00 to 2.00 ppm			
Exposure duration:	Exposure durations described in Table 1 on PDF page 52			
Number of workers:	900 employed at location with 450 potentially exposed to FA			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Technical report of a specific manufacturing sites FA exposure. Contains high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to the production of Formaldehyde.
	Metric 4:	Temporal Representativeness	Low	Data is from 1970s, over 20 years old.
	Metric 5:	Sample Size	Low	Characterized by a range of data but no other statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes worker activities, exposure route, physical form, area sampling, exposure duration and production volume of US.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at different worker activities and their exposures. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NATL PARTICLEBOARD ASSOC, (1986). Letter from the National Particleboard Association to USEPA concerning the issues discussed in the January 31, 1986 meeting on formaldehyde with attachments.				
HERO ID:	5901036				
Conditions of Use:	Emission				
EXTRACTION					
Parameter	Data				
Area sampling data:	Formaldehyde levels were measured in two of the 31 homes measured in 1981. Levels in home number 1 have remained at relatively consistent levels over the five-year period- the current reading is 0.048 ppm. However, home number 20, which was brand new in 1981, has experienced a dramatic reduction from 0.34 ppm to 0.053 ppm.				
EVALUATION					
Domain	Metric	Rating		Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Data methodology is known or expected to be accurate	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from an OECD country other than the U.S.,	
	Metric 3:	Applicability	High	Data are for an occupational scenario within the scope of the risk evaluation	
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old	
	Metric 5:	Sample Size	Low	Characterized by no statistics	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type, but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Data study does not address variability or uncertainty.	
Overall Quality Determination			Low		

Formaldehyde

Occupational Exposure

HERO ID: 4682850 Table: 1 of 1

Study Citation:	Nazaroff, W. W., Coleman, B. K., Destailats, H., Hodgson, A. T., Liu, D.,-L, Lunden, M. M., Singer, B. C., Weschler, C. J. (2006). Indoor air chemistry: Cleaning agents, ozone and toxic air contaminants.			
HERO ID:	4682850			
Conditions of Use:	Reactant Products - Prominent products of the reaction of terpenes with ozone included formaldehyde			
EXTRACTION				
Parameter	Data			
Worker activity description:	cleaning			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	derived from bench top studyKitchen floor mopping 48 d/yr 0.65 activity hrs 4 hrs exposure 1.3 mg/yBathroom floor mopping48 d/yr 0.42 activity hrs 0.42 hrs exposure 0.3 mg/yAppliances 48 d/yr 0.56 activity hrs 2 hrs exposure 1.3 mg/yWalls & doors12 d/yr 1.58 activity hrs 4 hrs exposure 0.4 mg/yAir freshenerExposure frequency 365 d/yr 18 hrs exposure 4.5Total annual inhalation intake 8 mg/y			
Exposure duration:	variesKitchen floor mopping 48 d/yr 0.65 activity hrs 4 hrs exposureBathroom floor mopping48 d/yr 0.42 activity hrs 0.42 hrs exposureAppliances 48 d/yr 0.56 activity hrs 2 hrs exposure Walls & doors12 d/yr 1.58 activity hrs 4 hrs exposure Air freshenerExposure frequency 365 d/yr 18 hrs exposure			
Exposure frequency:	Kitchen floor mopping 48 d/yr Bathroom floor mopping48 d/yr Appliances 48 d/yr Walls & doors12 d/yr Air freshenerExposure frequency 365 d/yr			
Number of workers:	3 million Janitors and Cleaners or maids and housekeeping cleaners			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	CARB
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for a bench study of an occupational scenario (Janitors/maids) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	2006 - after the PEL (1992) more than 10 years but less than 20
	Metric 5:	Sample Size	High	Detailed statistics and modeling of 15 different bench studies were provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	It should be noted that this is simulation of occupational exposure based on bench study. That said the data provided included all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study provided details of 15 different simulation allowing for an assessment of variability between the different scenarios. Some of the results included estimates for uncertainty (see table 4.2)
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 4071561 Table: 1 of 1

Study Citation:	Neghab, M., Delikhoon, M., Baghani, A.N., Hassanzadeh, J. (2017). Exposure to Cooking Fumes and Acute Reversible Decrement in Lung Functional Capacity. International Journal of Occupational and Environmental Medicine 8(4):207-216.			
HERO ID:	4071561			
Conditions of Use:	Cooking and kitchen use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Kitchen workers			
Exposure route:	inhalation			
Physical form:	vapor/gas			
Personal sampling data:	mean concentration of 0.45 +/- 0.41 [0.12-1.73] mg/m^3			
Exposure duration:	Exposure duration is estimated to be normal full 8 hour shift.			
Number of workers:	60 workers studied			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is for China, a non-OECD country
	Metric 3:	Applicability	Medium	Data is applicable to kitchen workers
	Metric 4:	Temporal Representativeness	High	Data is from 2017, less than 10 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range of data with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes worker activity, exposure route, physical form, sampling data, exposure duration and number of workers
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1313485 Table: 1 of 1

Study Citation:	Neghab, M., Soltanzadeh, A., Choobineh, A. (2011). Respiratory morbidity induced by occupational inhalation exposure to formaldehyde. Industrial Health 49(1):89-94.			
HERO ID:	1313485			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	0.78 ppm mean +/- 0.40 standard deviation			
Number of workers:	70			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Used the protocol recommended in NIOSH method 3500; using two impingers in series each containing 20 ml of 1% sodium bisulfite solution, as the absorbing medium. The sampling time for each sample was 40 minutes. Chromtropic and concentrated sulfuric acids were, then, added to each sample and the solutions were analyzed for formaldehyde using visible absorption spectrometry technique at 580 nm by Unicam UV/Vis Spectrophotometer (model 8625).
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Iran - not an OECD member country
	Metric 3:	Applicability	High	The data are for a melamine-formaldehyde resin plant which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report was published in 2011, after the most recent PEL (1992) and less than 10 years old.
	Metric 5:	Sample Size	Medium	Results were provided as an average value and associated standard deviation.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	variability in the determinants of exposure is not discussed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 2801581 Table: 1 of 1

Study Citation:	Nethercott, J.R., Albers, J., Guirguis, S., Ching, G., Hofstader, S., From, L. (1982). Erythema multiforme exudativum linked to the manufacture of printed circuit boards. Contact Dermatitis 8(5):314-322.				
HERO ID:	2801581				
Conditions of Use:	Multiple				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation, dermal(evidence suggests dermal contact)				
Area sampling data:	Ambient levels of formaldehyde in the area above the metalization process were less than 0.07 ppm.				
Comments:	In 2 cases, the patch tests produced a positive response to formalin. Skin biopsies taken from the patient test sites showed histopathologic changes in keeping with allergic contact dermatitis.				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country	
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	the data is more than 20 years old	
	Metric 5:	Sample Size	Low	no statistics	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	critical metadata included	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination			Low		

Study Citation:	Newman, M., Klein, M. (1990). Health Hazard Evaluation Report HETA 88-068-2077, Schmidt Cabinet Company, New Salisbury, Indiana. :40.			
HERO ID:	1510135			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Production workers at Schmidt Cabinet Company, which manufacturer kitchen cabinets and bathroom vanities			
Exposure route:	Inhalation			
Physical form:	gas			
Personal sampling data:	The general area air concentration of formaldehyde was 2.67 ppm at the face of spray booth #10 in an area equivalent to the operator’s breathing zone.			
Area sampling data:	A formaldehyde concentration of 2.57 ppm was determined at an area approximately 10 feet from spray booth #10 in the drying area for the varnished cabinets. A formaldehyde concentration of 2.33 ppm was found at an area approximately 6 feet from spray booth #9 in another drying area for the varnished cabinets.			
Exposure duration:	8 hour samples			
Number of workers:	The company employed 90 production workers.			
Personal protective equipment:	The company required half face respirators to be worn by all employees classified as ”sprayers”. The respirator cartridges (TC-23C-737) supplied were for organic vapors and for pesticides, paints, lacquers, and enamel mists and dusts and, where deemed appropriate by the company, cartridges (TC-23C-754) were supplied for formaldehyde. During the survey it was noted that the respirators were not being properly maintained (e.g. inhalation and exhalation valves damaged or missing, improper storage and cleaning of the respirators). The ”sprayers” and ”stain wipers” were supplied with nitrile gloves.			
Engineering control:	Only the spray booths had local exhaust ventilation to control emissions from the spraying. Other than this, the plant was under general dilution ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology is an approved NIOSH method (3500)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	Medium	Discrete samples were provided, 3 samples taken at the three different locations.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include sample type and exposure type but no other metadata (duration and frequency)
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site by testing at various location. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Newton, L. R. (1982). Formaldehyde emission from wood products: Correlating environmental chamber levels to "secondary" laboratory tests. 16:45-61.			
HERO ID:	6019448			
Conditions of Use:	Release			
EXTRACTION				
Parameter	Data			
Area sampling data:	The formaldehyde background levels observed in the environmental chamber was 0.037 +/- 0.019 ppm. To determine if double loading of the same product would result in the doubling of formaldehyde concentrations within the chamber, particleboard from two different production lots was divided into sets A and B. The environmental chamber was loaded with Sets A and B, and in 24 hours, chamber formaldehyde level for the combined set was determined to be 0.58 ppm. Set A was removed, and 24 hours later the single load formaldehyde chamber concentration of Set B was 0.41 ppm. Set B was replaced by Set A, and the chamber formaldehyde concentration was found to be 0.53 ppm. Chamber concentrations of formaldehyde were determined for a total combination of 1.57 m2/m3 for particleboard and paneling loaded at 0.52 m2/m3 and 1.05 m2/m3, respectively. With only particleboard, formaldehyde concentration ranged from 0.08 to 0.32 ppm. With only paneling, formaldehyde concentration ranged from 0.13 to 0.70 ppm. With combination of particleboard and paneling, formaldehyde concentration ranged from 0.20 to 0.69 ppm.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	Low	Data simulate off-gassing that may occur in a mobile home
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NFDA, (2021). Comment submitted by National Funeral Directors Association (NFDA) containing the formaldehyde exposure study.		
HERO ID:	10386042		
Conditions of Use:	embalming fluid		
EXTRACTION			
Parameter	Data		
Worker activity description:	embalming and non embalming tasks		
Exposure route:	inhalation, dermal		
Physical form:	liquid, vapor		
Personal sampling data:	See Table 3, pg. 13/38 for full shift samples for various tasks and ONUs		
Area sampling data:	Table 3 also provides background levels (pg. 13/38		
Exposure duration:	Table 4, pg. 14/38, provides statistics for task durations (32 mins to 154 mins with mean of 73 mins)		
Exposure frequency:	"The median number of embalming cases per year, whereas firms in the 95th percentile handled 165 or more embalming cases per year. The average (median) embalmer performed 50 embalming cases per year." pg.16/38		
Number of workers:	"Each firm reported between one and seven embalmers on staff (median=2.00), and on average, firms reported that 100% of their embalmers actively participated in embalming (percent calculated as number of embalmers at each firm who actively embalm divided by the total number of embalmers at each firm)." pg. 16/38		
Personal protective equipment:	"Embalmers wore PPE while performing these tasks, including scrubs or surgical gowns, latex gloves, face shields, surgical masks, booties, and safety glasses." pg. 14/38		
Engineering control:	ventilation		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	High	Report is based on data that is less than 10 years old
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 10386042 Table: 1 of 1

...continued from previous page

Study Citation:		NFDA, (2021). Comment submitted by National Funeral Directors Association (NFDA) containing the formaldehyde exposure study.		
HERO ID:		10386042		
Conditions of Use:		embalming fluid		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination			High	

Study Citation:	Nguyen, C.M. (2016). Indoor air quality of nail salons in the greater Los Angeles area: Assessment of chemical and particulate matter exposures and ventilation.				
HERO ID:	6019434				
Conditions of Use:	commercial use (nail salons)				
EXTRACTION					
Parameter	Data				
Worker activity description:	Nail salon workers				
Exposure route:	inhalation				
Area sampling data:	Most of the 30-minute formaldehyde readings were below the limit of detection (10 ppb). When formaldehyde was detected, the readings ranged between 11 and 16 ppb.				
Exposure duration:	article implies 6 - 8 hr work shift				
Number of workers:	Employees in 8 nail salons from the greater Los Angeles area				
Personal protective equipment:	Not indicated in the article				
Engineering control:	ventilation				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology is well described	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data	
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation	
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old	
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	addresses variability and uncertainty	
Overall Quality Determination			High		

Study Citation:	Niemelae, R., Priha, E., Heikkilae, P. (1997). Trends of formaldehyde exposure in industries. Occupational Hygiene 4(1):31-46.			
HERO ID:	6023452			
Conditions of Use:	Processing & Commercial Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Furan resins used as binding agents for foundry sand, urea-formaldehyde glue, phenol-formaldehyde glue, phenol-recorcinol-formaldehyde glue, crease-resistance treatment agents, cyclic reactants, durable flame retardants, phenol-formaldehyde resin used as a binding agent, acid-cured lacquers and paints containing urea-formaldehyde and melamine-formaldehyde resin as a binding agent, thermal degradation products, paints and thermal degradation products, colophony resins in soldering. (4/16)			
Exposure route:	inhalation (3/16)			
Area sampling data:	”The following are mean concentration values. All samples: 0.42 mg/m3 Plant means: 0.41 mg/m3 Textile and clothing: 1.09 mg/m3 Industry Manufacture of plywood: 0.21 mg/m3 Manufacture of particle board: 0.70 mg/m3 Wooden furniture & carpentry industry: 0.53 mg/m3 Resin and glue production: 0.67 mg/m3 Manufacture of plastic products: 0.14 mg/m3 Manufacture of glass and mineral wool: 0.20 mg/m3 Foundries: 0.25 mg/m3 Coating of metals: 0.29 mg/m3 Manufacture of electrical equipment: 0.11 mg/m3 (8/16)”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (medians, means, ranges, percentiles, p-values, number of samples) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, and/or exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at over 200 facilities.
Overall Quality Determination		Medium		

Study Citation:	Niemelä, R., Vainio, H. (1981). Formaldehyde exposure in work and the general environment. Occurrence and possibilities for prevention. Scandinavian Journal of Work, Environment and Health 7(2):95-100.			
HERO ID:	1982589			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	unclear but assuming area sampling: 0.7 cm3/m3 mean (range 0.05-3.5 cm3/m3)			
Comments:	Note, 1 cm3/m3 = 1.25 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that samples were collected in midget impingers and analyzed by the chromotropic add method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for hospitals which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1981 based on sampling implemented from 1974-1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range values are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1982589 Table: 2 of 12

Study Citation:	Niemelä, R., Vainio, H. (1981). Formaldehyde exposure in work and the general environment. Occurrence and possibilities for prevention. Scandinavian Journal of Work, Environment and Health 7(2):95-100.			
HERO ID:	1982589			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	unclear but assuming area sampling: 0.24 cm3/m3 mean (range 0.05-0.77 cm3/m3)			
Comments:	Note, 1 cm3/m3 = 1.25 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that samples were collected in midget impingers and analyzed by the chromotropic add method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for Offices/schools which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1981 based on sampling implemented from 1974-1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range values are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Study Citation:	Niemelä, R., Vainio, H. (1981). Formaldehyde exposure in work and the general environment. Occurrence and possibilities for prevention. Scandinavian Journal of Work, Environment and Health 7(2):95-100.			
HERO ID:	1982589			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	unclear but assuming area sampling: 2.8 cm3/m3 mean (range 0.5-7.0 cm3/m3)			
Comments:	Note, 1 cm3/m3 = 1.25 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that samples were collected in midget impingers and analyzed by the chromotropic add method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for construction sites which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1981 based on sampling implemented from 1974-1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range values are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Study Citation:	Niemelä, R., Vainio, H. (1981). Formaldehyde exposure in work and the general environment. Occurrence and possibilities for prevention. Scandinavian Journal of Work, Environment and Health 7(2):95-100.			
HERO ID:	1982589			
Conditions of Use:	Use of metal products			
EXTRACTION				
Parameter	Data			
Worker activity description:	soldering, lacquering, treatment of plastic			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	unclear but assuming area sampling: 0.35 cm3/m3 mean (range 0.2-0.5 cm3/m3)			
Comments:	Note, 1 cm3/m3 = 1.25 mg/m3;			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that samples were collected in midjet impingers and analyzed by the chromotropic add method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for workshops that manufacture electrical machinery which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1981 based on sampling implemented from 1974-1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range values are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1982589 Table: 5 of 12

Study Citation:	Niemelä, R., Vainio, H. (1981). Formaldehyde exposure in work and the general environment. Occurrence and possibilities for prevention. Scandinavian Journal of Work, Environment and Health 7(2):95-100.			
HERO ID:	1982589			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	unclear but assuming area sampling: 0.6 cm3/m3 mean (range 0.05-2.0 cm3/m3)			
Comments:	Note, 1 cm3/m3 = 1.25 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that samples were collected in midget impingers and analyzed by the chromotropic add method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for foundries which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1981 based on sampling implemented from 1974-1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range values are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1982589 Table: 6 of 12

Study Citation:	Niemelä, R., Vainio, H. (1981). Formaldehyde exposure in work and the general environment. Occurrence and possibilities for prevention. Scandinavian Journal of Work, Environment and Health 7(2):95-100.			
HERO ID:	1982589			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	unclear but assuming area sampling: 2.7 cm3/m3 mean			
Comments:	Note, 1 cm3/m3 = 1.25 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that samples were collected in midget impingers and analyzed by the chromotropic add method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for foundries which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1981 based on sampling implemented from 1974-1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	only a mean value provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1982589 Table: 7 of 12

Study Citation:	Niemelä, R., Vainio, H. (1981). Formaldehyde exposure in work and the general environment. Occurrence and possibilities for prevention. Scandinavian Journal of Work, Environment and Health 7(2):95-100.			
HERO ID:	1982589			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	unclear but assuming area sampling: 1.75 cm3/m3 mean (range 0.8-3.5 cm3/m3)			
Comments:	Note, 1 cm3/m3 = 1.25 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that samples were collected in midget impingers and analyzed by the chromotropic add method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for adhesives in a plastics and resin manufacturing plant which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1981 based on sampling implemented from 1974-1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range values are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1982589 Table: 8 of 12

Study Citation:	Niemelä, R., Vainio, H. (1981). Formaldehyde exposure in work and the general environment. Occurrence and possibilities for prevention. Scandinavian Journal of Work, Environment and Health 7(2):95-100.			
HERO ID:	1982589			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	unclear but assuming area sampling: 1.35 cm3/m3 mean (range 0.1-5.4 cm3/m3)			
Comments:	Note, 1 cm3/m3 = 1.25 mg/m3			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that samples were collected in midget impingers and analyzed by the chromotropic add method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for exposure for wood furniture plant which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1981 based on sampling implemented from 1974-1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range values are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1982589 Table: 9 of 12

Study Citation:	Niemelä, R., Vainio, H. (1981). Formaldehyde exposure in work and the general environment. Occurrence and possibilities for prevention. Scandinavian Journal of Work, Environment and Health 7(2):95-100.			
HERO ID:	1982589			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	unclear but assuming area sampling: 0.35 cm3/m3 mean (range 0.1-1.2 cm3/m3)			
Comments:	Note, 1 cm3/m3 = 1.25 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that samples were collected in midget impingers and analyzed by the chromotropic add method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for exposure for plywood plant which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1981 based on sampling implemented from 1974-1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range values are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Study Citation:	Niemelä, R., Vainio, H. (1981). Formaldehyde exposure in work and the general environment. Occurrence and possibilities for prevention. Scandinavian Journal of Work, Environment and Health 7(2):95-100.			
HERO ID:	1982589			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	unclear but assuming area sampling: 1.15 cm3/m3 mean (range 0.1-4.9 cm3/m3)			
Comments:	Note, 1 cm3/m3 = 1.25 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that samples were collected in midjet impingers and analyzed by the chromotropic add method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for exposure for particleboard plant which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1981 based on sampling implemented from 1974-1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range values are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Study Citation:	Niemelä, R., Vainio, H. (1981). Formaldehyde exposure in work and the general environment. Occurrence and possibilities for prevention. Scandinavian Journal of Work, Environment and Health 7(2):95-100.			
HERO ID:	1982589			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Formalin spraying			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	unclear but assuming area sampling: 1.9 cm3/m3 mean (range 0.9-2.7 cm3/m3)			
Comments:	Note, 1 cm3/m3 = 1.25 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that samples were collected in midjet impingers and analyzed by the chromotropic add method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for exposure for a shoe factory which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1981 based on sampling implemented from 1974-1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range values are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Niemelä, R., Vainio, H. (1981). Formaldehyde exposure in work and the general environment. Occurrence and possibilities for prevention. Scandinavian Journal of Work, Environment and Health 7(2):95-100.			
HERO ID:	1982589			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Finishing and dyeing substances			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	unclear but assuming area sampling: 0.2 cm3/m3 mean (range 0.1-0.5 cm3/m3)			
Comments:	Note, 1 cm3/m3 = 1.25 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that samples were collected in midjet impingers and analyzed by the chromotropic add method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for exposure for textile plants which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1981 based on sampling implemented from 1974-1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range values are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1233809 Table: 1 of 5

Study Citation:	Niemelä, R.I., Rantanen, J., Kiilunen, M.K. (1998). Target levels–tools for prevention. Risk Analysis 18(6):679-688.			
HERO ID:	1233809			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Area sampling data:	1.09 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for fabric, textile and leather products not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1998)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1233809 Table: 2 of 5

Study Citation:	Niemelä, R.I., Rantanen, J., Kiilunen, M.K. (1998). Target levels–tools for prevention. Risk Analysis 18(6):679-688.			
HERO ID:	1233809			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Area sampling data:	0.21-0.53 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1998)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1233809 Table: 3 of 5

Study Citation:	Niemelä, R.I., Rantanen, J., Kiilunen, M.K. (1998). Target levels–tools for prevention. Risk Analysis 18(6):679-688.			
HERO ID:	1233809			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Area sampling data:	0.67 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for adhesives and sealants, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1998)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1233809 Table: 4 of 5

Study Citation:	Niemelä, R.I., Rantanen, J., Kiilunen, M.K. (1998). Target levels–tools for prevention. Risk Analysis 18(6):679-688.			
HERO ID:	1233809			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Area sampling data:	0.14 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1998)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1233809 Table: 5 of 5

Study Citation:	Niemelä, R.I., Rantanen, J., Kiilunen, M.K. (1998). Target levels–tools for prevention. Risk Analysis 18(6):679-688.			
HERO ID:	1233809			
Conditions of Use:	Use of electrical and electronic products			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Area sampling data:	0.11 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for electrical and electronic products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1998)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination			Medium	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA-83-284-1536. Dialysis Clinic, Inc., Atlanta, Georgia. NIOSH:83-284.			
HERO ID:	1316690			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Nurse turns on the central pumps to flush formalin/methanol solution with saline solution from all stations. At the end of the day each station is flushed with formalin /methanol where it relays over nightPeritoneal Dialysis - at the end of the week nurses connect containers to receiving lines on the machine open the container valve and pump in 37% formalin directly into the machineRe-use technician - flushes dialyzer with 2% solution of hydrogen peroxide. the dialyzer is filed with 2% solution of formalin, excess flows into drain. dialyzer is sealed and submerged in a tank containing 2% bleach solution. After 30 minutes the unit is removed and place on the shelf for the next patient.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Asst Head nurse 0.12 ppmRe-use tech mixing 0.22 ppmRe-use tech cleaning 0.09-0.35 ppmCleaning centrals 0.35 ppmPeritoneum Dialysis Equipment Cleaning 1.57-1.77 ppm			
Area sampling data:	Turning on centralsStation 146 0.12 ppmStation 51 0.17 ppmCentral 0.43 ppmRe-use techRe-use room 0.32 ppmAbove auto-dialyzer 0.18 ppm			
Exposure duration:	up to 10 hours per day			
Exposure frequency:	40 hours per week			
Number of workers:	16			
Personal protective equipment:	Chemical cartridge type respirators should be worn when cleaning up spills.			
Engineering control:	install HVAC system that includes outside air makeupcentral and re-use room exhaust fans should be run 24 hours per dayFittings valves, containers, seals and drain covers should be sealed.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Investigation implemented in 1983 prior to the PEL (1992)
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, worker activities, but lacks additional metadata, such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by considering both area and personal samples. Uncertainty is not addressed.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1316690 Table: 1 of 1

...continued from previous page			
Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA-83-284-1536. Dialysis Clinic, Inc., Atlanta, Georgia. NIOSH:83-284.		
HERO ID:	1316690		
Conditions of Use:	Laboratory Use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA-82-349-1332. Woolrich Woolen Mills, Inc., Woolrich, Pennsylvania. NIOSH:82-349.			
HERO ID:	1316761			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Worker activity description:	cutting, separating, jointing and sewing, inspection, and pressing.			
Exposure route:	Inhalation			
Physical form:	vapor			
Personal sampling data:	Avis Plant (liquid media)Sewing buttons 0.20 ppmSewing pockets 0.12 ppmSewing pockets 0.11 ppmSewing collars 0.27 ppmSep. fronts from backs 0.16 ppmAvis Plant (CEA 555 Measurements)Collar Finisher 0.38 ppmHoward Plant (liquid media)Small parts 0.29 ppmCuffs 0.30 ppmSleeves 0.33 ppmSmall parts 0.34 ppmHoward Plant (solid sorbent)Small parts 0.48 ppmCuffs 0.190 ppmSleeves 0.57 ppmSleeves 0.42 ppmSmall parts 0.44 ppm			
Area sampling data:	Airborne formaldehyde concentrations at the Avis plant averaged roughly 0.3 ppm, and 0.5 ppm at the Howard plant. No significant differences were detected between breathing zone and general area concentrations, nor between jobs within a plant at the same time of day.Avis plant (liquid media)Auto. cutter 0.12 ppmCentral front area Area 0.12 ppmSleeves Area 0.18 ppmSouthwest area 0.16 ppmInspection 0.15ppm Press room 0.12 ppmAvis Plant (CEA 555 Measurements)Inspection: range 0.12-0.22 ppm; average 0.18 ppmMarking for Pockets: range 0.19-0.22 ppm; average 0.20 ppmSmall Parts: range 0.19-0.21 ppm; average 0.20 ppmCollar Finishers: range 0.21-0.42 ppm; average 0.36 ppmSteam Room: range 0.36-0.38 ppm; average 0.37 ppmSewing sleeves: range0.38-0.39 ppm; average 0.39 ppmSmall parts: range 0.30-0.36 ppm; average 0.33 ppmSewing Backs: range 0.47-0.53 ppm; average 0.5 ppmCuffs & Pockets: range 0.40-0.53 ppm; average 0.45 ppmCollar Finishers: range 0.39-0.47 ppm; average 0.44 ppmButton Facing: range 0.49-0.50 ppm; average 0.49 ppmHoward Plant (liquid media)Central area 0.36 ppmCuffs 0.20 ppmNW Floor area 0.35 ppmSE Floor area 0.25 ppmCuffs 0.36 ppmPress room 0.13 ppmHoward Plant (solid sorbent)Central area 0.23 ppmCuffs 0.47 ppmNW Floor area 0.55 ppmSE Floor area 0.47 ppmCuffs 0.20 ppmPress room 0.25 ppmHoward Plant (CEA 555 Measurements)Separating small parts: range 0.24-0.43 ppm; average 0.35 ppmSewing fronts: range 0.43-0.45 ppm; average 0.44 ppmSewing sleeves: range 0.50-0.64 ppm; average 0.58 ppmSewing Collars: range 0.60-0.67 ppm; average 0.62 ppmSewing sleeves: range 0.55-0.60 ppm; average 0.57 ppmSteam room: range 0.31-0.43 ppm; average 0.35 ppmSewing fronts: range 0.57-0.76 ppm; average 0.64 ppmSewing fronts: range 0.45-0.70 ppm; average 0.49 ppmFronts to backs: range 0.55-0.70 ppm; average 0.65 ppm			
Number of workers:	170 at the Avis plant and 130 at the Howard plant			
Personal protective equipment:	Wear long sleeves & long pants			
Engineering control:	- reduction of formaldehyde content of incoming material- use lower or non-formaldehyde finishing techniques- raw material should be off gassed before use-increase make up air in HVAC			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Study implemented in 1982, prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1316761 Table: 1 of 1

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Study Citation:		NIOSH, (1983). Health hazard evaluation report: HETA-82-349-1332. Woolrich Woolen Mills, Inc., Woolrich, Pennsylvania. NIOSH:82-349.		
HERO ID:		1316761		
Conditions of Use:		Textile Finishing		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	Medium	Variability addressed by taking both area and personal samples at various locations. Uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-80-144-1109. Film Processing Industry, Hollywood, California. NIOSH:1-34.			
HERO ID:	1316845			
Conditions of Use:	Use of photographic supplies			
EXTRACTION				
Parameter	Data			
Worker activity description:	Line operatorsLine supervisorsSplicer operatorsMaintenance mechanics			
Exposure route:	Inhalation			
Physical form:	vapor			
Personal sampling data:	Technicolor PlantMixing room operator 0.03 ppmMixing room operator 0.02 ppmMixing room operator 0.02 ppmDry end light side operator - line #16 0.33 ppmDry end light side operator - line #14 0.59 ppmDarkside operator - line #14 0.50 ppmDry end operator - line #12 0.52 ppmDarkside operator - line #12 0.49 ppmMovie Lab PlantFilm Positive Operator 1.6 ppmFilm positive - Line #13 & #14 operator 0.09 ppmFilm positive - Line #13 & #14 operator 0.09 ppmFilm positive - Line #13 & #14 operator 0.05 ppmDry end operator - line #10 1.4 ppmShift supervisor - Line # 10 4.4 ppmDry end operator - line #10 NDDry end operator - line #10 NDDry end operator - line #10 ND			
Area sampling data:	Technicolor PlantBetween stations #14 & #16 0.05 ppmBetween stations #14 & #16 0.05 ppmBetween stations #14 & #16 0.04 ppmStation #16 0.04 ppmStation #16 0.05 ppmStation #16 0.03 ppmBetween stations #12 & #13 0.03 ppmBetween stations #12 & #13 0.03 ppmBetween stations #12 & #13 0.02 ppmFirst floor mixing 0.04 ppmFirst floor mixing 0.03 ppmFirst floor mixing 0.03 ppmDarckside Line #16 0.62 ppmMovie Lab PlantFilm positive dry box 0.03 ppmLine #13 & #14 near dry box 0.11 ppmLine #13 & #14 near dry box 0.06 ppmLine #13 & #14 near dry box 0.04 ppmNear dry box line #14 0.96 ppmNear dry box line #13 0.64 ppmNear reel position line #10 11.6 ppmDry end Near Dry Box NDDry end Near Dry Box NDDry end Near Dry Box NDWet end operator desk NDWet end operator desk NDWet end operator desk NDDry end line #13 NDDry end line #13 NDDry end line #13 NDDry end line #10 near knock off squeegee NDDry end line #10 near knock off squeegee NDIn Dry Box line #10 24.4 ppm			
Dermal exposure data:	nan			
Exposure duration:	8 hours per day			
Exposure frequency:	40 hours per week			
Personal protective equipment:	Skin protection			
Engineering control:	HVAC should be serviced regularly and run continuously			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario(photographic film processing) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1980 Prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Medium	Results from each sampling event provided, based on the data provided summary statistics could be developed. Uncertainty not discussed.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include most critical metadata, such as sample type and exposure type, sample durations, exposure durations, exposure frequency, and worker activities.

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Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-80-144-1109. Film Processing Industry, Hollywood, California. NIOSH:1-34.		
HERO ID:	1316845		
Conditions of Use:	Use of photographic supplies		
Domain	Metric	EVALUATION Rating	Comments
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Variability is not discussed, but results from each sampling event are present and assessment between locations is possible. As this is a NIOSH study it is assumed that uncertainty is considered in the NIOSH methodology.
Overall Quality Determination		High	

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA-82-303-1271. St. Francis Hospital, Honolulu, Hawaii. NIOSH:82-303.			
HERO ID:	1316854			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Patients are connected to an artificial kidney (dialyzer) and dialysis console for three to five hours depending on the patient's diet, condition of the dialyzers being reused, and other medical factors. Once the patient is disconnected from the dialyzer, the nurse or technician connects the dialyzer to the sterilizing unit (lixivitron®), The Lixivitron system is designed to automatically clean, test, and disinfect up to four dialyzers simultaneously. The operator starts the cleaning operation which uses water, cleaning solution, and formaldehyde to automatically wash, rinse, clean, in-vitro leak and pressure drop test, and disinfect the dialyzers. Failure of a test halts the process. Once the cleaning operation is completed, the patient data is printed out and the dialyzer is removed from the Lixivitron®; then the dialyzer and the printout are sealed in a plastic bag. The Lixivitron® is operated by trained personnel.			
Exposure route:	inhalation and dermal			
Physical form:	vapor and liquid			
Area sampling data:	Concentrations of airborne formaldehyde ranged from 0.04 to 1.28ppm. Eight of the seventeen air samples were collected from the self-care unit for one hour periods. Formaldehyde concentrations ranged from 0.06 to 1.28 ppm. Six of the seventeen air samples were collected from the Leeward satellite facility during dialyzer sterilization. Formaldehyde air concentrations ranged from 0.04 to 0.28 ppm based on one hour air samples. Three of the seventeen air samples were collected for 20 minute periods during sterilization of the dialysis consoles in the limited care unit. Formaldehyde air concentrations ranged from 0.12 to 0.28 ppm. Self Care/top of Travenol # 5841 0.06 ppmSelf Care/right side of Lixivitron Odor of formalin from drains 0.31 ppmSelf Care/ left side of Lixivitron Odor of formalin from drains 1.28 ppmSelf Care/left side of Lixivitron Formalin spill occurred 0.48 ppmSelf Care/right side of Lixivitron 0.66 ppmSelf Care/right side of Lixivitron 0.12 ppmSelf Care/left side of Lixivitron 0.12 ppmSelf Care/right side of Lixivitron 0.37 ppmLeeward/left side of Lixivitron 0.23 ppmLeeward/right side of Lixivitron 0.41 ppmLeeward/Nurses Station 0.07 ppmLeeward/left side of Lixivitron 0.28 ppmLeeward/right side of Lixivitron 0.32 ppmLeeward/Nurses Station 0.04 ppmLimited Care/Nurses Station 0.12 ppmLimited Care/Middle of larger room 0.28 ppmLimited Care/Middle of small room 0.12 ppm			
Number of workers:	22			
Personal protective equipment:	Glove, eye protection			
Engineering control:	Lixivitron should be isolated from the patientsDrains from the Lixivitron should be sealed			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	1982 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete values provided).
Domain 3: Accessibility/ Clarity				
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Formaldehyde

Occupational Exposure

HERO ID: 1316854 Table: 1 of 1

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Study Citation:		NIOSH, (1983). Health hazard evaluation report: HETA-82-303-1271. St. Francis Hospital, Honolulu, Hawaii. NIOSH:82-303.		
HERO ID:		1316854		
Conditions of Use:		Laboratory Use		
		EVALUATION		
Domain	Metric	Rating	Comments	
	Metric 6:	Metadata Completeness	Medium	Monitoring data included critical metadata, such as sample type and exposure type, worker activities and sample durations, but lacks additional metadata, such as exposure durations and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Variability addressed by taking air samples at various locations but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-82-200-1233. Todd Uniform Company, Maury City, Tennessee. NIOSH Cincinnati:1-24.			
HERO ID:	1316870			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Production workers. Job classifications for the production personnel include seamstresses (50), inspectors (5), and service operators (3). There are two maintenance mechanics—the only males employed at the facility.			
Exposure route:	Inhalation and dermal			
Physical form:	vapor			
Personal sampling data:	Hem Front Machine 0. 15 ppmHem Front Machine 0.32 ppmHem Front Machine 0.38 ppmHem Front Machine 0.32 ppm Hem Front Machine 0.39 ppmMake Collars Machine 0.24 ppmMake Collars Machine 0.35 ppmMake Co11ars Machine 0. 45 ppmMake Co11ars Machine 0.38 ppm Make Collars Machine 0.44 ppm Crease & Band Machine 0.23 ppmCrease & Band Machine 0.35 ppmCrease & Band Machine 0.35 ppmCrease & Band Machine 0.40 ppmCrease & Band Machine 0.45 ppmSet Collar Machine 0.19 ppmSet Collar Machine 0.37 ppm Set Collar Machine 0.35 ppmSet Collar Machine 0.42 ppmSet Collar Machine 0.54 ppmQC Inspector QC Station 1 0.23 ppmQC Inspector QC Station 1 0.35 ppmQC Inspector QC Station 1 0.40 ppmQC Inspector QC Station 1 0.43 ppmQC Inspector QC Station 1 0.52 ppmBand Sandwich Machine 0. 26 ppmCrease & Band Machine 0.28 ppmSide Seaming Machine 0.08 ppmMake Collars Machine 0.39 ppmSet Collar Machine 0.44 ppmHem Front Machine 0.22 ppmPocket Setter Machine 0.37 ppmTail Hem Machine 0.09 ppmSew Buttons Machine 0.15 ppmSet Pockets Machine 0.41 ppmQC Inspector QC Station 0.42 ppm			
Area sampling data:	Machine 104 0.50 ppmMachine 086 0.50 ppm			
Number of workers:	60 workers			
Personal protective equipment:	long sleeve shirtsbarrier cream			
Engineering control:	Dilution ventilation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study Method P&CAM 354
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 - prior to the PEL and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling provided which can be used to develop statistical characteristics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by using both personal and area samples but uncertainty is not addressed.
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Formaldehyde

Occupational Exposure

HERO ID: 1316870 Table: 1 of 1

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Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-82-200-1233. Todd Uniform Company, Maury City, Tennessee. NIOSH Cincinnati:1-24.		
HERO ID:	1316870		
Conditions of Use:	Textile Finishing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	NIOSH, (1993). Health hazard evaluation report no. heta-92-092-2333, General Castings Power Street facility, Cincinnati, Ohio.		
HERO ID:	1317161		
Conditions of Use:	Foundries		
EXTRACTION			
Parameter	Data		
Worker activity description:	Three core making processes were used: hot shell, oil-baked, and no-bake.		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	Range 0.014 to 0.016 ppmPoring floor 0.016 TWA-ppm; Core making area: pepset mixer 0.16 TWA-ppm; Core making area baking ovens 0.015 TWA-ppm; molding area 0.014 TWA-ppm; Core making area pepset mixer 0.014 TWA ppm. (range 0.014 to 0.016 ppm)		
Personal protective equipment:	Safety shoes, hard hats, hearing protection (disposable plugs), and safety glasses were required throughout the facility. The grinders and cut-off saw operator used NIOSH/Mine Safety and Health Administration (MSHA) approved air-purifying respirator helmets which had high efficiency particulate air (HEPA) filters and a built-in face shield. The Bobcat operator used a NIOSH/MSHA approved disposable dust, mist, and fume mask. Flame retardant clothing was worn by the pourers and furnace operator.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH study - Five area air samples were collected using impingers filled with 1% sodium bisulfite solution at a flowrate of 1 l/min. For analysis, color was developed by adding chromotopic acid and concentrated sulfuric acid to each sample. Samples were heated in a 95C water bath for 15 minutes and allowed to cool 2 to 3 hours. The samples were read by visible spectroscopy accordingto NIOSH Method 3500.3
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for foundry operations which is an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The data were published in 1991, before the most recent PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	High	actual data for each sampling event were presents
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, and worker activities. but lacks additional metadata, such as exposure durations, and exposure frequency,
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The study provided actual data from different processes at the site that can be used to evaluate variability. Information about uncertainty was likely included in the NIOSH methods used.
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Formaldehyde

Occupational Exposure

HERO ID: 1317161 Table: 1 of 1

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Study Citation:		NIOSH, (1993). Health hazard evaluation report no. heta-92-092-2333, General Castings Power Street facility, Cincinnati, Ohio.		
HERO ID:		1317161		
Conditions of Use:		Foundries		
Domain		Metric	EVALUATION Rating	Comments
Overall Quality Determination			High	

Study Citation:	NIOSH, (1992). Health Hazard Evaluation Report No. HETA-90-174-2231: Modern Materials Incorporated, Rochester, Indiana.
HERO ID:	1317177
Conditions of Use:	Use of Paints/Coatings

EXTRACTION	
Parameter	Data
Worker activity description:	paintersmaintenance workersinspectorscleaners
Exposure route:	Inhalation
Physical form:	Vapor
Personal sampling data:	Leader, line 1 0.02 mg/m3.Painter 0.00 mg/m3.Hanger-inspector, line 3 0.04 mg/m3.Hanger-inspector, line 1 0.04 mg/m3.Painting and hanging 0.08 mg/m3.Painting and hanging 0.04 mg/m3.Hanging, line 3 0.02 mg/m3.Hanger, line 2 0.02 mg/m3.
Area sampling data:	Formaldehyde concentrations were only slightly higher than those reported for acetaldehyde and ranged from ND to 0.09 mg/m3.Top of booth (line 1) 0.01 mg/m3Oven outlet (line 1) 0.03 mg/m3Line 1 0.06 mg/m3Cyclone (line 1) 0.05 mg/m3Oven outlet (line 2) 0.03 mg/m3Side of spray booth (line 3) 0.04 mg/m3Bag house (line 3) 0.06 mg/m3Paint booth (line 3) 0.01 mg/m3Line 3 0.03 mg/m3Burn-off area 0.06 mg/m3High-tech area 0.06 mg/m3High-tech area 0.06 mg/m3High-tech area 0.09 mg/m3
Exposure duration:	8-10 hours per day
Number of workers:	80
Engineering control:	improvements to HVAC system
Comments:	Check table I,II, and IV.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study Method 2541
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (surface coating) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1990 - Prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Medium	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, and sample durations, but lacks additional metadata, such as exposure durations, exposure frequency, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Results from individual sampling events were provided which could be used to evaluate variability between locations/jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.

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Formaldehyde

Occupational Exposure

HERO ID: 1317277 Table: 1 of 1

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-275-1122. General Telephone Company, York, Pennsylvania. NIOSH:1-12.			
HERO ID:	1317277			
Conditions of Use:	Use of Ink, Toner, and Colorant Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	assigners, service representatives, clerks, dispatchers, and switchboard operators			
Exposure route:	inhalation and dermal			
Area sampling data:	0.22 (mg/m^3)			
Number of workers:	33 interviewed and examine			
Personal protective equipment:	white cotton gloves			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method. (NIOSH method P&CAM 318.)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for ink, toner, and colorant products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1981)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency, exposure duration, PPE, engineering control.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1973). Health hazard evaluation: Bakan Plastics.			
HERO ID:	1317291			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Injection molding machine operators. (2/4)			
Exposure route:	inhalation, dermal (3/4)			
Personal sampling data:	All of the air samples indicated that there was less than 2 mg/m3. (2/4)			
Number of workers:	There are a total of 18 injection mold machines and each machine has one operator. (2/4)			
Engineering control:	The entire plant is airconditioned and large man-cooling fans have recently been installed around the molding department to circulate the conditioned air . (2/4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure duration, frequency, physical form, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	NIOSH, (1992). Health Hazard Evaluation Report No. HETA-91-169-2196: Texprint Products, Macon, Georgia.
HERO ID:	1317776
Conditions of Use:	Use of fabric, textile and leather products

EXTRACTION	
Parameter	Data
Worker activity description:	During three shifts, approximately 25 employees work in the Input and Inspection Department, and 13 employees work in the Preparation and Finishing Department. The employees in the Stock-Paste Department make a carrier for the dye from a complex recipe. The Stock-Paste carrier is used to adjust the viscosity and application characteristics of the dye. Most of the chemicals are weighed manually and added by hand. The management of Texprint has written plans to automate the Stock-Paste Department. One employee works in the Stock-Paste Department. Stock paste is fed to the Dye Mixing Department ("color kitchen"). The auto-mixing machine is operated by one employee. One or two other employees are often in the area performing peripheral tasks (hauling barrels of dye, cleaning barrels, etc.). The manual mixing area is used to make fine adjustments in dye color or prepare low volume colors. Dye is scooped out of vats by hand, weighed, and mixed into other vats. A total of 12 employees work in this area. In the Strike-Off Department (Sample Department), dyes are mixed by hand, and trial patterns and colors are produced on an experimental basis. Dye is added to the roller with a hand-held pump. Approximately 15 employees work in this department, which operates over two shifts. In the Rotary Printing Department, dye is printed on cloth in a similar manner to that in the Strike-Off Department; except the operation is automated. There are four rotary printers, and one or two employees are stationed at each printer. The employees monitor the printing process for quality or mechanical problems and start new rolls of cloth when needed. Twelve employees work in the Rotary Printing Department. In the Finishing Department, three Hirano® machines are used for heat-tenting and application of soil-resist substances (Scotchgard®, Zonyl®) or "resists," which are actually resins, are applied to the cloth for shrinkage control.
Exposure route:	Inhalation
Physical form:	vapor
Personal sampling data:	Machine Operator Hirano #1 detected
Area sampling data:	Near Permafresh tank 0.23 TWA ppm On electrical Box 0.09 TWA ppm Back end of Hirano 0.06 TWA ppm Chemical Tank detected Back end of Hirano #1 detected Work Desk of Hirano #2 detected
Dermal exposure data:	nan
Exposure duration:	up to 10 hours per day
Exposure frequency:	40 hours per week
Number of workers:	76 production workers
Personal protective equipment:	googles Face shield Rubber latex gloves Rubber boots Aprons Respirators
Engineering control:	Use of low formaldehyde resins Modify exhaust to ensure vapors do not re-enter building. Automate process as soon as possible

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High NIOSH study - Methods 3500 and 2541
Domain 2: Representativeness	Metric 2:	Geographic Scope	High US
	Metric 3:	Applicability	High The data are for an occupational scenario (fabric printing) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low 1991- Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed to be a consideration in the NIOSH methods

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Study Citation:	NIOSH, (1992). Health Hazard Evaluation Report No. HETA-91-169-2196: Texprint Products, Macon, Georgia.		
HERO ID:	1317776		
Conditions of Use:	Use of fabric, textile and leather products		
Domain	Metric	EVALUATION Rating	Comments
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination		High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-82-337-1163. National Park Service, Patchogue, New York. NIOSH:1-11.			
HERO ID:	1318004			
Conditions of Use:	Unknown			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	Vapor			
Area sampling data:	House #1Living room 2/81 0.06 ppmLiving room 7/82 0.06 ppmMaster bedroom 2/81 0.05 ppmMaster bedroom 7/82 0.12 ppmHouse #3Living/dining area 2/81 0.13 ppmLiving/dining area 5/81 0.07 & 0.12 ppmLiving/dining area 7/82 0.09 ppmMaster bedroom 2/81 0.08 ppmMaster bedroom 5/81 0.12 ppmBedroom A 5/81 0.13 ppmBedroom A 7/82 0.12 ppmBedroom B 5/81 0.06 ppmBedroom B 7/82 0.15 ppm			
Engineering control:	Remove foam insulation - this was done for House #3 but concentrations did not drop.			
Comments:	see Table 1			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (park ranger) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981-82, prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (area) but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods
Overall Quality Determination		High		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-315-1227. Pennsylvania State University, Dubois Campus, Dubois, Pennsylvania. NIOSH:1-17.			
HERO ID:	1318529			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	The Student Learning Office houses the administrative offices, an auditorium, an information center, bookstore, a Health Center, library and a student lounge. The Health Center consists of a waiting room, hallway, a center room and two treatment areas. (Page 4 of 17)			
Exposure route:	Formaldehyde gas may have an irritant effect on the mucous membranes of the respiratory tract and eyes . Eye irritation is a common complaint and has been reported in industrial workers at airborne concentrations of 0.3-0 . 9 ppm. (page 6 of 17)			
Area sampling data:	On July 7, 1981, the airborne concentration of formaldehyde measured in the library,health center, Room 108 ranged from 0.02 to 0.04 ppm of air sampled. The followingmorning after no air circulation overnight , the concentrations ranged from 0. 05 to0. 10 ppm. When the air fans were activated in the same areas . Levels in other areas ranged from 0. 01 to .07 ppm. These levels are lower than might be expected to cause significant eye and upper respiratory irritation. (Page 8 of 17). All results are below:July 7, 1981 (Table 1, Page 12 of 17)Room 108 0.017 ppmLibrary 0.024 ppm Health Services 0 .031 ppm Room 108 0.024 ppm Health Services 0.029 ppm Librarians Office 0.036 ppm July 8, 1981 (Table 1, Page 12 of 17)Room 108 0.073 ppm Library 0.099 ppm Health Center 0.053 ppm Room 102 0.059 ppm Book Store 0.067 ppm Library 0.021 ppm Room 101 0.015 ppm Room 106 0.013 ppm February 24, 1982 (Table V, Page 16 of 17)Room 108 < 0.001Room 102 < 0.001Room 106 < 0.001Health Center (Desk) < 0.001Book Store < 0.001Auditorium < 0.001Health Center (Treatment) < 0.001Library < 0.001			
Number of workers:	approximately 25 employees (Page 3 of 17)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4:	Temporal Representativeness	Low	Greater than 20 years
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
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Formaldehyde

Occupational Exposure

HERO ID: 1318529 Table: 1 of 1

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Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-315-1227. Pennsylvania State University, Dubois Campus, Dubois, Pennsylvania. NIOSH:1-17.		
HERO ID:	1318529		
Conditions of Use:	Office Environment		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	NIOSH, (1980). Health hazard evaluation report: HHE-77-74-720. Ottenheimer and Sons, Inc., Dawson, Springs, Kentucky. NIOSH:77-74.			
HERO ID:	1318533			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Worker activity description:	The report does not make clear what specifically is done by the workers, but the following is potential contact with the clothing: rolls of cloth are spread by machine on large tables and tracing paper is placed on top of the cloth layers and marked. The cloth is then cut by an automatic cutter with a blade which moves in an up and down motion. Next there is a sewing room, which comprises most of the floor space in the main plant, and subdivided into six sections for the various phases of assembly of the uniforms. (See page 2 of 8)			
Exposure route:	inhalation, dermal			
Physical form:	vapor (page 1 of 8)			
Personal sampling data:	3/13/78 Pressing Operation 0.14 ppm (Table 1, page 7 of 8)			
Area sampling data:	See Table I for values (page 7 of 8, and listed below). See page 3 of 8 for discussion.6/23/77 General Area - Cutting Room 0.20 ppm6/23/77 General Area - Cutting Room 0.13 ppm6/23/77 General Area - Sewing Machine 0.57 ppm6/23/77 General Area - Pressing Operation 0.40 ppm6/23/77 General Area - Pressing Operation 0.30 ppm3/13/78 General Area - Pressing Operation 0.26 ppm3/13/78 General Area - Pressing Operation 0.21 ppm3/13/78 General Area - Sewing Operation 0.15 ppm3/13/78 General Area - Sewing Operation 0.16 ppmFor latent formaldehyde content of cloth samples, including various colors and two companies' clothing, see Table 3 (page 8 of 8). 3/21/78 values were 938, 912, 700, and 580ppm. On 4/5/78 they were 86, 88, 70, and 84ppm. See page 4 of 8 for discussion (pasted here): A decrease of 86 - 91% over three weeks. Although these data are limited, they show a definite correlation between the age of the resin treated fabric and latent formaldehyde content. Storage of the fabric in a ventilated area for a determined time period, therefore, should significantly reduce the potential for worker exposure to vaporous formaldehyde.			
Dermal exposure data:	nan			
Exposure duration:	There is one shift per day at the plant (2 of 8)			
Number of workers:	210 employees total at the plant, 175 production workers (2 of 8)			
Comments:	Three durable press fabrics including "MEDA," "Valid Poplin," and "Resolute," were reportedby the workers to be of primary concern (2 of 8)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method P&CAM 125
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (garment fabrication) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1977 - Prior to the PEL (1992)
	Metric 5:	Sample Size	High	The airborne formaldehyde concentration ranged from 0.13 to 0.57 ppm (mean 0.25, S.D. + 0.14)
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
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Formaldehyde

Occupational Exposure

HERO ID: 1318533 Table: 1 of 1

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Study Citation:		NIOSH, (1980). Health hazard evaluation report: HHE-77-74-720. Ottenheimer and Sons, Inc., Dawson, Springs, Kentucky. NIOSH:77-74.		
HERO ID:		1318533		
Conditions of Use:		Use of fabric, textile and leather products		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in Method P&CAM 125.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-82-264-1232. Olympic Medal Laboratories, Bremerton, Washington. NIOSH:1-10.			
HERO ID:	1319165			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Two technicians conduct the slide preparation. The third one logs the specimens, assists in gross tissue examination and disposes of the specimens. The pathologist conducts the gross tissue examination. (Page 4 of 10)			
Exposure route:	inhalation (Page 4 of 10)			
Physical form:	airborne vapor (Page 4 of 10)			
Personal sampling data:	The formaldehyde concentrations ranged from 0.08 to 2.58ppm. Two of the technicians exposure ranged from 0.08 to 0.27, however it is not exposed to the lowest feasible level. Another technician had exposures of 0.43 (134 minutes long with about 20 minutes being disposing of old specimens, then misc. work not related to the use of formaldehyde), 0.93 (logging in specimens, doing misc. work, and working with pathologist during gross tissue examination, the latter work which lasted 43 minutes "undoubtedly" was the highest portion of this sample where the concentration was probably higher than 1 ppm), and 2.58ppm (over 30 minutes while disposing of old specimens. Technician stated his eyes and nose burned and he squinted his eyes when disposing of the specimens, but once task was complete the symptoms ceased). The pathologist's formaldehyde exposure, while he conducted gross examination of tissue, was 1.26 ppm, and he stated that his eyes and nose did not burn but that it was a light day (small specimens and not much formaldehyde) and on heavy days his eyes and nose will burn. Other technicians did not report any symptoms during the sampling periods. (Page 7 of 10)See Table 1 on Page 10 of 10, the formaldehyde information is transcribed below:7/13/82 Lab Tech# 1 -Slicing Specimens, Preparing Blocks 0.23ppm (over 186 minutes) & 0.27 ppm (over 124 minutes)7/13/82 Lab Tech #3 -Disposal of Specimens 2.58 ppm (over 30 minutes)7/13/82 lab Tech #3 -Log Specimens in, Assist in Gross Exam,Miscellaneous work 0.93 ppm (over 82 minutes)7/13/82 Pathologist - Gross Examination of Tissue 1.26 ppm (over 43 minutes)7/21/82 Lab Tech #1 - Slicing Specimens, Slide Preparations 0.08 ppm (over 152 minutes)7/21/82 Lab Tech #1 - Slicing Specimens, Slide Preparations 0.14 ppm (over 141 minutes)7/21/82 Lab Tech #2 - Slicing Specimens, Slide Preparations 0.18 ppm (over 152 minutes)7/21/82 Lab Tech #2 - Slicing Specimens, Slide Preparations 0.22 ppm (over 141 minutes)7/21/82 LabTech #3 - Disposal of Specimens, Loqged in New Specimen, Misc. Work 0.43 ppm (over 134 minutes)			
Dermal exposure data:	nan			
Exposure duration:	3 technicians full time, 3 pathologist 1 hour per day on a rotational basis (Page 4 of 10)			
Engineering control:	There is one local exhaust hood in the room. It is a canopy type hood over the counter next to one of the two sinks. It is not enclosed on the sides or front, is 21 inches above the counter top, has 10.5 square feet of open face area and exhausts approximately 250 cfm. Smoke tube tests show that it captures very little of the vapor emitted from the specimens during gross tissue examination of from the sink. (page 4 of 10)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method P&CAM 125
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (pathology lab) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity				
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Formaldehyde

Occupational Exposure

HERO ID: 1319165 Table: 1 of 1

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Study Citation:		NIOSH, (1982). Health hazard evaluation report: HETA-82-264-1232. Olympic Medal Laboratories, Bremerton, Washington. NIOSH:1-10.		
HERO ID:		1319165		
Conditions of Use:		Laboratory Use		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, sample durations, exposure durations, and worker activities, but lacks exposure frequency.
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in Method P&CAM 125.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-329-1049. Nyasco Products, Incorporated, Long Island City, New York. 81-329-1049:1-10.			
HERO ID:	1319169			
Conditions of Use:	Distribution in commerce			
EXTRACTION				
Parameter	Data			
Worker activity description:	Duties include billing and shipping of work clothing. (Page 4 of 9)			
Physical form:	Vapor (page 4 of 9)			
Area sampling data:	Airborne concentrations of formaldehyde were determined to be present by two methods of survey. Concentrations of airborne formaldehyde were 1 to 1.5 ppm throughout the NYASCO area and the retail store area using detector tubes as the sampling medium. Using chromatropic treated charcoal sampling tubes as the sampling media, the concentrations of airborne formaldehyde ranged from 0.1 to 0.6 ppm. The detector tube sampling method has not been certified for accuracy by NIOSH, and should be considered only an approximation of the true concentration of airborne formaldehyde. The four samples of permanent press fabrics were determined to contain formaldehyde ranging from 190 to 710 ppm (latent formaldehyde method of analysis), identifying the fabrics as probable sources of the airborne formaldehyde. (page 5 of 9)			
Number of workers:	3 (page 4 of 9)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (retail) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 - Prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range. Uncertain statistics not provided, but as this is a NIOSH study it is assumed that uncertainty was considered in the methods.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as exposure type, sample type, and worker activities, but lacks additional metadata, such as sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability or uncertainty, but it is assumed that uncertainty was considered in this NIOSH study in the sampling and analysis methods.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-80-190-1135, American Cyanamid Company, Kalamazoo, Michigan. NIOSH:1-23.			
HERO ID:	1319179			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	Employee exposure to chemicals are predominantly from leaks in pipe lines, and transfer junctions, and leaks from seals and fittings around kettle agitators. Also, high chemical exposure from inadvertent spills of chemicals or emergency repair of process equipment during a batch process cycle. (Page 4 of 23)			
Personal sampling data:	The 1.6 ppm was a short-term personal sample collected from a specialty chemical operator. (Page 7 of 23)The sampling results are as follows (from page 16 of 23):January 6, 1981 Reactor Vessel EI20-Q03 1.6 ppm (1.9 mg/M3)January 7, 1981 Quench Tank 0.11 ppm January 7, 1981 Weigh Tank 0.04 ppm			
Area sampling data:	Formaldehyde was detected in 8 of 8 samples in the specialtychemical building, and ranged from 0.03 ppm to 1.6 ppm. The mean concentration was 0.33 ppm. (Page 7 of 23)The sampling results are as follows (from page 16 of 23):January 6, 1981 Reactor Vessel 0.05 ppmJanuary 7, 1981 Quench Tank 0.30 ppm January 7, 1981 Operator’s Desk 0.43 ppmJanuary 7, 1981 Weigh Tank 0.06 ppm January 7, 1981 Near Reactor Vessel EI20-003 0.03 ppm			
Number of workers:	There are 43 workers in production, 11 in maintenance, and approximately 14 salaried workers. (Page 3 of 23)			
Personal protective equipment:	Personal protective equipment such as boots, gloves, safetyglasses, coveralls, hard hats, and respirators are supplied by thecompany. (Page 3 of 23)			
Engineering control:	Ventilation measurements taken during chemical operations atvarious hoods show average face velocities generally exceeded 100feet per minute (fpm). (Page 8 of 23, where these rates are also summarized)The main positive engineering control feature was operation of a number of well-designed and sturdy local exhaust ventilation units installed on reactor vessel sampling stations, drum handling stations, certain major transfer or recirculation pump sites, and pre-mix tanks. However, there were a number of process equipment units on which both local and general exhaust ventilation were either nonexistent or ineffective (particularly in the specialty chemical department). (Page 10 of 23)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method P&CAM 125
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (chemical product manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1980-81 Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method P&CAM 125.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, sample durations, but lacks additional metadata, such as exposure durations, exposure frequency, andworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations and jobs.As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
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Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-80-190-1135, American Cyanamid Company, Kalamazoo, Michigan. NIOSH:1-23.		
HERO ID:	1319179		
Conditions of Use:	Multiple		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA-83-418-1449. Randolph County Register of Deeds Office, Asheboro, North Carolina. NIOSH:83-418.
HERO ID:	1319222
Conditions of Use:	Installation/Demolition of Building Materials

EXTRACTION

Parameter	Data
Worker activity description:	The Deeds offices are on the ground floor of a recently-built brick courthouse annex, first occupied in August 1981, and consist of a main office, records room, and copy/storage room. Activities of the five regular employees consist of recording, storing, and copying deeds and other documents. Binding of deed books is done elsewhere. Three sides of the offices are exterior brick cavity walls containing urea-formaldehyde foam insulation, according to the building architect's office. The offices are carpeted. Records and furnishings, except for some table tops and a built-in counter with drawers and cabinets, were moved from the facility's previous location , where no respiratory problems were experienced during the previous several years.The regular employees have desks located in the main office area behind the service counter, but their duties take them to the records and copy rooms frequently. Smoking is not permitted in the Deeds offices. (Page 3 of 13). See page 4 for a floorplan and corresponding formaldehyde concentrations mapped onto it.
Exposure route:	Inhalation
Area sampling data:	Five 4-hour samples were collected on September 16, and four 24-hour samples on December 13. In addition, several short-term formaldehyde analyses were made with detector tubes during the December 13 survey. (Page 5 of 13). Formaldehyde concentrations in the air of the Deeds office varied from 0.05 to 0.69 ppm, concentrations associated with some of the reported symptoms. (Page 8 of 13). See Table 1 on page 9 for all the concentrations found at the various locations during the two sampling events. After results [in September] indicated substantial formaldehyde concentrations, further sampling was carried out in December in an attempt to discover the source. In December there was little formaldehyde detected in the office air, and the only indicated emission source was the built-in cabinetry, principally in the Deeds office service counter. Although some wooden cabinets are known to contain and emit formaldehyde, there is some question whether the counter installation alone could deliver the concentrations found in September. The lower general air formaldehyde concentrations may be indicative of higher winter ventilation rates. (Page 10 of 13).
Number of workers:	five regular employees (page 3 or 13)
Comments:	Possible sources of formaldehyde in the air of office buildings are urea-formaldehyde foam insulation, cigarette smoke, carpeting, laminated and particle-board furniture, wall fabrics, and carbonless forms if present in abundance. Experience has shown that the formaldehyde contamination, if caused by emissions from materials other than foam insulation, often disappears in a year or more. (Page 10 of 13)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method
Domain 2: Representativeness	Metric 2: Geographic Scope	High	In USA
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	From 1984
	Metric 5: Sample Size	Medium	Samples were taken in various locations in the office and repeated twice over, around 3 months apart
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.

Domain 4: Variability and Uncertainty

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Formaldehyde

Occupational Exposure

HERO ID: 1319222 Table: 1 of 1

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Study Citation:		NIOSH, (1984). Health hazard evaluation report: HETA-83-418-1449. Randolph County Register of Deeds Office, Asheboro, North Carolina. NIOSH:83-418.		
HERO ID:		1319222		
Conditions of Use:		Installation/Demolition of Building Materials		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	The office was sampled twice at different times of year and there is some discussion of the causes of variability and uncertainty
Overall Quality Determination			High	

Study Citation:	NIOSH, (1992). Health Hazard Evaluation Report No. HETA-91-131/193-2261, EPA Superfund Site, Newark, New Jersey.			
HERO ID:	1320485			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Area sampling data:	a formaldehyde level of 0.65 ppm in the new trailers. (Page 2 of 4)			
Number of workers:	40 people on site, 35 performing the physical clean-up (Page 2 of 4)			
Personal protective equipment:	SCBA and moon suits in the "hot zone", no special protection in support area (Page 3 of 4)			
Engineering control:	Triple air filtration (Page 2 of 4)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - prior to PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	A single value was provided without characterizing statistics. Also, uncertainty was not discussed, but as this is a NIOSH study, it is likely that uncertainty was considered in the methods used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	A single value was provided so it is not possible to evaluate variability. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1320505 Table: 1 of 1

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-82-045-1108. University of Colorado Medical School, Denver, Colorado. NIOSH:1-15.			
HERO ID:	1320505			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Personal sampling data:	Values for the formaldehyde samples ranged from less than 0.02 mg/W to 3.3 mg/W. Eight of 25 (32%) formaldehyde air samples exceeded the former NIOSH recommended criteria of 1.2 mg/W for any 30 minute sampling period. (Page 7 of 15) See Tables 1 and 2 on page 10 and 11 of 15 for all the data.			
Exposure duration:	1-2 hours per day (Page 4 of 15)			
Engineering control:	The only ventilation is general comfort ventilation which serves as air conditioning in the summer and heat in the winter. (Page 4 of 15).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method P&CAM 125
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (exposure to chemicals in an academic laboratory) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 - prior to PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH method P&CAM 125.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, and exposure durations,but lacks additional metadata, such as exposure frequency, andworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between students. As this is a NIOSH study, it is assumed that uncertainty was considered in Method P&CAM 125.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1992). Health Hazard Evaluation Report No. HETA-88-240-2210: The Mueller Company, Decatur, Illinois.
HERO ID:	1320542
Conditions of Use:	Use of Adhesives and Sealants

EXTRACTION	
Parameter	Data
Worker activity description:	Mueller Operator"4-D" OperatorCore Cleaner CB5 Core MakerLaempe Operator Bench Core Maker Set-up; Auto.
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	July 27, 1988Mueller Oper. 0.47 ppm"4-D" Oper. 0.6 ppmCore Cleaner 0.65 ppmCB5 Core Maker 0.49 ppmCore Cleaner 0.38 ppmLaempe Oper. 0.33 Bench Core Maker 0.32 ppmSet-up; Auto. 0.4 ppmDecember 2, 1988Mueller Oper. 0.48 ppm"4-D" Oper. 1.21 ppmCore Cleaner #1 0.96 ppmCB5 Core Maker 1.18 ppmCore Cleaner #2 1.03 ppmLaempe Oper. (not operating during this survey) Bench Core Maker 0.53 ppmSet-up; Auto. 0.94 ppm
Area sampling data:	General Area/ CB5 Core Oven 1.32 ppmGeneral Area/ North Wall 1.39 ppm
Exposure duration:	up to 10 hours per day
Exposure frequency:	40 hours per week
Engineering control:	Substituting a "low free-formaldehyde" resin binder for the resin binder currently used should be thoroughly explored by the Mueller Company. Have local exhaust ventilation system installed on the ovens
Comments:	See Table 1 and Table 2.

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH Study - Method 2502
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for an occupational scenario (foundry) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1988 - prior to the PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	High	Results from individual sampling events for two different days were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations, jobs and different days. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 1320542 Table: 1 of 1

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Study Citation:		NIOSH, (1992). Health Hazard Evaluation Report No. HETA-88-240-2210: The Mueller Company, Decatur, Illinois.		
HERO ID:		1320542		
Conditions of Use:		Use of Adhesives and Sealants		
Domain		Metric	EVALUATION Rating	Comments
Overall Quality Determination			High	

Study Citation:	NIOSH, (1980). Health hazard evaluation report: HHE-79-86-675. Tufts Medical School, Boston, Massachusetts. NIOSH:79-86.			
HERO ID:	1320877			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Professor/student			
Exposure route:	Inhalation			
Physical form:	vapor			
Area sampling data:	The 'level of formaldehyde in each sample was less than the quantitation limit. The charcoal tube samples are reported containing less than 4 micrograms of formaldehyde per sample, a level which is less than the 1 ppm, NIOSH recommended standard for formaldehyde.			
Exposure duration:	8 hour per day			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method P&CAM 125
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (academic lab) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1979 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Only a single not to exceed value was provided - no statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, worker activities, exposure duration, but lacks additional metadata, such as sample durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability was not discussed. Only a single not to exceed value was provided so it was not possible to assess variability. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1983). Health evaluation and technical assistance report: HETA-81-422-1387. California Society For Histotechnology, Los Angeles, California.		
HERO ID:	HETA-81-422-1387:1-49. 1321033		
Conditions of Use:	Laboratory Use		
EXTRACTION			
Parameter	Data		
Worker activity description:	DissectionTissue processingSlide preparationTissue dumping		
Exposure route:	Inhalation		
Physical form:	Vapor		
Personal sampling data:	Lab #6During tissue dumping 1.9 ppmLab # 95/21 Disposing spent formalin and replenishing containers ND5/21 Cleaning tissue processors, embedding ND6/14 Neuro-Room washing tissue containers ND6/8 Cutting and loading cassette 0.7 ppm6/8 Neuro-room washing tissue containers ND6/8 Embedding, cutting, sorting paraffin blocks ND9/27 Neuro-room, removing tissue from container ND9/28 Change solutions in tissue processor 0.2 ppm9/28 Loading tissue processor with cassette 0.8 ppm		
Area sampling data:	Lab #6 Pathologist cutting area 0.5 ppm		
Exposure duration:	8-10 hours per day.		
Number of workers:	Questionnaire submitted to 94 workers		
Personal protective equipment:	Respiratory masks worn incorrectly.		
Engineering control:	Local exhaust ventilation should be used to control chemical vapors.Tissue processors should be enclosed and ventilated to the outdoors or isolated from the general work area.		
Comments:	Study noted that phenol, xylene, toluene, and alcohol negatively interference with P&CAM 125		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH Study - Method P&CAM 354 and 125(Study noted that phenol, xylene, toluene, and alcohol negatively interference with P&CAM 125)
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for an occupational scenario (histology) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1982 prior to the PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH method P&CAM 354 and 125.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, exposure durations, and worker activities, but lacked additional meta-data, such as exposure frequency.
Domain 4: Variability and Uncertainty			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 1321033 Table: 1 of 1

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Study Citation:	NIOSH, (1983). Health evaluation and technical assistance report: HETA-81-422-1387. California Society For Histotechnology, Los Angeles, California.				
HERO ID:	HETA-81-422-1387:1-49. 1321033				
Conditions of Use:	Laboratory Use				
			EVALUATION		
Domain	Metric		Rating	Comments	
	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations and activities. As this is a NIOSH study, it is assumed that uncertainty was considered in Methods P&CAM 125 and 354.	
Overall Quality Determination			High		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-80-81-1173. Keokuk Steel Castings, Incorporated, Keokuk, Iowa. NIOSH:1-31.			
HERO ID:	1321050			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	Eight workers are employed in the core production area. Three operators, two on the smaller core system (small blower) and one on the larger, are involved in actual core production. The remaining workers are involved in painting cores with an alcohol-based substance, trimming, and transporting the cores to, temporary storage. Seven workers are employed in the mold production areas. Three operators, two on the large mold system and one on the small, filling the mold shells with the chemically treated sand. The remaining four workers strike off, transport, and "finish" the molds. The primary job categories for the metal pouring operation are the Pourer (the worker who pours molten metal into the molds) and the Skimmer (involved with skimming contaminants from the top of the molten metal during pouring operations). The primary job in shakeout area involves the manual separation of the casts from the broken sand molds at a position downstream, yet adjacent to the mold destruction process. Two workers are normally stationed at this position and manually remove the casts.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Eight breathing zone samples for formaldehyde collected at the core and mold area indicated exposure levels ranging from 0.18 to 0.50 mg/M3. Three breathing zone samples collected from workers in the core production area and three from the mold production area indicate an overall average of approximately 0.36 mg/M3 for both locations. The highest measured exposure, 0.50 mg/M3, was obtained from the Stripper at the core production location. 3/10/1981 Lg. Mold/Head Operator 0.29 mg/m3/10/1981 Core/Stripper 0.50 mg/m3/10/1981 Core/Head Operator 0.18 mg/m3/11/1981 Lg. Mold/Head Operator 0.36 mg/m3/11/1981 Sm. Mold/Head Operator 0.43 mg/m3/11/1981 Core/Head Operator 0.41 mg/m3			
Number of workers:	Isocure 7 Other core and molding 41 Pouring and Skimming 14 Other 22			
Personal protective equipment:	Half-face respirators are required for entry into the metal pouring area.			
Engineering control:	Engineering controls for reduction of chemical exposures include . general dilution ventilation, local exhaust ventilation, and the use of seals around closure points on the metal molds. Union officials and workers in this area said that these controls, installed and improved within the year prior to the survey, substantially reduced chemical exposures. Eight workers are employed in the core production area. Three operators, two on the smaller core system (small blower) and one on the larger, are involved in actual core production. The remaining workers are involved in painting cores with an alcohol-based substance, trimming, and transporting the cores to, temporary storage. Recommended: Exhaust ventilation in the shakeout area should be improved.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study Method P&CAM 318
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (foundry) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 Prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH method P&CAM 318.
Domain 3: Accessibility/ Clarity				
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Formaldehyde

Occupational Exposure

HERO ID: 1321050 Table: 1 of 1

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Study Citation:		NIOSH, (1982). Health hazard evaluation report: HETA-80-81-1173. Keokuk Steel Castings, Incorporated, Keokuk, Iowa. NIOSH:1-31.		
HERO ID:		1321050		
Conditions of Use:		Use of Adhesives and Sealants		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, and worker activities, but lacks additional metadata, such as exposure durations, and exposure frequency,
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations and jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in NIOSH Method P&CAM 318.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1980). Health hazard evaluation report: HHE-79-146-670, Cincinnati, College of Mortuary Science, Embalming Laboratory, Cincinnati, Ohio.			
HERO ID:	NIOSH:79-146.1322362			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	9/11/79 Personal conducting simulated embalming operations NA9/11/79 Personal conducting simulated embalming operations 1.75 ppm1/22/80 Personal - student 3.93 ppm 1/22/80 Mortician - instructor 1.30 ppm 1/23/80 Student (personal) 0.91 ppm 1/23/80 Embalming instructor 0.67 ppm			
Area sampling data:	9/11/79 Overhead between operating Table I and II NA9/11/79 Overhead between operating Table I and II 0.51 ppm9/11/79 At the foot of Table II 3.99 ppm9/11/79 At the foot of Table II & III N.A.1/22/80 Hanging from ceiling (head height) 3.65 ppm 1/22/80 Office Adjacent Embalming Area 2.03 ppm 1/22/80 Center of Embalming Area (table) 2.49 ppm 1/23/80 Above worker's head - center of room 0.56 ppm 1/23/80 Office Adjacent Embalming Area 0. 20 ppm 1/23/80 Table - Center of Embalming Area 0.24 ppm			
Exposure duration:	8, 12, 21, and 50 hours per week			
Number of workers:	Three full-time and 8 to 10 part time employees, plus students. In 1973, a new addition for embalming services wasadded to the building which now employs four full-time employees.			
Personal protective equipment:	Recommended: Protective clothing should be provided for the embalming employees. Such clothing should include gloves made of impervious materials, protective aprons, leather or rubber safety shoes, and eye protection.			
Engineering control:	Recommended:A ventilation consultant should be retained to evaluate the efficiency of the present exhaust system. An adequate system should eliminate the recirculation of air by incorporating a "once-through" air handling system. This involves resizing the refrigeration and heating elements. Removal of formaldehyde and other vapors can also be achieved by charcoal adsorptionprocesses.A formaldehyde meter with an audible alarm system should be installed in the embalming area. The alarm on the device should be set to sound when the 1.0 ppm level is reached. When the alarm sounds, respiratory protection such as a gas mask with an organic vapor canister or a chemical cartridge full facepiece respirator should be donned.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	1979-1980 Prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, exposure durationsbut lacks additional metadata, such as exposure frequency, and worker activities.
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Study Citation:	NIOSH, (1980). Health hazard evaluation report: HHE-79-146-670, Cincinnati, College of Mortuary Science, Embalming Laboratory, Cincinnati, Ohio.		
HERO ID:	NIOSH:79-146.1322362		
Conditions of Use:	Laboratory Use		
Domain	Metric	EVALUATION Rating	Comments
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations and roles (teacher/ student). As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 1322624 Table: 1 of 1

Study Citation:	NIOSH, (1980). Health hazard evaluation determination report: HHE-79-72-680, Energyloc, Inc., Portland, Oregon. NIOSH:79-72.			
HERO ID:	1322624			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Worker activity description:	Worker involved in fibrous glass floor insulation			
Exposure route:	Inhalation and dermal			
Physical form:	included in phenol-formaldehyde binder			
Area sampling data:	Air concentrations of formaldehyde ranged from 0.007 to 0.033 ppm. [Range cited here, but discrete values are in table 2]			
Number of workers:	Four men and one woman			
Personal protective equipment:	During this evaluation, the installers wore coveralls taped at the wrists.			
Engineering control:	Cartridge-type half-face respirators (for dust) were worn but not during the entire time the materials were being handled or the entire time spent in the crawl space.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is approved by NIOSH (77-126)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old prior to recent PEL
	Metric 5:	Sample Size	High	Discrete samples are provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include sample type, job position but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 1357922 Table: 1 of 1

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA-83-276-1499. Charlie’s Taxidermy And Gifts, Fleetwood, Pennsylvania. NIOSH:83-276.			
HERO ID:	1357922			
Conditions of Use:	Taxidermy			
EXTRACTION				
Parameter	Data			
Worker activity description:	Taxidermy			
Exposure route:	Inhalation and dermal			
Physical form:	vapor			
Personal sampling data:	No personal sample for formaldehyde was reported in this article			
Area sampling data:	Formaldehyde in air was found to be below evaluation criteria.			
Exposure duration:	The taxidermist would normally work on a couple of trophies per day and would process several hundred trophies per year. Time spent on each trophy would vary from hours to days depending upon the specimen type and treatment processes.			
Personal protective equipment:	It is recommended that gloves and aprons should be used to prevent solvents or other toxic materials from getting on the hands and clothing. These gloves and aprons should be impervious to the materials being used and should be left in the work area. Protective goggles should be used when working with caustics, acids, and solvents. Safety glasses should be worn when there is a chance for eye injury.			
Engineering control:	It was recommended that toxic compounds, including formaldehyde, be substituted with less toxic material. It is recommended that taxidermy shops have a forced draft ventilation system. Just an open window is usually not adequate when working with solvents to any degree. A simple and well-placed exhaust fan with an open door or window to provide make up air would provide adequate ventilation for nearly all taxidermy shops. It is recommended that such process steps as pouring of a urethane form, spray painting, and cleaning with solvents, be done immediately in front of the exhaust fan (within a foot or two). Sometimes it is possible to work out-of-doors, where a great amount of natural dilution usually occurs.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The data collected is more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-283-1224. Southern Minnesota Beet Sugar Cooperative, Renville, Minnesota. 40:1-32.			
HERO ID:	1516473			
Conditions of Use:	Non-TSCA			
EXTRACTION				
Parameter	Data			
Worker activity description:	welders, lime kiln employees, process area, and general laborer			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	No formaldehyde detected			
Number of workers:	A medical questionnaire was administered to eight employees (full-time welders during the off-season) and seven workers (three lime kiln employees, three employees in the carbonation-Peterson filter area, and one general laborer) on the initial and follow-up surveys, respectively.			
Personal protective equipment:	NIOSH recommended use of respirators till engineering controls have been implemented and by employees engaged in welding on stainless steel.			
Engineering control:	NIOSH recommended substitution of less hazardous process materials, automation, redesign or replacement of existing mechanical ventilation systems or a combination of these measures.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Methodology is not referred to by a numbered method and the report indicates some IH confusion on the appropriate method. Method appears to be short-term, direct reading, colorimetric tube detector
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Uninformative	The report is for an occupational scenario, however, the condition of use is outside of the scope of the risk evaluation due to non-TSCA uses. Formaldehyde is being used as a bactericide, which may be cover under FIFRA and/or under FDA due to use during food manufacturing.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old prior to recent PEL
	Metric 5:	Sample Size	N/A	Below detection, unknown number of samples.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability(appears to only measure for formaldehyde in one location at the site). Uncertainty is assumed to be addressed in methodology method.
Overall Quality Determination		Uninformative		

Study Citation:	NIOSH, (1982). Health hazard evaluation, report: HETA-81-033-1208. Placer County Distributors, Tahoe City, California. NIOSH:81-033.		
HERO ID:	1599520		
Conditions of Use:	Multiple		
EXTRACTION			
Parameter	Data		
Worker activity description:	Monitored silkscreen operators and area samples near dryer, therefore workers who may work near dryer.		
Exposure route:	inhalation		
Physical form:	gas		
Personal sampling data:	Formaldehyde was non-detectable		
Area sampling data:	During the survey period the formaldehyde results ranged from non -detectable to 0.02 mg/M3 .Laboratory limit of detection: 0.005 mg/sample		
Exposure duration:	8 to 10 hrs day		
Exposure frequency:	operates daily, 7 days a week; the number of days an employee would work is not specified		
Number of workers:	2-3 employees		
Engineering control:	The present shop has general room ventilation and local exhaust type ventilation which helps reduce and/or eliminate any buildup of gases or vapors generated by the heat drying operation.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Methodology is approved by NIOSH P&CAM 127
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5: Sample Size	High	All values provided, sample size was 5.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations, worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The monitoring study does not address variability. Assume that uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 1627795 Table: 1 of 1

Study Citation:	NIOSH, (1981). Health hazard evaluation report No. HHE-80-077-847, Signetics Corporation, Sunnyvale, California. NIOSH:80-077.				
HERO ID:	1627795				
Conditions of Use:	Office Environment				
EXTRACTION					
Parameter	Data				
Worker activity description:	Clerical staff working in the Military Division office at Signetics Corporation, Sunnyvale, California				
Exposure route:	inhalation				
Physical form:	gas				
Area sampling data:	No formaldehyde was detected using gas detector tubes				
Number of workers:	Medical interviews were conducted with 15 of the approximately 50 employees who usually work in the area.				
Engineering control:	The heating and ventilation system of the area does not appear to provide optimal comfort conditioning; therefore ventilation adjustments should be attempted to improve comfort control.				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is an approved NIOSH method	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States	
	Metric 3:	Applicability	Low	The data are for an occupational scenario, however a potential source of formaldehyde is not specified to determine which condition of use fits the scenario.	
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old	
	Metric 5:	Sample Size	Low	Not detected, number of samples is unclear.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.	
Overall Quality Determination			Low		

Study Citation:	NIOSH, (1976). Criteria for a recommended standard: Occupational exposure to formaldehyde.		
HERO ID:	192344		
Conditions of Use:	Distribution in Commerce		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation and ingestion		
Physical form:	vapor and liquid		
Area sampling data:	Pg. 45/177: Air sampled in the dress shops was found to contain 0.13-0.45 ppm formaldehyde. Samples of apparel from these same shops contained 5-8 mg of formaldehyde for each 10 g of rayon textiles and 3.4 mg/10 g of cotton, while a wool dress was found to be formaldehyde-free. In a 1966 study [53] of a clothing store, the California Department of Public Health reported airborne work zone concentrations of 0.9-3.3 ppm formaldehyde.		
Dermal exposure data:	Dermal exposure data		
Exposure duration:	up to 10 hours per day		
Engineering control:	The authors recommended a ventilation rate of 15 air changes/hour for the shops to remedy the situation in the case of the dress shop.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling and Analytic methods not always provided, but as this is a NIOSH study I assume it is acceptable.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for an occupational scenario (retail shop) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	NIOSH Study was published in 1976, but test data is earlier. Still all data are prior to the PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	Low	Distribution of samples is not characterized nor are uncertain statistics provided.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low	

Occupational Exposure

Study Citation:	NIOSH, (1976). Criteria for a recommended standard: Occupational exposure to formaldehyde.			
HERO ID:	192344			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation, dermal (including possibly contact of skin with formaldehyde vapor and/or resin)			
Physical form:	vapor			
Personal sampling data:	Glass reported in 1961 that breathing-zone concentrations of 16- 30 ppm formaldehyde, as determined by detector tubes, produced irritation of the throat and smarting of the eyes in an unspecified number of the 60 employees in a resin-manufacturing and paper plant.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling and Analytic methods not always provided, but as this is a NIOSH study I assume it is acceptable.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	NZ which is an OECD member
	Metric 3:	Applicability	High	The data are for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	NIOSH Study was published in 1976, but test data is earlier (1961). Still all data are prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	A range of exposure concentrations is reported.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability or uncertainty is not addressed.
Overall Quality Determination			Low	

Study Citation:	NIOSH, (1976). Criteria for a recommended standard: Occupational exposure to formaldehyde.				
HERO ID:	192344				
Conditions of Use:	Paper Manufacturing				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation				
Physical form:	vapor				
Personal sampling data:	Pg. 45/177: Exposure to formaldehyde in a paper-conditioning installation. Two employees were exposed to airborne formaldehyde released from paper treated with either urea-formaldehyde or melamine-formaldehyde resin. Samples of air taken in the area of the employees’ breathing zone contained 0.9-1.6 ppm formaldehyde.				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling and Analytic methods not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	seems to be US	
	Metric 3:	Applicability	High	The data are for an occupational scenario (manufacture of paper treated with resin) within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	NIOSH Study was published in 1976, but test data is earlier (1961). Still all data are prior to the PEL (1992) and more than 20 years old.	
	Metric 5:	Sample Size	Low	The number of samples is unknown.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination			Low		

Study Citation:	NIOSH, (1976). Criteria for a recommended standard: Occupational exposure to formaldehyde.			
HERO ID:	192344			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter		Data		
Worker activity description:		Pg. 61/177: An aqueous solution containing 40% formalin solution (500 ml/1), ethanol (250 ml/1), and monochloroacetic acid (40 ml/1) was painted on the sheep skins, which were then calendered with rollers heated to 190-210 C.		
Exposure route:		inhalation		
Physical form:		vapor		
Personal sampling data:		Pg. 61/177: The air in the breathing zone of the women contained gaseous formaldehyde (5-78 mg/cum)		
Area sampling data:		8 textile plants had formaldehyde concentrations of 0-2.7 ppm, with an average of 0.68 ppm. 58A textile garment factory where "perma-press" clothing was manufactured. The airborne formaldehyde concentrations ranged from 0.9 to 2.7 ppm. 54		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Sampling and Analytical Methodology	Medium	Sampling and Analytic methods not always provided, but as this is a NIOSH study I assume it is acceptable.
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	The location of the exposed workers is not reported but is assumed to be relevant to the US because the document is a NIOSH document.
		Metric 3: Applicability	High	The data are for an occupational scenario (Textiles) within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	Low	NIOSH Study was published in 1976, but test data is earlier (1966 & 68). Still all data are prior to the PEL (1992) and more than 20 years old.
		Metric 5: Sample Size	Low	Distribution of samples is not characterized nor are uncertain statistics provided.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:		NIOSH, (1976). Criteria for a recommended standard: Occupational exposure to formaldehyde.		
HERO ID:		192344		
Conditions of Use:		Compressed Wood Product Manufacturing		
EXTRACTION				
Parameter		Data		
Exposure route:		inhalation		
Physical form:		vapor		
Area sampling data:		Two laminating plants using four different phenol-resorcinol glues which released formaldehyde upon curing, Formaldehyde concentrations were 0.04-4.2 ppm in the first plant and 4.2-10.9 ppm in the second. The concentrations varied as a function of the operation of the process at different times of day and of the specific glue being used.		
Dermal exposure data:		Dermal exposure data		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling and Analytic methods not always provided, but as this is a NIOSH study I assume it is acceptable.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (lamination manufacturing) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	NIOSH Study was published in 1976, but test data is earlier (1971). Still all data are prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is not characterized nor are uncertain statistics provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 192344 Table: 6 of 6

Study Citation:	NIOSH, (1976). Criteria for a recommended standard: Occupational exposure to formaldehyde.			
HERO ID:	192344			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation and dermal			
Physical form:	vapor and particulate			
Area sampling data:	Six funeral homes using formaldehyde and paraformaldehyde in the embalming process. The average concentrations in the air of the embalming rooms were 0.25-1.39 ppm formaldehyde while the total range for all samples was 0.09-5.26 ppm. 52			
Dermal exposure data:	Dermal exposure data			
Comments:	Formaldehyde air concentration measurement may have been affected by presence of paraformaldehyde. Eye irritation may be the result of exposure to paraformaldehyde dust or dust containing adsorbed formaldehyde.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling and Analytic methods not always provided, but as this is a NIOSH study I assume it is acceptable.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	NIOSH Study was published in 1976, but test data is earlier (1975). Still all data are prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is not characterized nor are uncertain statistics provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1976942 Table: 1 of 6

Study Citation: NIOSH, (1986). Current intelligence bulletin: Reprints - Bulletins 31 thru 47.
HERO ID: 1976942
Conditions of Use: Processing as a reactant

EXTRACTION

Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	type of sampling undetermined assumed it was area samplingFertilizer production 0.2-1.9 ppm
Dermal exposure data:	Dermal exposure data
Exposure duration:	57,000 employees are exposed to formaldehyde 4 or more hours per day.
Number of workers:	1.6 million workers in more than 60 industrial categories.
Personal protective equipment:	respirator, goggles, gloves
Engineering control:	enhanced HVACenclosure of operation vented externally separation of equipment and employees
Comments:	noted that a pack of cigarettes contains 40 ppm of formaldehyde by volume or 0.38 mg per pack.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1982 - Prior to PEL (1992) and more than 20 years old
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Monitoring data do not include any needed metadata
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination **Uninformative**

Formaldehyde

Occupational Exposure

HERO ID: 1976942 Table: 2 of 6

Study Citation:	NIOSH, (1986). Current intelligence bulletin: Reprints - Bulletins 31 thru 47.
HERO ID:	1976942
Conditions of Use:	Textile Finishing

EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	type of sampling undetermined assumed it was area samplingDyestuffs <0.1-5.8 ppmTextile Manufacture <0.1-1.4 ppm
Dermal exposure data:	Dermal exposure data
Exposure duration:	57,000 employees are exposed to formaldehyde 4 or more hours per day.
Number of workers:	1.6 million workers in more than 60 industrial categories.
Personal protective equipment:	respirator, goggles, gloves
Engineering control:	enhanced HVACenclosure of operation vented externally separation of equipment and employees
Comments:	noted that a pack of cigarettes contains 40 ppm of formaldehyde by volume or 0.38 mg per pack.

		EVALUATION		
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 - Prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	Monitoring data do not include any needed metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination **Uninformative**

Formaldehyde

Occupational Exposure

HERO ID: 1976942 Table: 3 of 6

Study Citation: NIOSH, (1986). Current intelligence bulletin: Reprints - Bulletins 31 thru 47.
HERO ID: 1976942
Conditions of Use: Use of Adhesives and Sealants

EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	type of sampling undetermined assumed it was area samplingResins (foundry) <0.1-5.5 ppmBronze foundry 0.12-0.8Iron foundry <0.02-18.3 ppm
Dermal exposure data:	Dermal exposure data
Exposure duration:	57,000 employees are exposed to formaldehyde 4 or more hours per day.
Number of workers:	1.6 million workers in more than 60 industrial categories.
Personal protective equipment:	respirator, goggles, gloves
Engineering control:	enhanced HVACenclosure of operation vented externally separation of equipment and employees
Comments:	noted that a pack of cigarettes contains 40 ppm of formaldehyde by volume or 0.38 mg per pack.

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1982 - Prior to PEL (1992) and more than 20 years old
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Monitoring data do not include any needed metadata
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination **Uninformative**

Formaldehyde

Occupational Exposure

HERO ID: 1976942 Table: 4 of 6

Study Citation:	NIOSH, (1986). Current intelligence bulletin: Reprints - Bulletins 31 thru 47.		
HERO ID:	1976942		
Conditions of Use:	Paper Manufacturing		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	type of sampling undetermined assumed it was area samplingTreated paper 0.14-0.99 ppm		
Dermal exposure data:	Dermal exposure data		
Exposure duration:	57,000 employees are exposed to formaldehyde 4 or more hours per day.		
Number of workers:	1.6 million workers in more than 60 industrial categories.		
Personal protective equipment:	respirator, goggles, gloves		
Engineering control:	enhanced HVACEnclosure of operation vented externally separation of equipment and employees		
Comments:	noted that a pack of cigarettes contains 40 ppm of formaldehyde by volume or 0.38 mg per pack.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High US
	Metric 3:	Applicability	High The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low 1982 - Prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Medium Distribution of samples is characterized by a range; uncertain statistics not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative Monitoring data do not include any needed metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Uninformative	

Formaldehyde

Occupational Exposure

HERO ID: 1976942 Table: 5 of 6

Study Citation:	NIOSH, (1986). Current intelligence bulletin: Reprints - Bulletins 31 thru 47.
HERO ID:	1976942
Conditions of Use:	Laboratory Use

EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	type of sampling undetermined assumed it was area samplingHospital autopsy room 2.2-7.9 ppm
Dermal exposure data:	Dermal exposure data
Exposure duration:	57,000 employees are exposed to formaldehyde 4 or more hours per day.
Number of workers:	1.6 million workers in more than 60 industrial categories.
Personal protective equipment:	respirator, goggles, gloves
Engineering control:	enhanced HVACenclosure of operation vented externally separation of equipment and employees
Comments:	noted that a pack of cigarettes contains 40 ppm of formaldehyde by volume or 0.38 mg per pack.

		EVALUATION		
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 - Prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	Monitoring data do not include any needed metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination **Uninformative**

Formaldehyde

Occupational Exposure

HERO ID: 1976942 Table: 6 of 6

Study Citation:	NIOSH, (1986). Current intelligence bulletin: Reprints - Bulletins 31 thru 47.		
HERO ID:	1976942		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	type of sampling undetermined assumed it was area samplingPlywood Industry 1.0-2.5 ppm		
Dermal exposure data:	Dermal exposure data		
Exposure duration:	57,000 employees are exposed to formaldehyde 4 or more hours per day.		
Number of workers:	1.6 million workers in more than 60 industrial categories.		
Personal protective equipment:	respirator, goggles, gloves		
Engineering control:	enhanced HVACenclosure of operation vented externally separation of equipment and employees		
Comments:	noted that a pack of cigarettes contains 40 ppm of formaldehyde by volume or 0.38 mg per pack.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1982 - Prior to PEL (1992) and more than 20 years old
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range; uncertain statistics not provided.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Monitoring data do not include any needed metadata
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Uninformative	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA-83-301-1478. Lion Uniform Company, Beattyville, Kentucky. 83-301-1478:1-26.		
HERO ID:	201729		
Conditions of Use:	Textile Finishing		
EXTRACTION			
Parameter	Data		
Worker activity description:	The fabric is cut to order, and the various pieces are stored in binsawaiting assembly. The sewing operators are responsible for making one part of the jacket; they locate and sew the pieces needed to make this part (e.g., a collar or a sleeve). This completed piece is then passed on to the assembly people who sew the pieces together, add linings, pockets, collars, sleeves, and buckles until a jacket has been completed. The completed jacket is then passed on to another area for quality control checking.		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	eight-hour time-weighted averages were 0.15 to 0.18 ppm		
Area sampling data:	Airborne formaldehyde levels ranged between 0.15 and 0.23 ppm;		
Dermal exposure data:	nan		
Personal protective equipment:	Long-sleeve shirts		
Engineering control:	- source fabric with the lowest concentration of formaldehyde- Set fabric aside to allow for off-gassing before use.-improve HVAC		
Comments:	In addition to the facility being evaluated, the study also noted other occupational exposure studies of similar textile facilities: 8 permanent press fabric plants 0.3-2.7 ppm; 1977 uniform manufacturer 0.13-0.57 ppm; 1982 uniform manufacture 0.08-0.44 ppm; another 1982 uniform manufacturer 0.12-0.53 ppm (area), 0.11-0.27 ppm (personal 8 hr TWA), 1984 study 0.34-0.53 ppm; shirt manufacture 0.07-0.34 (1980) and 0.15-0.30 ppm (1981) - personal, Additional east European studies were provided.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	NIOSH report indicates area and personal sampling data was done by the Kentucky Department of Labor but did not further state the sampling and analytical methodology used.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States (Kentucky).
	Metric 3: Applicability	High	The data are for an occupational scenario (textile workers) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	report came out in 1984 prior to the release of the PEL (1992)
	Metric 5: Sample Size	Low	The distribution of samples is characterized by a range with no uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (personal breathing zone) but no other metadata (method, duration, worker activities, exposure frequency).
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study addresses variability in the determinants for the sampled site by comparing with other reported studies for similar sites. The uncertainty is not addressed.
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Formaldehyde

Occupational Exposure

HERO ID: 201729 Table: 1 of 1

...continued from previous page			
Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA-83-301-1478. Lion Uniform Company, Beattyville, Kentucky. 83-301-1478:1-26.		
HERO ID:	201729		
Conditions of Use:	Textile Finishing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Low	

Formaldehyde

Occupational Exposure

HERO ID: 2068882 Table: 1 of 1

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA-82-96-1259. Kaiser Aluminum and Chemical Corporation, Ravenswood, West Virginia.			
HERO ID:	NIOSH:19831983.			
Conditions of Use:	Other Byproduct			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers involved in rolling mills [more specific information detailed in source]			
Exposure route:	inhalation			
Physical form:	gas			
Personal sampling data:	Mean personal breathing zone exposure to fonnaldehyde was 0.024 mg/M3 (0.011-0.031 mg/M3)			
Area sampling data:	Mean concentration of area formaldehyde concentrations was 0.010 mg/M3 (0.005-0.016 mg/M3)			
Dermal exposure data:	Dermal exposure data			
Number of workers:	There were about 700 hourly employees working in the area covered by this request at the time of the survey. Eight workers from areas in the plant with the greatest oil mist exposure			
Comments:	Article states that the personal breathing zone data was statistically higher than area samples. The report mentions that workers wore the personal samplers for the full shift including breaks and lunch, it is possible that some formaldehyde exposure could come from cigarette smoke (pg. 16)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is a NIOSH method, P&CAM 125 with minor modification.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario(decomposition product) not specified within the scope of the risk evaluation but may be useful for other occupational scenarios(metal products).
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include almost all associated metadata, including sample types, exposure types, sample durations, exposure durations. worker activities, but not exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-79-119-1068. The Evening News, Southbridge, Massachusetts. NIOSH:1-24.			
HERO ID:	2147572			
Conditions of Use:	Use of photographic supplies			
EXTRACTION				
Parameter	Data			
Worker activity description:	pressroom workers			
Exposure route:	inhalation			
Physical form:	gas			
Personal sampling data:	No personal samples collected for formaldehyde			
Area sampling data:	Measurements for formaldehyde, which is sometimes found in photo processing, were negative.			
Exposure duration:	8-hour TWA			
Number of workers:	Sixty-five production workers are employed at the Southbridge facility, excluding reporters, administrators, and administrative support personnel. Nine employees were administered confidential medical questionnaires by the NIOSH investigator.			
Engineering control:	The ventilation design of the new facilities should make provisions for local exhaust of the hand plate developing operations in addition to the minimum four air changes per hour recommended for photo processing laboratories. The newsroom photo lab should be provided general exhaust and replacement air inlet at the opposite end of the room to ensure good air circulation at a minimum of four air changes per hour.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is approved by NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA-82-206-1306. New Renaissance Glass Works, Oakland, California. NIOSH:82-206.			
HERO ID:	2199499			
Conditions of Use:	Processing aid			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees at New Renaissance Glassworks at Oakland, CA.			
Exposure route:	inhalation			
Physical form:	gas			
Area sampling data:	No formaldehyde was detected			
Number of workers:	The Glass Works employed 22 full -time employees in December, 1981 when workers first reported work related health complaints to their employer as a result of light ballast fires.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is approved by NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA-82-377-1376. D and F Corporation, Warren, Michigan. NIOSH:82-377.			
HERO ID:	2452947			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers involved with wood model making, fixture and mold building, and machining operations			
Exposure route:	inhalation			
Physical form:	gas			
Area sampling data:	[Using solid sorbent tubes, 2/16] Formaldehyde TWA concentrations were 0.18 ppm at above impregnated stock, 0.12 ppm near sanders using solid sorbent tubes. [Using impingers, 4/28] Formaldehyde TWA concentrations were <LOQ at above impregnated stock, 0.083 ppm at above sanders, <LOQ near sanders using impingers.			
Exposure duration:	8-10 hrs/day			
Number of workers:	95 production .-workers over two shifts			
Personal protective equipment:	NIOSH recommended that employees should be encouraged to utilize NIOSH/MSHA approved dust respirators during use of machinery in the wood shop (e.g. shaper, router, and sander operation) and during the use of hand-held powered woodworking tools (belt sanders etc.). Safety glasses and face shields should continue to be utilized when using any powered woodworking equipment.			
Engineering control:	NIOSH recommended that the local exhaust ventilation systems at woodworking machinery should be regularly inspected to insure that they are properly operating, and ongoing efforts should be made to improve these systems where possible. Sufficient flow rates should be maintained to capture and carry away the generated wood dust.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is approved by NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	High	Discrete values provided, 5 samples at similar locations provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 2972529 Table: 1 of 1

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA-81-450-1378. Inland Steel Company, East Chicago, Indiana. NIOSH:81-450.			
HERO ID:	2972529			
Conditions of Use:	Other Byproduct			
EXTRACTION				
Parameter	Data			
Worker activity description:	Approximately six employees are engaged in the stripping and relining of the trough system and rotate among the various jobs of stripping the old refractory liner, filling the troughs with new sacks of Narmacarb®, and pounding the refractory (Narmacarb®) filler.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	7/27/82 Repairman #1 < 5.03 ug per 237 minute sample 7/27/82 Repairman #1 < 5.03 ug per 139 minute sample 7/27/82 Repairman #1 Total Concentration < 5.03 ug per 376 minute sample 7/30/82 Repairman #2 <5.03 ug per 351 minute sampleBlank is 5.03 ug			
Exposure duration:	up to 10 hours per day			
Number of workers:	6			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method P&CAM 354
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (steel mill) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 - prior to PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	only trace amounts of formaldehyde were found so there were insufficient data to develop meaningful statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	only trace amounts of formaldehyde were found so there were insufficient data to assess variability between locations or jobs and no data were provided on uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1992). Health Hazard Evaluation Report No. HETA-91-395-2244, Veterans Administration Medical Center, Los Angeles, California.			
HERO ID:	2972764			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Histopathology Cytology, Surgical pathology,Neuropathology, Bacteriology Parasitology Mycology.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Technician/Cytology (Room 1300D) NDHistologist/Neuropathology (Room 1300C) NDHistology Technician/Histopathology (Room 1300) 0.05 ppmHistology Technician/Surgical Pathology (Room 1299) 0.05 ppmPathology Resident/Surgical Pathology (Room 1299) 0.17 ppm			
Area sampling data:	Histology storage, Room 1300E (near long-term specimen storage)0.13 ppmSurgical Pathology, Room 1299 (near short-term specimen storage) 0.02 ppmHistopathology, Room 1300F (center of the room) 0.02 ppmHistology technology, Room 1299A (during tissue disposal) 1.1 ppm			
Dermal exposure data:	nan			
Exposure duration:	8 hr shifts			
Exposure frequency:	5-7 days per week			
Personal protective equipment:	Gloves			
Engineering control:	Concentrations should be reduced by providing local exhaustventilation above the waste drum or performing the procedure inside of a fume hood.			
Comments:	Right side of page truncated.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method 350 and Method 2541
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (Hospital laboratory) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1992 - during the same period as the PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	High	actual data from each sampling event which could be compiled into statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations, and exposure frequency, but did not provide details about employee activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations/jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
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Formaldehyde

Occupational Exposure

HERO ID: 2972764 Table: 1 of 1

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Study Citation:		NIOSH, (1992). Health Hazard Evaluation Report No. HETA-91-395-2244, Veterans Administration Medical Center, Los Angeles, California.		
HERO ID:		2972764		
Conditions of Use:		Laboratory Use		
Domain		Metric	EVALUATION Rating	Comments
Overall Quality Determination			High	

Study Citation:	NIOSH, (1981). Health hazard evaluation report no. HHE-80-180-841, Scott Paper Company, Chester, Pennsylvania. 80-180-841:1-10.			
HERO ID:	3118412			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees at Scott Paper Company, promotional Services Division, Chester, PA. Workers are employed in the following areas : (1) the advertising and sales materials section where promotional materials are packaged in polyolefin film using a hot wire sealing device; (2) coupon redemption -where incoming discount coupons are received and processed; (3) a warehouse where materials are stored; (4) a keypunch data processing area; and (5) the administrative offices. (Page 4 of 10)			
Physical form:	Gas (page 6 of 10)			
Area sampling data:	detected in "very low" concentrations (<0.1 ppm) from bulk samples of "Cryouac" polyolefin plastic wrap (page 7 of 10)			
Number of workers:	Approximately 100 workers (page 4 of 10)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method and is well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 3648484 Table: 1 of 1

Study Citation: NIOSH, (1982). Health hazard evaluation report: HETA-81-348-1225. Public Utilities Commission, San Francisco, California. 15:1-18.
HERO ID: 3648484
Conditions of Use: Automobile Exhaust

EXTRACTION

Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	Ten formaldehyde air samples were collected from the Muni Center; however, no formaldehyde was detected.
Exposure duration:	8 hr per day
Exposure frequency:	5 days per week
Number of workers:	200

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH study - P&CAM 354
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	Uninformative	The data are for an occupational scenario (transit rail operator) but automobile exhaust (by-product formation) is not within scope
	Metric 4: Temporal Representativeness	Low	1982 - prior to the PEL (1992)
	Metric 5: Sample Size	N/A	No formaldehyde was detected therefore no summary statistics were provided.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, exposure durations, and exposure frequency, but lacks additional metadata, such as sample durations, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	No formaldehyde was detected therefore there was no variabilities between the sites studied. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.

Overall Quality Determination **Uninformative**

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-100-1140. Raybestos Friction Materials Company, Crawfordsville, Indiana. NIOSH Cincinnati:1-25.
HERO ID:	3649297
Conditions of Use:	Use of fuels and related products

EXTRACTION

Parameter	Data
Worker activity description:	Raw Material Prep.; Curing Press Operator; Rotary Briquetter Operator; Curing Press Operator
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	Formaldehyde concentrations collected on eight personal samples ranged from below the limit of detection to 0.82 parts formaldehyde per million parts of air (ppm). One partial shift sample (3 hours) had a concentration of 1.24 ppm. Detector tube sampling during the morning of the day shift near the rotary briquetter indicated employee exposure to formaldehyde ranging from nondetected to 3.0 ppm. Therefore, a personal sample was obtained on an employee working at the rotary briquetter for the remaining 3 hours of the shift. Highest exposures were for rotary briquetter operators, although one sample, as noted, was for a 3-hour period. Subsequent to the field survey, NIOSH laboratory personnel discovered that the method (P&CAM No. 318) used to collect formaldehyde samples had a problem of sample stability. Quality control tests of the method indicated that actual airborne concentrations are 20 to 50% higher than reported values. Therefore, the values in Table I1 must be considered as minimum concentrations. Results of sampling using direct-reading indicator tubes to measure airborne concentrations of formaldehyde ranged from nondetected to 4.0 ppm. Four tubes (two per shift) used at a height of approximately 5 feet indicated airborne formaldehyde concentrations of 1.0, 2.0, 3.0, and 4.0 ppm in the rotary briquetter area. Three other detector tubes used in the curing press area, on a platform on top of the rotary briquetter, and in the finishing department (as background for other areas) detected no airborne formaldehyde concentrations. These values should be considered as indicating a range of potential exposures rather than exact exposure concentrations. Certified direct-reading indicator tubes have +35% accuracy at one-half the exposure limit and - +25% at 1 to 5 times the limit. The formaldehyde tubes have not been certified and thus may not be as accurate as certified tubes are. The formaldehyde indicator tubes are still useful for estimating air-borne contaminant concentrations and for evaluating short-term or ceiling values. Raw Material Prep. LLD Curing Press Oper 1 LLD Curing Press Oper. 0.39 ppm Rotary Briquetter Oper 2 1.24 ppm Curing Press Oper. LLD Curing Press Oper. LLD Curing Press Oper. 0.37 ppm Rotary Briquetter Oper. 0.82 ppm LLD-Below limit of detection
Number of workers:	the company employed approximately 430 hourly workers. Of this total, approximately 270 worked in the sintered metal division, 93 worked in the brake block division, and approximately 68 were employed as machinists, mechanics, and other skilled craftsmen.
Engineering control:	local exhaust ventilation equipment The only machinery without local exhaust ventilation was the rotary briquetter, which was partially enclosed, and the curing presses, which were not enclosed.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low
			Sampling or analytical methodology is an approved NIOSH method, however NIOSH notes that the method causes loss of formaldehyde so the actual concentration could be higher than measured (NIOSH P&CAM 318). Data is still usable as a minimum concentration.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High
	Metric 3:	Applicability	High
	Metric 4:	Temporal Representativeness	Low
	Metric 5:	Sample Size	High
			US
			The data are for an occupational scenario (brake and clutch manufacture) within the scope of the risk evaluation.
			1981 - prior to the PEL (1992) and more than 20 years old.
			Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was discussed.

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Formaldehyde

Occupational Exposure

HERO ID: 3649297 Table: 1 of 1

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Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-100-1140. Raybestos Friction Materials Company, Crawfordsville, Indiana. NIOSH Cincinnati:1-25.		
HERO ID:	3649297		
Conditions of Use:	Use of fuels and related products		
Domain	Metric	EVALUATION Rating	Comments
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations and/or worker activities.but lacks additional metadata, such as exposure durations and exposure frequency,
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability between different jobs and also addresses uncertainty, in the report and implicitly in the NIOSH method P&CAM 318.
Overall Quality Determination		Medium	

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 82-127-1370. Hoover Company, Industrial Park, North Canton, Ohio. 82-127-1370:1-31.			
HERO ID:	3970584			
Conditions of Use:	Plastic and Rubber products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Involved in several industrial processes, including a foundry operation, injection molding, spray painting, degreasing, plating, extruding, and numerous assembly line operations. The primary operations include assembly, injection molding, plastic blending and pelletizing, painting, metal fabrication, and plastic extrusion. Formaldehyde monitoring was done in injection molding area because an 'aldehyde-containing' plastic material was in use.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Environmental monitoring was conducted for formaldehyde by obtaining breathing zone samples from two set-up operators for the duration of the shift, and during a purge cycle (15 minute cycle). Short-term monitoring for formaldehyde in the breathing zone of set-up operators indicated exposure levels of up to 1.3 mg/m3.			
Area sampling data:	General area and process formaldehyde samples (sample acquisition directly adjacent to the injection molder using the Delron material) were collected, using both solid sorbent and liquid media sampling devices. All solid sorbent results were below the 5 microgram limit of detection (<0.23-0.44 mg/m3 air volume adjusted). An additional liquid media sample was placed near an injection molder during the use of the Delron material. Results indicate average airborne formaldehyde levels of 0.33 mg/m3 in the general area of the molder.			
Number of workers:	3000 workers in the plant-Three set-up operators normally work in the injection molding area where most of the formaldehyde emissions occur.			
Personal protective equipment:	Furnish respirators for the set-up operators for use when conducting purge operations. A chemical cartridge respirator with an organic vapor cartridge is recommended.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - P&CAM 354
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (injection modeling) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 - prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean and upper bounds with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include sample type, worker activity, exposure duration and frequency but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	No data were provided to evaluate variability. it was assumed that uncertainty was addressed in the NIOSH Method P&CAM 354.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 3970609 Table: 1 of 1

Study Citation:	NIOSH, (1981). Health hazard evaluation report no. HETA 81-007-985, Health Services Administration Building, Hyattsville, MD. 81-007-895:1-31.
HERO ID:	3970609
Conditions of Use:	Unknown - Offices

EXTRACTION

Parameter	Data
Area sampling data:	No formaldehyde found in the samples, limit of detection was 0.5 ppm
Comments:	No condition of use identified as a potential formaldehyde source, and no formaldehyde found in the samples.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Uninformative	No condition of use identified as a potential formaldehyde source, and no formaldehyde found in the samples.
	Metric 4: Temporal Representativeness	Low	More than 20 years old
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site . The uncertainty can be determined from the sampling and analytical method.

Overall Quality Determination	Uninformative

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-82-196-1187. U.S. Department of Treasury, Bureau of Government Financial Operations, Washington, D.C. NIOSH:1-5.			
HERO ID:	4040306			
Conditions of Use:	Office source of Formaldehyde was unknown			
EXTRACTION				
Parameter	Data			
Worker activity description:	office work			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	below the limit of detection (<0.5 ppm)			
Number of workers:	24			
Engineering control:	The ventilation system in the Treasury Annex Building should beredesigned so that fresh air is uniformly supplied to all the occupied areas. Air supply and circulation also should be increased,particularly during the winter, to help improve office working conditions.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study, so assumed used an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario (office work) within the scope of the risk evaluation, but unknown source of formaldehyde.
	Metric 4:	Temporal Representativeness	Low	1982 - prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Low	only less than value provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., short term detector tube) but no other meta-data
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	No information on variability and assume uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-388-1129. Santa Cruz Metropolitan Transit District, Santa Cruz, California. NIOSH:1-20.			
HERO ID:	4040607			
Conditions of Use:	Use of fuels- Exhaust			
EXTRACTION				
Parameter	Data			
Worker activity description:	vehicle servicingutility- sweepers, cleaners, washers and fuelers			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Vehicle Service Operator (A) N.D. N.D. N.D. N.D. Vehicle Service Operator (B) N.D. N.D. 0.5 ppm N.D. Vehicle Service Operator (C) 1.4 ppm 0.8 ppm N.D. Vehicle Service Operator (D) N.D. 0.4 ppm N.D.			
Exposure duration:	8 hours per day			
Exposure frequency:	5 days per week			
Number of workers:	14			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling and/or analytical methodology is based on P&CAM 318 with minor variations.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (diesel/gas bus servicing) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 - Prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. 15 samples were measured. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between workers. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-82-023-1136. National Institute of Mental Health, Rockville, Maryland. NIOSH:1-4.			
HERO ID:	4040611			
Conditions of Use:	Unknown- Office Building			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office workers for the National Institute of Mental Health. Report mentions large candles.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Formaldehyde not detected			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling methodology used detector tube measurements but does not go into detail or provide a numbered NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (Office) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 - prior to PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	No formaldehyde was detected - so no statistics were provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data only indicated that formaldehyde was not detected. No metadata were provided regarding sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	No information was provided concerning variability. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA-83-129-1296. American Enterprise Institute, Washington, D.C. NIOSH:83-129.			
HERO ID:	4058324			
Conditions of Use:	Office Work			
EXTRACTION				
Parameter	Data			
Worker activity description:	office work- within 12 story office building built in 1969			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Formaldehyde below limit of detection (<0.05 ppm)			
Number of workers:	21			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling and analytical methodology was short term colorimetric detector tubes, assumed that it was an approved NIOSH method as study is a NIOSH HHE.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario (office adjacent to parking garage) but source of the formaldehyde is not determined but suggested from sources contained within an commercial building (e.g., building products, furnishings, coatings, or normal activities) which include commercial use of products within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1983 - Prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Low	Formaldehyde was below detection limit so no statistical data were provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., area) but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Formaldehyde was not detected therefore no data were provided concerning variability between locations and workers. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1980). Potential health hazards of video display terminals: TA-79-061-844. Oakland Tribune, San Francisco, California. Hazard Evaluations and Field Studies:79-061.			
HERO ID:	4058375			
Conditions of Use:	Chemical substances in photographic supplies - No formaldehyde was detected, but the report suggested that the sources such as photographic darkrooms, photocopiers and other photo-reproduction equipment produced airborne chemical exposures BUT could also be related to smoking			
EXTRACTION				
Parameter	Data			
Number of sites:	1			
Worker activity description:	journalism			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Composing /TV room formaldehyde ND			
Number of workers:	49 VDT operators responded to the questionnaires which represented 48 % response rate, so that would suggest a total VDT operators is 102.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (news paper journalist) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1980 - prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	No formaldehyde was detected so no statistics were provided. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	The study did not provide any information about sample types, exposure types, sample durations, exposure durations worker activities, or exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	No formaldehyde was detected therefore no assessment of variability could be provided. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-396-1118. Keebler Company, Cincinnati, Ohio. NIOSH:1-24.			
HERO ID:	4058405			
Conditions of Use:	Baking			
EXTRACTION				
Parameter	Data			
Worker activity description:	In mixing, there are two major types of workers, those who transfer mixing tubs, both full of dough and empty, and mixer operators who operate the mixer controls. A typical oven requires 1 operator, 1 inspection person, and a few troubleshooters. The operators spend most of their time at the discharge end of the oven operating the control panel. The remaining time is spent making periodic checks on oven operation by walking the oven line. Inspection personnel are responsible for picking broken crackers off the conveyor belt at the discharge end of the oven. Troubleshooters are located about 100-200 feet downstream from the inspector and are responsible for keeping crackers properly aligned on the conveyor belt. The workforce in Redi Serve consists of around 10 people, 2 machine operators, 4 packers, 1-2 box makers, and 2-3 nonclassified packers. The machine operators monitor the control of all 4 packing machines. The relief (nonclassified) employees monitor the line of crackers being fed into the machine on the conveyor belt system. The box makers assemble small cardboard boxes and give them to the packers who manually transfer the two cracker packages from the machines into the box. Machine operators, packers, box makers, and relief people alternate jobs spending about 2 hours at each.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Generally, formaldehyde exposures measured on the machine operators were higher than those measured on the oven operators which would be expected, since machine operators are located on the receiving end of the oven where cracker dough is first exposed to this oven heat causing the alcohols liberated from the yeast fermentation to form aldehydes. Also as expected, samples collected around the older #4 oven in general resulted in higher level than those taken around the new enclosed #A-1 oven. The #A-1 Redi Serve packer exposure measured was much lower than the old Redi Serve packer. This is easily explained by the fact that A-1 Redi Serve is located in a separate room from the machine and oven area, whereas the old Redi Serve is located in the same room, relatively close to the ovens. Packer/old redi serve line 0.16 mg/m3 Machine operator/ # 4 oven 1.08 mg/m3 Oven operator/ #4 oven 0.34 mg/m3 Machine operator/ #A1 oven 0.78 mg/m3 Oven operator/ #A1 oven 0.16 mg/m3 Packer/A-1 Red1 Serve Line 0.09 mg/m3			
Area sampling data:	Between oven #3 and #4, column 32 1.28 mg/m3 Between oven #A1 and #2, column 30 0.25 mg/m3			
Exposure duration:	8 hours per day			
Exposure frequency:	40 hours per week			
Number of workers:	1000			
Engineering control:	Since the old #4 oven appears to be causing the majority of the inside air contamination, NIOSH supports Keebler's intentions of taking it out of service.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH - P&CAM 127
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (baking) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 - Prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in NIOSH method P&CAM 127.
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Formaldehyde

Occupational Exposure

HERO ID: 4058405 Table: 1 of 1

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Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-396-1118. Keebler Company, Cincinnati, Ohio. NIOSH:1-24.		
HERO ID:	4058405		
Conditions of Use:	Baking		
Domain	Metric	EVALUATION Rating	Comments
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between workers and locations. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination		High	

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA-81-416-1334. Trailways Bus System, Denver, Colorado. 81-416-1334:1-14.			
HERO ID:	4058425			
Conditions of Use:	Mobile source - Diesel Bus exhaust			
EXTRACTION				
Parameter	Data			
Worker activity description:	baggage handler / bus station receptionist			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	A total of eight area samples were taken for formaldehyde. All of the formaldehyde levels were non-detectable. Package Receiving Area NDConcourse-Lane 1 NDConcourse-Lane 5 NDConcourse-Lane 9 NDConcourse-Lane 1 NDConcourse-Lane 5 NDConcourse-Lane 9 ND			
Engineering control:	If certain climatic conditions (hot or cold weather) require the buses to remain running in order to maintain the interior temperature of the bus then a means to exhaust the emissions from the buses tail pipe should be developed. This could be an exhaust system with flexible ducting which extends down to the buses exhaust pipe. An alternative to the exhausting of the buses emissions would be an exterior means of heating or cooling the interior of the bus during those periods required. A heating/refrigeration type system is presently being used by another bus company which operates on the other side of the Denver terminal. This system effectively meets the needs of the heating and cooling concerns of the buses interior and would then eliminate the need for running the buses during hot or cold periods.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study Method P&CAM 125
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (bus baggage handlers) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 - prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	N/A	Formaldehyde was not detected therefore there were no statistics provided. Uncertainty was not discussed but assumed that it was addressed in NIOSH method P&CAM 125.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Formaldehyde was not detected therefore there was no data to evaluate variability. Uncertainty was not discussed but assumed that it was addressed in NIOSH method P&CAM 125.
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 4058598 Table: 1 of 1

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-451-1137. Fordham University, New York, New York. NIOSH:1-9.			
HERO ID:	4058598			
Conditions of Use:	Commercial Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	The staff on the tenth and eleventh floors of the building consists of professors, research associates, and secretaries. (4/9)			
Exposure route:	inhalation (3/9)			
Area sampling data:	No formaldehyde was detected in area sampling. The limit of detected was 0.05 pm. (6/9)			
Number of workers:	84 workers (3/9)			
Engineering control:	The central ventilation system supplies air to the eleventh floor. (4/9)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for ambient air in an office, which is similar to the in-scope occupational scenario use of furniture products.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Exposure type, worker info, and sampling data provided, but missing exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 4058601 Table: 1 of 1

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-82-124-1141. Mazza Gallerie Productions, Washington, D.C. NIOSH:1-5.			
HERO ID:	4058601			
Conditions of Use:	Ink, toner, and colorant products			
EXTRACTION				
Parameter	Data			
Worker activity description:	The office uses a xerographic copier on an intermittent basis			
Exposure route:	inhalation (3/5)			
Area sampling data:	Formaldehyde, if present, was at concentrations lower than 0.5 ppm. (3/5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	Data are for ambient air in an office with a xerox copier, which is similar to the in-scope occupational scenario use of ink, colorant, and toner products.	
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Only exposure type and area sampling provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 4058603 Table: 1 of 1

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-397-1084. Ridge Central Medical Building, Evanston, Illinois. NIOSH:1-10.			
HERO ID:	4058603			
Conditions of Use:	Unknown- Medical Office			
EXTRACTION				
Parameter	Data			
Worker activity description:	Physicians and support staff. (4/10)			
Exposure route:	inhalation (5/10)			
Area sampling data:	No detectable levels of formaldehyde in the building. (6/10)			
Number of workers:	The medical group submitting the request consisted of 2 physicians, each working one-half day shifts, and a support staff consisting of 4 full-time and 1 part-time employees.(4/10)			
Engineering control:	The entire building is supplied by one central ventilation system. Recent changes in the system included the transfer of a fresh air intake from the rear of the building onto the roof of the building. (4/10)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology iwa drager hand pump, assumed to be an approved NIOSH method as study is an NIOSH HHE.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for ambient air in a medical office, which is similar to the in-scope occupational scenario use of laboratory chemicals.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	All samples were below limit of detection.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Exposure type and worker information provided, but missing exposure duration, frequency, PPE, and personal sampling.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1983). Health hazard evaluations report: HETA-82-53-1263. Bay Area Hospital Coos Bay, Oregon. NIOSH:1-18.			
HERO ID:	4440791			
Conditions of Use:	Cleaning and furniture care products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Housekeeping staff at a hospital buffing and waxing floors (14/18); In the past, workers applied cleaning product using spray application, but at the time of the study, only window cleaner and floor wax restorer were spray applied. Mixing is mostly done by supervisor except germicidal solution. Additional tasks include handling mops and pails, dumping the solution down the drain, cleaning on their hands and knees and wiping down beds. Formaldehyde was present in the floor wax and floor wax restorer			
Exposure route:	dermal, inhalation (7/18)			
Physical form:	vapor, liquid, spray/mist (14/18);			
Personal sampling data:	Breathing zone air samples were below the limits of detection for formaldehyde. (8/18)			
Number of workers:	30 employees (4/18)			
Personal protective equipment:	The use of protective gloves was made mandatory just prior to the NIOSH environmental survey, and the cleaning solutions were applied with rags rather than spray bottles. (4/18)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method (P& CAM 354).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for commercial use of cleaning and furnishing care products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Exposure type, worker info, and sampling data provided, but missing exposure duration, frequency, and engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-280-1042. Harlem Hospital Center, New York City, New York. NIOSH 81-280-1042:1-14.				
HERO ID:	5096414				
Conditions of Use:	disposal - The actual source of the formaldehyde emissions appears to be unknown but researches focused on traps for acid waste, and normal plumbing, food waste systems, dumping volatile waste down the drain and acid waste tanks. Additionally, formaldehyde could have come from the histology lab .				
EXTRACTION					
Parameter	Data				
Worker activity description:	lab worker				
Exposure route:	inhalation				
Physical form:	Vapors				
Area sampling data:	Rm 8120 (surgical pathology) 0.12 ppm Rm 8122 (histology) 0.03 ppm Rm 8123 (chemistry) 0.02 ppm				
Number of workers:	185 employees and students				
Engineering control:	Repair of the ventilation system, repair of the fume hoods, sealing of the holes in the floor, sealing of the dried drains and improved maintenance of the waste acid treatment tanks and of the Somat digester have led to a decrease in the number of complaints of poor air quality among workers in the 8th floor laboratories.				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	High	The data are for an occupational scenario (Hospital lab) within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	1981 - Prior to the PEL (1992) and more than 20 years old.	
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and better details about worker activities.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.	
Overall Quality Determination			High		

Study Citation:	NIOSH, (1996). Initial submission: prepublication version of health hazard evaluation of a Unocal Corp urea fertilizer facility, Kenai AK, with cover letter dated 6/13/96.			
HERO ID:	5888126			
Conditions of Use:	Processing into Reactant- Fertilizer			
EXTRACTION				
Parameter	Data			
Worker activity description:	Unloading operators, prill tower operators, maintenance, electricians, process operators. (30/38) The environmental samples were collected during the manufacture of the urea fertilizer, as well as during the loading of the product on a freighter for sea transport. Environmental sampling was also performed during the unloading of a truck tanker containing the UF-85 additive and during the cleaning or "blow-down" of the #5 urea granulation plant.			
Exposure route:	inhalation (7/38)			
Physical form:	vapors, and formaldehyde on dust (7/38)			
Personal sampling data:	Unloading Operator (sorbet tube) : 0.25 ppm (29/38); Airborne concentration particulate formaldehyde equivalent [note method does not distinguish free from reacted formaldehyde]Plant #2- Operator (back-end): 2 ug/m3; prill tower operator: 2.3ug/m3; maintenance: 3.6 ug/m3; maintenance: 9.0; Plant #5-process operator: (0.6)ug/m3*; Plant #5-helper: 11.5 ug/m3; operator: 2.9 ug/m3; electrician: 7.4 ug/m3; electrician: 5.8 ug/m3.			
Area sampling data:	Plant #2- Area Near Prill Tower Melt Box: ND Plant #2 - Area Near Sizing Screens: ND Plant #5 -Area on second Deck: ND Plant #5 - Area on third Deck: trace Plant #2 -Area Near Prill Tower Melt Box: 0.024 ppm Plant #2- Area Near Prill Tower Melt Box: 0.028 ppm Prill Warehouse -Area Near Wall: 0.007 ppm Granular Warehouse- Area Near Grizzly: 0.004 ppm Granular Warehouse- Area at South End : 0.004 ppm (29/38) Area Between Tanker & Transfer Pipes (sorbet tube):2.2 &1.6 ppm Airborne concentration particulate formaldehyde equivalent [note method does not distinguish free from reacted formaldehyde]-> Area samples range from 5.6 to 42ug/m3			
Particle size characterization:	Total inhalable weight and particulate formaldehyde equivalent for personal samples are listed in Table 2. (30/38)			
Exposure duration:	8-10 hours/day (16/38) [part of the evaluation criteria]			
Exposure frequency:	40 hours/week for a working lifetime (15/38)[part of the evaluation criteria]			
Number of workers:	200 workers (11/38)			
Personal protective equipment:	During daily blow down operations: operator wears a half-face respirator equipped with HEPA cartridges. During unloading: wear Tyvek® suits coated with polyethylene, rubber gloves, and a face shield with chemical goggles. When there is the possibility of exposure to formaldehyde vapor, the Unocal safety procedures dictate that a MSA full face piece chest mounted respirator with yellow GMC-SS supersize canisters should be worn. (19/38)			
Engineering control:	Daily blow down starts on the top deck and cleans each deck in successive order until all the dust is accumulated on the ground floor, where it can be swept up.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are form the U.S.
	Metric 3:	Applicability	High	Data are for use as an intermediate in the manufacture of fertilizers, an in-scope occupa- tional scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data pro- vided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.

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Study Citation:	NIOSH, (1996). Initial submission: prepublication version of health hazard evaluation of a Unocal Corp urea fertilizer facility, Kenai AK, with cover letter dated 6/13/96.		
HERO ID:	5888126		
Conditions of Use:	Processing into Reactant- Fertilizer		
Domain	Metric	EVALUATION Rating	Comments
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability is addressed by looking at different locations and days.
Overall Quality Determination		High	

Study Citation:	NIOSH, (1983). In-depth industrial hygiene survey report of the arrow shirt company Atlanta, Georgia no: 125.12 (36). 14:B2-14.		
HERO ID:	5908875		
Conditions of Use:	Commercial Use of Fabric, textile, and leather products not covered elsewhere		
EXTRACTION			
Parameter	Data		
Worker activity description:	workers involved in shirt making		
Exposure route:	inhalation		
Physical form:	gas		
Personal sampling data:	The results of multiple personal air samples for formaldehyde collected by Travellers’ Insurance Company are as follows: Laundry apparel press – 0.05 to 0.07 ppm; Final fusing area – 0.13 to 0.23 ppm; Crease band area – 0.07 ppm. Each of these samples was collected for a duration of 1 hour. Formaldehyde exposure levels were determined for 54 of 72 job titles in 5 different departments. 1 hour sampling time.		
Number of workers:	1000 workers at the facility, 916 operated sewing machines while the rest worked managerial, administrative, and maintenance duties. 188 workers sampled		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	methodology is referenced (chromotropic acid method) but not enough information to determine if equivalent to NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data
	Metric 3: Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	data greater than 20 years old
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include almost all associated metadata including sample type, sample duration, work area.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability is measured by sampling at different locations within the site, report does not have any discussion on uncertainties for these measurements.
Overall Quality Determination		Medium	

Study Citation:	NIOSH, (1983). In-depth industrial hygiene survey report of the arrow shirt company Atlanta, Georgia no: 125.12 (36). 14:B2-14.			
HERO ID:	5908875			
Conditions of Use:	Commercial Use of Fabric, textile, and leather products not covered elsewhere			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers involved in shirt making			
Exposure route:	inhalation			
Physical form:	gas			
Personal sampling data:	Formaldehyde exposure levels were determined for 54 of 72 job titles in 5 different departments. Exposure concentrations ranged from 0.037-0.456 TWA.			
Number of workers:	Includes # of workers per job title(Table 1). 1000 workers at the facility, 916 operated sewing machines while the rest worked managerial, administrative, and maintenance duties. 188 workers sampled			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Uninformative	Report indicates that there was a problem with instability with P&GAM 318, which was used for personal sampling. Sample loss occurred due to shipment of samples as well as the temperature and time of sample storage. The sample loss was estimated to range from 30 to 70%.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include almost all associated metadata including sample type, sample duration, work area.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is measured by sampling at different locations within the site, report does not have any discussion on uncertainties for these measurements.
Overall Quality Determination		Uninformative		

Study Citation:	NIOSH, (1981). Current intelligence bulletin 34: Formaldehyde: evidence of carcinogenicity.			
HERO ID:	63806			
Conditions of Use:	Unknown			
EXTRACTION				
Parameter	Data			
Worker activity description:	Hospital autopsy room			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	hospital autopsy room 2.2-7.9 ppm			
Number of workers:	1972-74 NIOSH estimates 507,200 were engaged in medical and other health services.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Monitoring data was done by NIOSH investigators, who use NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US publication
	Metric 3:	Applicability	High	The data are for lab use (autopsy) which is within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 prior to the PEL which was proposed in 1992.
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by a range without uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include area sample type but no other metadata or references to specific details.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	No discussion on the variability or uncertainty in the reported exposure data.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1981). Current intelligence bulletin 34: Formaldehyde: evidence of carcinogenicity.			
HERO ID:	63806			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Worker activity description:	textile manufacture			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	textile manufacture <0.1-1.4 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Monitoring data was done by NIOSH investigators, who use NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US publication
	Metric 3:	Applicability	High	The data are for an occupational scenarios included within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 prior to the PEL which was proposed in 1992 and greater than 20 years ago.
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by a range without uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include area sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	No discussion on the variability or uncertainty in the reported exposure data.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 63806 Table: 3 of 7

Study Citation:	NIOSH, (1981). Current intelligence bulletin 34: Formaldehyde: evidence of carcinogenicity.			
HERO ID:	63806			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	use of molds in foundry applications			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	bronze foundry 0.12-8.0 ppm; iron foundry <0.02-18.3 ppm;			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Monitoring data was done by NIOSH investigators, who use NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US publication
	Metric 3:	Applicability	High	The data are for a occupational scenario included within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 prior to the PEL which was proposed in 1992, and more than 20 years ago.
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by a range without uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include area sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	No discussion on the variability or uncertainty in the reported exposure data.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 63806 Table: 4 of 7

Study Citation:	NIOSH, (1981). Current intelligence bulletin 34: Formaldehyde: evidence of carcinogenicity.			
HERO ID:	63806			
Conditions of Use:	Use of Ink, Toner, and Colorant Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Dyestuff (unclear formaldehyde function)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	<0.1-5.9 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Monitoring data was done by NIOSH investigators, who use NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US publication
	Metric 3:	Applicability	High	The data are for a occupational scenario included within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 prior to the PEL which was proposed in 1992, and more than 20 years ago.
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by a range without uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include area sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	No discussion on the variability or uncertainty in the reported exposure data.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1981). Current intelligence bulletin 34: Formaldehyde: evidence of carcinogenicity.			
HERO ID:	63806			
Conditions of Use:	Use of Paper Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Treated Paper			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.14-0.99 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Monitoring data was done by NIOSH investigators, who use NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US publication
	Metric 3:	Applicability	High	The data are for a occupational scenario included within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 prior to the PEL which was proposed in 1992, and more than 20 years ago.
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by a range without uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include area sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	No discussion on the variability or uncertainty in the reported exposure data.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 63806 Table: 6 of 7

Study Citation:	NIOSH, (1981). Current intelligence bulletin 34: Formaldehyde: evidence of carcinogenicity.			
HERO ID:	63806			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	Fertilizer Production; Resin (non-foundry)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	fertilizer production: 0.2-1.9 ppm; resins: <0.1- 5.5 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Monitoring data was done by NIOSH investigators, who use NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US publication
	Metric 3:	Applicability	High	The data are for a occupational scenario included within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 prior to the PEL which was proposed in 1992, and more than 20 years ago.
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by a range without uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include area sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	No discussion on the variability or uncertainty in the reported exposure data.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 63806 Table: 7 of 7

Study Citation:	NIOSH, (1981). Current intelligence bulletin 34: Formaldehyde: evidence of carcinogenicity.			
HERO ID:	63806			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Plywood Industry			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1.0-2.5 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Monitoring data was done by NIOSH investigators, who use NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US publication
	Metric 3:	Applicability	High	The data are for a occupational scenario included within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 prior to the PEL which was proposed in 1992, and more than 20 years ago.
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by a range without uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include area sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	No discussion on the variability or uncertainty in the reported exposure data.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-135-912. US Department of Transportation, East Liberty, OH.			
HERO ID:	8588559			
Conditions of Use:	Chemical substances in automotive and fuel products-Automotive care products; Lubricants and greases; Fuels and related products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Vehicle Preparation Area No. 1 has three drive through bays to process ,heavy-duty vehicles (straight trucks, tractor trailer units , buses} . Area is currently used primarily for maintenance and instrumentation of diesel tractors and related trailers. Occasionally a diesel is idled within the area but this is kept to a minimum (pdf pg 4) Typically about four diesel tractors would leave and re-enter this area once each day. (pdf pg 6)			
Exposure route:	inhalation			
Area sampling data:	(ND, and <0.05 ppm)(pdf pg 3)			
Number of workers:	37 employees (engineers, technicians, administrators)...Up to 10 men may work in this area and are potentially exposed to diesel exhaust emissions. (pdf pg 4)			
Engineering control:	An overhead exhaust ventilation system with six flexhosedrops is operational. Two of the flexhoses are normally capped. Use of the flexhose drops is required for vehicles with horizontal taU pipes but not II 1: required for vehicles with ve tical tail pipes. Two 30-inch roof fans may be operated to aid in removiu g exhaust fumes. (pdf 4)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH methods used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu- ated.
	Metric 3:	Applicability	Medium	The data are for exhaust emissions, which may be similar to use in fuels, an occupa- tional scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Source is from 1980 and unlikely to represent current operations, exhaust makeup, or equipment.
	Metric 5:	Sample Size	Medium	Small number of samples, though they are fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determi- nants of exposure for the sampled site or sector.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 8592482 Table: 1 of 1

Study Citation:		NIOSH, (1981). Health hazard evaluation report: HETA 81-298-944. Hospital of the University of Pennsylvania, Philadelphia, PA.		
HERO ID:		8592482		
Conditions of Use:		Processing: Plastic materials and resin manufacturing		
EXTRACTION				
Parameter		Data		
Worker activity description:		Forming plastic legs		
Exposure route:		Dermal and inhalation		
Physical form:		Vapor		
Area sampling data:		General air near oven: 0.46 mg/m^3General air near work bench: 0.90 mg/m^3		
Engineering control:		Window fan for ventilation		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Report is from more than 20 years back.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by multiple area samples, uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-417-1008. National Broadcasting Company, New York City, NY.			
HERO ID:	8607288			
Conditions of Use:	Building and construction materials			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Gas			
Area sampling data:	0.3-0.5 (ppm)			
Engineering control:	Ventilation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario (office building but unknown sources of formaldehyde) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability. Assume uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-084-916. Kutztown State College, Kutztown, PA.		
HERO ID:	8607314		
Conditions of Use:	Furniture and furnishings not covered elsewhere		
EXTRACTION			
Parameter	Data		
Exposure route:	Inhalation		
Physical form:	Vapor		
Area sampling data:	Room 302 (on desk): 0.02 (ppm)Room 302 (in credenza): 0.03 (ppm)Room 302 (on metal desk): 0.02 (ppm)Room 220: 0.03 (ppm)		
Engineering control:	Ventilation		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH method: chemically treated charcoal tubes (Sample durations were about six hours) and analyzed by NIOSH method P&CAM 318.short-term samples (about 1 hour) were collected by midget impingers and analyzed by NIOSH method P&CAM 125.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The data werecollected before the most recent PEL establishment
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling method. Variability addressed by different sam- pling locations.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 8607314 Table: 2 of 2

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-084-916. Kutztown State College, Kutztown, PA.			
HERO ID:	8607314			
Conditions of Use:	Furniture and furnishings not covered elsewhere			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	gas			
Area sampling data:	Spotts, Stevens, and McCoy: Air concentrations ranged from 0.07 to 0.12 ppm with a mean of 0.09 ppm.Air Quality Services Inc.: Air concentrations ranged from 0.04 to 0.12 ppm with a mean of 0.07 ppm. Six samples taken in the Annex Building ranged from 0.03 to 0.04 ppm with a mean of 0.035 ppm. Six air samples for formaldehyde were collected in wood credenzas and desks. Air concentrations ranged from 0.21 to 0.90 ppm with a mean of 0.5 ppm. One air sample collected in a metal desk indicated 0.06 ppm formaldehyde. Seven bulk samples {drape, dust, wallboard, paint chips) analyzed for formaldehyde emissions ranged from none detected (N.D.) to 0.02 ug/M3 with a mean of 0.006 ug/M3. Four samples of drawer divider, closet shelf, paneling, and desk ranged from N.D. to 0.18 ug/M~ with a mean of 0.106 ug/M3. A carpet sample showed an emission of 0.06 ug/M3.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Spotts data use NIOSH methods- midget impinger/sodium bisulfite method (NIOSH P&CAM 125). AQS used similar NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, butlacks additional metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-211-984. USPHS Hospital, San Francisco, CA.			
HERO ID:	8609616			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Technicians and nurses providing dialysis treatment for medical patients.			
Exposure route:	Dermal and inhalation.			
Physical form:	Vapor			
Personal sampling data:	Chief dialysis tech: 0.42 (ppm)Dialysis technician: 0.63 (ppm)Dialysis nurse: 0.27 (ppm)			
Area sampling data:	Central system machine: 0.90 (ppm)Hallway outside room 6309: 0.29 (ppm)Nurses station in dialysis room: 0.29 - 0.58 (ppm)Kidney wash area: 0.62 (ppm)Isolation room: 0.45 (ppm)			
Number of workers:	20 employees total: 6 technicians and 14 nurses.			
Personal protective equipment:	Rubber gloves, protective apron, and eye and face protection to prevent skin contact.			
Engineering control:	General room exhaust fan.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Report is more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by multiple samples and sample types (pbz and area), uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 8610220 Table: 1 of 1

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-108-883. Tri Valley Federal Credit Union, East Helena, MT.			
HERO ID:	8610220			
Conditions of Use:	Building/construction materials			
EXTRACTION				
Parameter	Data			
Worker activity description:	Credit union workers (4/9)			
Exposure route:	inhalation, dermal (4/9)			
Physical form:	gas (4/9)			
Area sampling data:	All area samples were below the LOD of 1.2mg/m3. (8/9)			
Number of workers:	4 employees (3/9)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for commercial use of building and construction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker activity provided, but missing exposure duration, frequency, engineering controls, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-142-892. McKeesport Hospital, McKeesport, PA.		
HERO ID:	8610371		
Conditions of Use:	Laboratory Chemical		
EXTRACTION			
Parameter	Data		
Worker activity description:	Medical Technologists, Histologists and Cytologists (3/12)		
Exposure route:	dermal, inhalation (5/12)		
Physical form:	aqueous solution (5/12)		
Personal sampling data:	Lab Technician 2.3 mg/m^3Histo Technician 2.8 mg/m^3Pathologist 2.7 mg/m^3		
Area sampling data:	Lab Technician 2.4 mg/m^3Pathologist Bench 2.5 mg/m^3		
Exposure duration:	8 hours (7/12)		
Engineering control:	Exhaust ventilation in this laboratory is supplied by a 18-inch window fan. (7/12)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability is addressed by including personal and area samples from different locations, uncertainty is not addressed.
Overall Quality Determination		High	

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HHE 80-103-827. Joel & Aronoff, Ridgefield, NJ.			
HERO ID:	8610377			
Conditions of Use:	Production of Printed Decals			
EXTRACTION				
Parameter	Data			
Worker activity description:	Major operations consisted of the printing, chopping, laminating, cutting, and sewing of decals.			
Exposure route:	inhalation			
Physical form:	gas			
Personal sampling data:	Personal breathing zone samples of laminating employees for formaldehyde had ranged from non-detectable levels to 0.20 milligrams per cubic meter (mg/M3) in a 30-minute sample. The mean TWA exposure was 0.04 mg/M3 .			
Number of workers:	At the time of the study, the plant employed 54 workers. 2 laminating employees.			
Engineering control:	A local-exhaust canopy hood was located against the wall about three feet over the spraying area. (5/18)NIOSH recommended that local exhaust ventilation be increased in the screen cleaning room. The main problem with the existing ventilation system was the long distance from the spraying area to the exhaust hood (about 3 feet). Although hood face velocities ranged from 100-175 feet per minute, the actual capture velocity was minimal. Simply lowering the exhaust hood would increase its efficiency. A much better approach would be to enclose as much of the spraying area as possible within the exhaust system. This could be mostly easily achieved by hanging solvent-resistant curtains from the sides and front of the hood while leaving an opening just large enough to allow the spray cleaning of the screens inside. The ideal solution would be to replace the existing system with one of the spray booths. A minimum capture velocity of 100 feet per minute is required to control organic vapors. Screenwashing should be suspended in this area when the fan is not working.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is assumed to done by OSHA, however, the OSHA method is not specified or further discussed.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not expand on the formaldehyde testing done by OSHA so therefore does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 8620035 Table: 1 of 1

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HHE 80-240-855. New York University, New York, NY.			
HERO ID:	8620035			
Conditions of Use:	Commercial Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Staff of New York University in an office building. (4/20)			
Exposure route:	inhalation (14/20)			
Area sampling data:	Formaldehyde levels ranged from 20 to 30 ppb in all locations. The mean value for the sixth floor was 25 ppb. (8/20)			
Number of workers:	40 employees (5/20)			
Engineering control:	The fifth and sixth floors share an air ventilation system. Air intake is located on the north side of the building, facing a courtyard, at the fifth floor level. Fresh air averaged about 20%, but has been increased at times since July to "air out" the office. Windows in the exterior offices can be opened, but generally were kept closed for temperature control. The second, third and fourth floors share a separate air ventilation system. (5/20)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for ambient air in an office, which is similar to the in-scope occupational scenario use of furniture products.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but mission exposure duration, frequency, physical form, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 8620325 Table: 1 of 1

Study Citation: NIOSH, (1981). Health hazard evaluation report: HHE 79-128-806. Bob Gerren Ford, Inc., Manistee, MI.
HERO ID: 8620325
Conditions of Use: Other-Unknown

EXTRACTION

Parameter	Data
Worker activity description:	Automobile sales and servicing.
Exposure route:	Inhalation
Physical form:	Vapor
Area sampling data:	Formaldehyde general area sampling was done at the accounting office, the middle of the loft area for sample parts, the warranty parts room, and the ceiling in showroom near the sink. All samples for formaldehyde were non-detects.
Comments:	NIOSH investigated an automotive sales and service facility, however, the building was no longer in use during the environmental sampling. Potential sources of formaldehyde are not clearly identified but the report did test emissions of formaldehyde from heating polyurethane foam insulation, which had been used as a building material.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling and analytical methodology is an approved NIOSH method (Sipin monitoring pumps with specially impregnated charcoal tubes operated at 200 ml per minute and were analyzed by ion chromatography (IC), P & CAM 318).
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Uninformative	The data are for an occupational scenario but the source of formaldehyde is unknown. As formaldehyde was not detected, it's uncertain if products containing formaldehyde were present.
	Metric 4: Temporal Representativeness	Low	The data were collected before the most recent PEL establishment.
	Metric 5: Sample Size	Low	Non-detect
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site by sampling multiple areas. Assumed some uncertainty can be determined from the sampling and analytical method.

Overall Quality Determination

Uninformative

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HHE 80-181-909. Ralston Purina Company, Cincinnati, OH.			
HERO ID:	8621028			
Conditions of Use:	Use in cleaning products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Site is animal feed producer, who uses a liquid product to clean extruders. On Fridays, two operators pump the liquid product into a closed mixing tank to dilute with water, then a piping system fills extruders. Workers do monitor the process and move plastic bins to catch extra liquid product during this process, which is then emptied down the floor drain. On Sundays, the filled extruders are heated then drained and rinsed by two operators. Operators also mentioned opening the mixing tank.			
Exposure route:	Inhalation, dermal			
Physical form:	Vapor			
Area sampling data:	Drum Head Space: 7.5 (ppm)Plastic cart: Non-detectExtruder exit port: Non-detect			
Exposure duration:	Exposure occurs for 2 hours on friday and 2 hours on Sunday			
Exposure frequency:	indicates a weekly cleaning (2 days/week, unknown weeks/yr)			
Engineering control:	Adding an external sight gauge to the mixing tank, equipping the plastic cart with a drain plug so that it can be easily emptied into the floor drain, adding a clear plastic cover to the cart to reduce emissions.			
Comments:	NIOSH reported that formaldehyde was not an ingredient of the liquid product (pg. 7)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method (an impinger containing 10 milliliters of 1% SodiumBisulfide and analyzed by direct injection into a gas chromatographequipped with a flame ionization detector.)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario but lacks information on source of formaldehyde. Report states that it was not an ingredient of the product. This data may be similar/useful for the use of cleaning products.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment
	Metric 5:	Sample Size	High	: Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, sample durations, exposure durations, exposure frequency, worker activities but lacks source information.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability and uncertainty in the determinants of exposure for the sampled site.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 8621028 Table: 1 of 1

...continued from previous page

Study Citation:		NIOSH, (1981). Health hazard evaluation report: HHE 80-181-909. Ralston Purina Company, Cincinnati, OH.		
HERO ID:		8621028		
Conditions of Use:		Use in cleaning products		
Domain	Metric	EVALUATION		Comments
		Rating		
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HHE 80-220-830. Fenwick, Stone, Davis, and West, Palo Alto, CA.			
HERO ID:	8621553			
Conditions of Use:	Commercial Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees in a law office conducting general office type work on the 8th floor of a 10 floor building. (4/7)			
Exposure route:	inhalation (4/7)			
Physical form:	vapor (4/7)			
Area sampling data:	The formaldehyde concentrations measured were 0.05 to 0.06 ppm. (4/7)			
Engineering control:	The ventilation system is a central heating and freon refrigeration air conditioning system that serves the entire building. (4/7) The ventilation rate for the Southwest office provided by the building maintenance personnel is supposed to be 385 cfm per each of the 2 air inlets or 770 cfm total. Based on the size of the room this amounts to an air change every 2.5 minutes or 24 air changes per hour. (5/7)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for ambient air in an office, which is similar to the in-scope occupational scenario use of furniture products.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Exposure type, engineering controls, and area sampling provided, but missing exposure duration, frequency, number of workers, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty about the source of the formaldehyde is addressed. Variability isn’t addressed.
Overall Quality Determination		Low		

Study Citation:	NIOSH, (1980). Health hazard evaluation report: HHE 79-006-782. Coastal Industries, Inc., Selma, AL.			
HERO ID:	8627585			
Conditions of Use:	Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Handling material, hemming bottoms and front pockets, setting hip pockets, joining crotches, setting front pockets, seaming sides. (page 12-13 of 15)			
Exposure route:	Dermal and inhalation (page 4 of 15)			
Physical form:	Vapor (page 5 of 15)			
Personal sampling data:	Samples were taken about every 30 minutes during operations. The range of concentrations for each operator is given below in ppm. From pages 11-13 of 15Machine operator 1 (stay front pockets): 0.54 - 1.1Machine operator 2 (hem bottoms): 0.68 - 1.0Machine operator 3 (belt loops): 0.62 - 1.6Machine operator 4 (slides and stops): 0.3 - 1.2Machine operator 5 (set hip pockets): 0.68 - 1.6Machine operator 14 (side seamer): 0.9 - 1.8Machine operator 15 (bänder): 0.76 - 1.6Machine operator 12 (join crotches): 0.82 - 1.7Machine operator 13 (front pockets): 0.51 - 1.5Machine operator 6 (left fly): 1.0Machine operator 7 (hem bottoms): 0.82Machine operator 8 (bands): 1.1Machine operator 9 (set front pockets): 0.56Machine operator 10 (hem front pockets): 0.79Machine operator 11 (set hip pockets): 0.64Material handler: 0.67			
Number of workers:	126 (page 4 of 15)			
Engineering control:	The most efficient manner to control formaldehyde exposure is to implement both local exhaust and dilution ventilation techniques. (page 8 of 15)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH/OSHA method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for finishing agents in textiles, apparel, and leather manufacturing, which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure duration.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by considering various worker activities.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1980). Health hazard evaluation report: HHE 80-2-727. Continental Plastic Containers, Springdale, OH.			
HERO ID:	8627948			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Operators monitor two modules and spend most of their time down by the conveyor and regularly check the chutes where the completed bottles are blown from the dies. (8/14)			
Exposure route:	inhalation (7/14)			
Physical form:	gas (7/14)			
Area sampling data:	"Formaldehyde samples located directly above the modules indicated levels of 0.72 mg/M3, 0.90 mg/M3, and 0.81 mg/M3. (8/14)"			
Exposure duration:	8 hours/day (2/14)			
Exposure frequency:	5 days/week, days/yr. not specified (2/14)			
Number of workers:	The area is run by 66 workers divided among 3 shifts. (2/14)			
Engineering control:	No local exhaust is present, but six large ceiling fans and two sets of wall louvers were operating. (8/14)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for intermediates in plastic and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Most critical metadata provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at multiple ovens and areas of the plant.	
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 8628587 Table: 1 of 1

Study Citation:	NIOSH, (1979). Health hazard evaluation report: HHE 79-106-635. Beth Israel Hospital Laboratory, Denver, CO.			
HERO ID:	8628587			
Conditions of Use:	Laboratory chemicals			
EXTRACTION				
Parameter	Data			
Worker activity description:	Using formaldehyde in the analyses of biological samples and in the preparation of tissue slides.			
Exposure route:	Dermal and inhalation			
Physical form:	Vapor			
Personal sampling data:	Pathologist: non-detectHistologist: non-detect			
Area sampling data:	General room: non-detect			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Report is more than 20 years old.	
	Metric 5: Sample Size	N/A	No sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations, and exposure frequency.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is not addressed. Variability addressed by personal and area samples in different locations.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 8630652 Table: 1 of 1

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 82-014-1057. Computer Services of Roanoke, Inc., Roanoke, VA.			
HERO ID:	8630652			
Conditions of Use:	Commercial Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers at a computer service office building. (3/14)			
Exposure route:	inhalation, dermal (6/14)			
Physical form:	vapors (3/14)			
Area sampling data:	"All samples indicated less than 0.06 ppm formaldehyde. (6/14)"			
Number of workers:	12-13 persons (4/14)			
Engineering control:	The building has two stories and a basement and is air-conditioned by six units, five of which serve different portions of the area surveyed. (4/14) Pages 6,9, and 10 discuss the ventilation further.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for ambient air in an computer service office, which is similar to the in-scope occupational scenario use of electronic products.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure duration, frequency, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination	Medium			

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 82-084-1147. American Medical Supply D.B.A. Community Dialysis Services of Denver, Denver, CO.			
HERO ID:	8630654			
Conditions of Use:	Cleaning Products (Dialysis)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Sterilizing the reverse osmosis water treatment system and the 12 individual patient dialysis units with formaldehyde.			
Exposure route:	Dermal and inhalation			
Physical form:	Gas			
Personal sampling data:	Two nurse breathing zone samples were taken for formaldehyde and both were non-detectible.			
Area sampling data:	A total of 8 general room samples were taken which ranged from formaldehyde concentrations of non-detectible to 1.9 (mg/m^3)			
Exposure duration:	3.5 hours/day			
Exposure frequency:	approximately once a week			
Engineering control:	Ventilation with a minimum of 5 air changes per hour in the work area should be installed.			
Comments:	described as 'sterilizer'			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	more than 20 years old and after establishment of the recent PEL
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, including sample types, exposure types, sample durations, exposure durations worker activities, but not exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site by sampling different areas and personal breathing zone samples. Assume uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 8630657 Table: 1 of 1

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 82-313-1221. USDA Food and Nutrition Service, Burlington, MA.			
HERO ID:	8630657			
Conditions of Use:	Unknown- Office Building			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in office building. Potential sources could be from building products, items contained within offices and/or cigarette smoke.			
Exposure route:	Dermal and inhalation			
Area sampling data:	Three general area samples were taken but no formaldehyde was detected. The limit of detection was 5 micrograms per sample, equivalent t o 0.01 ppm. (pdf pg. 6)			
Number of workers:	125			
Engineering control:	Air handling systems are used to recirculate office air and are located on the roof of the building.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method (P & CAM 354)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The study did not identify formaldehyde or discuss potential sources of formaldehyde but could be relevant for the use of building products. Note that cigarette smoke was mentioned (non-TSCA use).
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment or update and are more than 20 years old
	Metric 5:	Sample Size	Low	No statistics as all samples were non-detects
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, butlacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty can be determined from the sampling and analytical method but variability was not discussed.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 82-038-1127. Federal Aviation Administration Airways Facilities Sector, Fremont, CA.			
HERO ID:	8630659			
Conditions of Use:	Commercial substances in Paper			
EXTRACTION				
Parameter	Data			
Worker activity description:	Air traffic controllers			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Six environmental air samples were collected for formaldehyde at both teleprinter stations and from the paper storage area, and no formaldehyde was detected. (pg. 6)			
Exposure duration:	10 am to 2 pm and 11:30 am to 3:30 pm for teleprinters (pg.4)			
Exposure frequency:	daily (7 days/week, 24 hours/day) (pg. 4)			
Number of workers:	225 workers total for site(pg. 4); maximum of 10 workers exposed to the teleprinter emissions (pg. 4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study Methods P&CAM 318
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (Commercial Use of paper) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 - prior to PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	No formaldehyde was detected in samples
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability was not addressed. Assumed that NIOSH Method P&CAM 138 considered uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 82-242-1234. Olympic Peninsula Kidney Center, Bremerton, WA.		
HERO ID:	8630765		
Conditions of Use:	Laboratory chemical		
EXTRACTION			
Parameter	Data		
Worker activity description:	Formaldehyde exposure occurs when the formaldehyde is flushed through the artificial kidney and when the carboy of 2% formaldehyde is refilled, which occurs several times a week.		
Exposure route:	Inhalation		
Physical form:	Vapor		
Personal sampling data:	Breathing zone of worker during time 4 artificial kidneys were flushed: 0.36 ppmBreathing zone during emptying formaldehyde solution into sink and refilling carboy: 1.75 ppm		
Area sampling data:	Above sink in lab before any artificial kidneys were flushed: 0.13 ppmAbove sink in lab during time 4 artificial kidneys were flushed: 0.38 ppmIn patient dialysis area. Four kidneys were flushed and one carboy of formaldehyde was mixed in adjacent lab: 0.12 ppmIn patient dialysis area (no kidneys were flushed during this time): 0.04 ppmIn patient dialysis area (4 artificial kidneys were flushed and one carboy of formaldehyde was mixed in adjacent lab): 0.09 ppmAbove sink in lab (time before flushing of 1 kidney): 0.23 ppmAbove sink in lab (3 kidneys were flushed and one carboy of formaldehyde was mixed): 0.51 ppm		
Exposure duration:	Employees work 10 hr/day shifts		
Exposure frequency:	6 days/week		
Number of workers:	7		
Engineering control:	An exhaust system should be installed in the dialysis area. A lateral exhaust slot hood can be used. Baffles on the sides and the top increase the capture efficiency.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	Report is more than 20 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is not addressed. Variability addressed by taking samples at different locations and including both personal breathing zone and area monitoring data.
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Formaldehyde

Occupational Exposure

HERO ID: 8630765 Table: 1 of 1

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Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 82-242-1234. Olympic Peninsula Kidney Center, Bremerton, WA.		
HERO ID:	8630765		
Conditions of Use:	Laboratory chemical		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 82-342-1223. William Blount High School, Maryville, TN.		
HERO ID:	8630777		
Conditions of Use:	Chemical substances in construction products		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	A total of 23 area air · samples were collected for evaluation of formaldehyde vapor concentrations in the school. The levels measured are considered to represent a worst possible case situation since ventilation systems were not and had not been operating in the two weeks prior to sampling, and temperature and humidity conditions favored high formaldehyde levels originating from the insulation. The time-weighted average formaldehyde concentrations inside the school ranged from 0.02 parts per million (ppm) to 0.17 ppm (0.03 mg/M3 to 0.20 mg/M3), with an arithmetic mean of 0.07 ppm (0.09 mg/M3). Short term {i.e. about 2 hours) area sample concentrations ranged from 0.01 ppm (0.01 mg/m3) to 0.11 ppm (0.14 mg/m3). The time-weighted average over the total sampling period combining three short-term samples ranged from 0.02 PJJTI (0.03 mg/m3) to 0.07 ppm (0.09 mg/m3}. A sample of about three hours in duration obtained above the suspended ceiling tile in room 213 demonstrated a concentration of 0.005 ppm (0.006 mg/m3)Rm 201 center-desk 0.12 ppmRm 202 center-desk 0.17 ppmRm 204 center-desk 0.08 ppmStudent Affairs Office-desk 0.09 ppmRm 206 center-desk 0.04 ppmRm 213 back filing cabinet 0.05 ppmRm 213 front center desk 0.04 ppmRm 214 front desk 0.02 ppmRm 219 center-desk 0.05 ppmCommons - locker area 0.07 ppmBand room closet (exposed insulation) 0.08 ppmArithmetic mean: 0.07 ppm +/- 0.04 ppmShort term Sampling Rm 213 front center desk 0.02 ppmRm 213 front center desk 0.01 ppmRm 213 front center desk 0.11 ppm TWA 0.05 ppm Rm 219 center-desk 0.02 ppmRm 219 center-desk 0.04 ppm Rm 219 center-desk 0.01 ppm TWA 0.02 ppmBand room closet (exposed insulation) 0.07 ppm Band room closet (exposed insulation) 0.09 ppm Band room closet (exposed insulation) 0.06 ppm TWA 0 .07 ppmRm 213 above suspended ceiling 0.005 ppm		
Engineering control:	The operation of the ventilation system along with normal infiltration and system design air changes is considered sufficient to keep formaldehyde concentrations at a low level, most likely below the documented levels presented here.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH study - Method P&CAM 125
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for an occupational scenario (school) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1982 - prior to PEL (1992) and more than 20 years old
	Metric 5: Sample Size	High	Statistical data provided plus results from individual sampling events were provided. Uncertainty was not discussed but assumed that it was addressed in NIOSH method P&CAM 125.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, but lacks additional metadata, such as exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 8630777 Table: 1 of 1

...continued from previous page

Study Citation:		NIOSH, (1982). Health hazard evaluation report: HETA 82-342-1223. William Blount High School, Maryville, TN.		
HERO ID:		8630777		
Conditions of Use:		Chemical substances in construction products		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in Method P&CAM 125.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 81-032-1174. Tahoe Designs, Tahoe City, CA.			
HERO ID:	8631142			
Conditions of Use:	Ink, toner, and colorant products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees use heat-transfer machines to apply rubber ink decals to garments. (4/18)			
Exposure route:	inhalation, dermal (6/18)			
Physical form:	gas (6/18)			
Personal sampling data:	Two personal samples and once area sample didn’t detect any formaldehyde. (7/18)			
Area sampling data:	Two personal samples and once area sample didn’t detect any formaldehyde. (7/18)			
Exposure duration:	10-12 hours/day (4/18)			
Exposure frequency:	Store is open 7 days/week, so assume 365 days/yr. (4/18)			
Number of workers:	Normally 2-3 employees (4/18)			
Engineering control:	”The present store has general room ventilation which helps reduce and/or eliminate any buildup of gases or vapors which are generated off the heat transfer operation. The employees also use a circular tabletop fan which is positioned next to the heat transfer machine. They use this fan to reduce the heat and any fumes which may emanate off the heat transfer process. (8/18)”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for commercial use of inks, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 81-226-1048. University of Georgia College of Veterinary Medicine Histopathology Laboratory, Athens, GA. 81-226-1048:1-14.			
HERO ID:	8631180			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Laboratory technicians during processing and mounting of tissue specimens in the histopathology laboratory. (4/14)			
Exposure route:	inhalation, dermal (7/14)			
Physical form:	vapors (3/14)			
Personal sampling data:	Of 3 personal samples, only one sample had detectable concentrations of formaldehyde at 12.8 ppm. (13/14)			
Area sampling data:	Two area samples had concentrations of 0.8 and 1.0 ppm. (13/14)			
Exposure duration:	30 minutes/day (4/14)			
Exposure frequency:	1 day/week (4/14)			
Number of workers:	4 technicians, a chief technician, and 3 assistants. (4/14)			
Personal protective equipment:	Organic vapor respirator, rubber gloves, and an apron. (4/14)			
Engineering control:	A small exhaust hood located in the tissue process area (Room 115) had been previously used but the exhaust air velocity was not considered adequate. A larger laboratory hood, located in room 177, was being used at the time of the survey. (5/14)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by including personal and area samples. Uncertainty is not addressed.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 8632189 Table: 1 of 1

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HHE 80-167-1078. Stephenson and Lawyer, Inc., Grand Rapids, MI.			
HERO ID:	8632189			
Conditions of Use:	Foam cutting (not a COU) but no emissions detected			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Adhesive Spraying NDHot-Wire Cutting ND			
Area sampling data:	Adhesive Storage Area ND			
Exposure duration:	exposure part of 40 hours per week			
Number of workers:	130 production workers total - includes those who may not be involved in hot wire cutting.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (hot wire cutting) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1980 - prior to PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 81-337-1125. Borden Chemical Division, Fayetteville, NC.			
HERO ID:	8632204			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	Operating, maintenance, shipping, general labor and laboratory personnel. (page 4 of 32)			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	See page 10-12 for table of results in the various roomsImpinger mean values ranged from 0.16 to 0.55The single badge mean values was 5.30 M.S. (molecular sieve tubes) ranged from 0.10 to 0.50See pages 13-15 for discussion. See pages 20-32 for individual data points.			
Area sampling data:	See page 10-12 for table of results in the various rooms. Impinger mean values ranged from 0.04 ppm to 0.86Badge mean values ranged from 0.20 to 2.66M.S. (molecular sieve tubes) ranged from 0.06 to 1.33See pages 13-15 for discussion. See pages 20-32 for individual data points.			
Number of workers:	40 (page 4 of 32)			
Engineering control:	Portable charcoal absorbers with recirculating fans are provided in the quality control rooms for the purpose of removing organic contaminants. Except for the five quality control rooms, storage warehouse and the hexa plant, the major production areas are outside or in open sheds. (page 4 of 32)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by sampling at multiple locations.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 81-180-1171. Robert A. Taft Laboratories, Cincinnati, OH.			
HERO ID:	8632213			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Tissue preparation and autopsies (page 6 of 87)			
Exposure route:	Dermal and inhalation (10 of 87)			
Personal sampling data:	Disecting: 0.09-0.11 mg/m^3Recorder: 0.13 mg/m^3Weighing: 0.18 mg/m^3Sectioning: 0.08 mg/m^3Hematology technician: 0.18 mg/m^3 Histology technician: 0.43 mg/m^3Biology technician: 0.57 mg/m^3 (page 44 of 87)			
Exposure duration:	Autopsies last about 4 hours, tissue preparation lasts about 8 hours. (page 7-8)			
Number of workers:	NIOSH has approximately 50 administrative and 220 Division employees working in the building. (page 4 of 87)			
Personal protective equipment:	Laboratory gowns, surgical gloves, and masks. (page 18 of 87)			
Engineering control:	Ventilation and fume hoods are used. (page 15-16 of 87)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data from the U.S.
	Metric 3:	Applicability	High	Data are for laboratory chemicals, applicable to all occupational exposure scenarios.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability addressed by comparing exposures for different worker activities, uncertainty is addressed with the given sampling methods.
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 8632259 Table: 1 of 1

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 81-411-1182. Corhart Refractory, Louisville, KY.			
HERO ID:	8632259			
Conditions of Use:	Adhesive in construction material manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Mixer operators, core blowers, rollover operators (23/27)			
Exposure route:	inhalation, dermal (9/27)			
Physical form:	binder resins (5/27)			
Personal sampling data:	PBZ samples ranged from ND-0.64 mg/m3 (Table 9) (23/27).			
Area sampling data:	Area samples didn’t detect formaldehyde. (23/27)			
Number of workers:	130 workers (3/27)			
Personal protective equipment:	PPE includes gloves, eye protection, respirators, safety shoes, and hard hats. (21/27)			
Engineering control:	New and old ”No-Bake” mixers and rollover machines are equipped with local exhaust ventilation hoods located on the side opposite the operator. The true cast and VF areas relies on one general exhaust fan located in the ceiling of the VF area for air movement. In the true cast area, a large door remains open to the outside allowing air flow through true cast into VF areas. (6/27)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for use as a sealant in construction material manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Exposure type, worker info, and sampling data provided, but missing exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 81-452-1128. Santa Cruz Metropolitan Transit District, Santa Cruz, CA.			
HERO ID:	8632260			
Conditions of Use:	Fuels and related products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Driving a bus.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Bus driver personal air sampling resulted in non-detections for formaldehyde.			
Exposure duration:	4-10 hours/day			
Number of workers:	20-30 bus drivers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Analytical methodology is an approved NIOSH method, P & CAM 318.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for fuels and related products, which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment. Assessment is based on data greater than 20 years old and industry conditions that are expected to be out-dated.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, butlacks additional metadata, such as sample durations, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability are not addressed. Assumed uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 82-205-1314. North Central Dialysis Centers, Chicago, IL.			
HERO ID:	8632564			
Conditions of Use:	Use of Cleaning Products (Dialysis)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Cleaning and disinfecting of artificial kidney units.			
Exposure route:	Inhalation			
Physical form:	Gas			
Personal sampling data:	Initial SurveyRe-Use Technician: non detect - 0.57 ppmMaintenance Technician: non detectFollowup SurveyRe-Use Technician: non detect - 0.84 ppmMaintenance Technician: non detect			
Area sampling data:	Initial SurveyAbove machine: 0.60 ppmAbove work area: non detect - 0.53 ppmAbove desk: 0.57 ppmFollowup SurveyAbove work area: non detectCenter of room: non detect			
Personal protective equipment:	Rubber gloves and protective eyeglasses. Respirators are also available but not routinely used.			
Engineering control:	A window fan is present next to operations to provide ventilation.			
Comments:	Samples taken at 3 different facilities			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method (P & CAM 354 modified)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, sample durations, worker activities butlacks additional metadata, such as exposure durations, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site. Uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 82-223-1340. Rubbermaid, Incorporated, Wooster, OH.		
HERO ID:	8632596		
Conditions of Use:	Plastic and resin manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	Wire finishers, welder finishers, and employees near the cure oven inlet. (27/36)		
Exposure route:	inhalation, dermal (25/36)		
Physical form:	gas(12/36)		
Personal sampling data:	The results of personal and area samples for formaldehyde exposures on the wire line obtained during the initial survey were all below the calculated environmental limit of detection of 0.2 parts per million or 0.3 mg/m3. (10/36)		
Area sampling data:	The results of personal and area samples for formaldehyde exposures on the wire line obtained during the initial survey were all below the calculated environmental limit of detection of 0.2 parts per million or 0.3 mg/m3. (10/36) During the follow-up survey, formaldehyde concentrations in these three samples (one at the welding end of the Wire Line, one at the product take-off, and one in the Extrusion Area) ranged from 0.04 to 0.05 mg/m3 (0.05 to 0.07 ppm). A process sample located inside the cure oven inlet had 0.3 mg/m3 (0.4 ppm). (12/36)		
Exposure duration:	8-10 hours (9/36)		
Number of workers:	”The plant employs 1820 workers, 59% of whom are productionworkers. The Wire Line operates fully staffed (16 workers) duringthe first shift and a half-shift (with 9 workers) during the secondshift. Plastics II operates on all three shifts, five days per week, with four color changers per shift. Plastics II had 160 workers, including the 12 color changers. Eighteen maintenance workers serve the two areas. (5/36)”		
Personal protective equipment:	Respirators were provided to workers upon request. (15/35)		
Engineering control:	Local exhaust units are located on the printers to remove solvent vapors from the sheets as they pass through. (5/36)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology for first initial survey was an approved NIOSH method (P & CAM 354), while the second survey used an 'experimental method' .
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for incorporation during plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Most critical metadata provided except exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability was addressed by sampling personal and area, and on multiple days and areas.
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 8632596 Table: 1 of 1

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Study Citation:		NIOSH, (1983). Health hazard evaluation report: HETA 82-223-1340. Rubbermaid, Incorporated, Wooster, OH.		
HERO ID:		8632596		
Conditions of Use:		Plastic and resin manufacturing		
Domain		Metric	EVALUATION Rating	Comments
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 8633017 Table: 1 of 1

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 82-269-1341. Cincinnati Technical College, Cincinnati, OH.			
HERO ID:	8633017			
Conditions of Use:	General Population Exposure: Building and construction materials			
EXTRACTION				
Parameter	Data			
Worker activity description:	College learning resource center workers: Workers in television control room, television studio, and the media distribution center.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Media distribution area: Non-detectTelevision Control Room: Non-detectTelevision Control Room 278A: Non-detectTelevision Control Room 277: Non-detectTelevision Studio: Non-detectWorkroom #147: Non-detect			
Number of workers:	200 full-time and 125 part-time faculty on staff.			
Engineering control:	Ventilation system set to provide 10% fresh outdoor air.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Low	The monitoring data is for general population exposure but may be used for a similar occupational exposure scenario like building/construction materials.
	Metric 4:	Temporal Representativeness	Low	Report is more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by sampling at different locations but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 82-368-1308. Appalachian Laboratory for Occupational Safety and Health, Morgantown, WV.			
HERO ID:	8633860			
Conditions of Use:	Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Worker activity description:	Histology technicians using a surgical biopsy hood. (4/6)			
Exposure route:	inhalation (5/6)			
Physical form:	vapors (5/6)			
Area sampling data:	The technician’s average exposure was approximately 3.6 ppm with peaks of approximately 8 ppm. Later that day, her exposure averaged approximately 4.9 ppm with a peak exposure of approximately 11 ppm. When a pathologist used the hood to prepare tissues from a human lung, his average exposure during this time was approximately 6.7 ppm with peak exposures of 10 to 11 ppm. (5/6)			
Exposure duration:	2 hours/day (4/6)			
Engineering control:	Operations take place under a fume hood. (4/6) In allthree sash positions the modified hood provided more than 100 linear feet per minute of airflow at the face of the hood (5/6)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing number of workers, exposure frequency, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling multiple times on multiple employees.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 8634713 Table: 1 of 1

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 83-063-1364. Louis A. Johnson Medical Center, Clarksburg, WV.			
HERO ID:	8634713			
Conditions of Use:	Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Worker activity description:	Histology technicians use formalin as a fixative for gross tissue specimens. (4/8)			
Exposure route:	inhalation, dermal (5/8)			
Physical form:	gas (6/8)			
Area sampling data:	No formaldehyde was detected with an LOD of 0.5 ppm. (6/8)			
Number of workers:	2 technicians (4/8)			
Personal protective equipment:	Appropriate gloves should be work when there is a possibility of skin contact with formaldehyde. (7/8)			
Engineering control:	Ventilation of the laboratory is provided by a duct from the general hospital ventilation system, an exhaust hood, and window mounted air conditioner. According to a histology technician, the window in the lab is kept partially open for additional air. (4/8)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty since data values are not given.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 82-391-1303. Mitchell Plastics, Inc., Cheswick, PA.			
HERO ID:	8639198			
Conditions of Use:	Reactant-Adhesives and sealant chemicals in: Plastic and resin manufacturing; Wood product manufacturing; All other basic organic chemical manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Personal sampling data:	In reviewing the air sampling data it is interesting to note that the formaldehyde levels for the personal samples were higher than the levels measured at the mold head. The higher exposure levels for the mold press operators may suggest that workers are being exposed to formaldehyde from other sources. One likely source could be from cigarette smoke present in the break room.			
Area sampling data:	Detectable levels were measured in seven of the eight air samples, with concentrations ranging from 0.005 to 0.084 ppm. The highest levels were measured in sample~ collected from the mold press operators, with progressively lower levels measured for the air samples collected from above the mold head, main office, and outdoors. (pdf pg 8)			
Exposure frequency:	Production scans 3 shifts/day, 5 days/week. (pdf pg 4)			
Number of workers:	The plant employs 16 production workers including 10 mold press operators, 4 material handlers and set-up persons, an inspector, and a shipper. The mold press operators normally rotate machines on a daily basis. (pdf pg 4)			
Comments:	Table 1: Formaldehyde Concentrations			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data are from 1982 and are unlikely to be associated with representative operations, equipment or activities.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA 83-191-1423. National Zoological Park Conservation Center, Front Royal, VA.			
HERO ID:	8646306			
Conditions of Use:	Wood and engineered wood products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers at the Smithsonian Zoo Conservation Center doing daily chores, changing habitats, and conducting observations in the Small Mammal building. (4/10)			
Exposure route:	inhalation (4/10)			
Physical form:	gas (4/10)			
Area sampling data:	Formaldehyde levels ranged from 0.11 to 0.43 ppm and averaged .26 ppm. (6/10)			
Exposure duration:	One worker will work 8 hours a day. Up to three will work on an as-necessary basis. Once a month, researchers will conduct 24-hour observations. (4/10)			
Number of workers:	1-3 workers (4/10)			
Engineering control:	Repeated treatment with ammonia gas reduced exposure levels considerably. (4/10)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method (P & CAM 125).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for commercial use of wood products, an in-scope occupational scenario,
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	All sample measurements provided, statistics can be determined.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided, except exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability is addressed by sampling at different locations, height of above floor, and time of the day.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA 82-348-1442. The Dotson Company, Mankato, MN.		
HERO ID:	8646356		
Conditions of Use:	Foundries- Binder/Industrial Adhesive		
EXTRACTION			
Parameter	Data		
Worker activity description:	Making iron cores.		
Exposure route:	Inhalation, dermal		
Physical form:	Liquid		
Personal sampling data:	Isocure coremaker (U-180 machine): 0.3 (mg/m^3)Bench Isocure coremaker: 0.9 (mg/m^3)		
Area sampling data:	At coremaker’s work station (shell core dept.): 0.4 (mg/m^3)Adjacent to control panel(U-180 isocure machine): 0.4 (mg/m^3)On work bench(isocure): 0.4 (mg/m^3)		
Exposure duration:	8 hours/day (pdf pg. 4/27)		
Exposure frequency:	5 days/week (4/27)		
Number of workers:	50 production and 30 office/administrative personnel; 6 to 9 full time employees work at the three coremaking operations. (4/27)		
Personal protective equipment:	NIOSH recommends protective gloves, impervious to the binder components used, and flexible enough to be used for the task performed, should be worn. respiratory program. (16/27)		
Engineering control:	NIOSH recommends Local exhaust ventilation (16/27)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is P&CAM 125 (otherwise known as NIOSH 3500)
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for foundry use as a component/residue of the binder/resin which is an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by multiple area and personal samples.
Overall Quality Determination		High	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA 84-430-1518. DMG Incorporated, Philadelphia, PA.			
HERO ID:	8647106			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation, dermal (4/8)			
Physical form:	vapor, solutions, and resin (4/8)			
Personal sampling data:	Four personal samples detected concentrations of 0.07-0.24 ppm. (8/8)			
Area sampling data:	Two area samples detected concentrations of 0.33 ppm. (8/8)			
Exposure duration:	8 hours (5/8)			
Engineering control:	General ventilation is minimal as there are no windows. Floor air movement fans are used for the comfort of the employees. (3/8)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesives and sealants in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type, exposure type, and engineering controls provided, but missing worker information, exposure frequency, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA-84-065-1519. Southern Oregon State College, Ashland, OR.			
HERO ID:	8647135			
Conditions of Use:	Paper products			
EXTRACTION				
Parameter	Data			
Worker activity description:	College bookstore employees (3/13) Exposure to formaldehyde containing particles would occur during the separation of paper sheets or later when the sheets are again handled. (8/13)			
Exposure route:	dermal (4/13)			
Physical form:	particles (8/13)			
Area sampling data:	Air samples collected for formaldehyde showed concentrations of 0.01, 0.02, and 0.014 ppm. (13/13)			
Number of workers:	7 workers have been affected. (9/13)			
Engineering control:	The heating, ventilation, and air conditioning system (HVAC) is a forced air system. The heat is provided by hot water from a central campus boiler and the air conditioning is a refrigeration system. (4/13)			
Comments:	Table 2.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for commercial use of paper products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure duration, frequency, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA 84-155-1489. Clara Maass Medical Center, Belleville, NJ.		
HERO ID:	8647180		
Conditions of Use:	Laboratory Chemicals		
EXTRACTION			
Parameter	Data		
Worker activity description:	The pathologists are responsible for visual examination and dissection of 10% formalin preserved surgical and post-mortem tissue samples and microscopic evaluation of stained tissue sections for cellular abnormalities. The technicians are responsible for assisting the pathologist during grossing, preparing tissue samples for microscopic evaluation (includes cutting, mounting, and staining of tissue specimens), and cytology. (4/19)		
Exposure route:	dermal, inhalation (7/19)		
Physical form:	vapor and solutions (7/19)		
Personal sampling data:	Personal samples ranged from ND-4.08 ppm formaldehyde. Short term samples were between 7 to >10 ppm. (15/19)		
Area sampling data:	Two area samples ranged from 0.27-3.42 ppm formaldehyde. Short term area samples were 1.0-2.0 ppm. (15/19)		
Exposure duration:	Less than 1 hr/day. (4/19)		
Number of workers:	6 workers in the histopathology lab (3 pathologists and 3 technicians). (4/19)		
Personal protective equipment:	Aside from lab coats, latex surgeon-type gloves are the only other protective equipment used by the lab personnel. (10/19)		
Engineering control:	Exhaust vents and air supply vents were present in the lab. (5/19)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling on different days and taking long and short-term samples.
Overall Quality Determination		High	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA 83-076-1414. St. Joseph’s Hospital, Denver, CO.		
HERO ID:	8647374		
Conditions of Use:	Laboratory chemical		
EXTRACTION			
Parameter	Data		
Worker activity description:	Staining, chemical mixing, mold preparation, and the removal/filling of chemicals used in the tissue processing machine.		
Exposure route:	Dermal and inhalation.		
Physical form:	Vapor		
Personal sampling data:	Histology DepartmentFormalin preparation: non detectChanging formalin: 0.10 mg/m^3Surgical PathologyPathologist: 0.20 - 0.80 mg/m^3Technician: 0.33-0.54 mg/m^3Reagent PreparationFirst day chemical mixing: 1.90 mg/m^3Second day chemical mixing: 0.21 mg/m^3Pathology/Morgue Waste DisposalWaste Disposal: 0.82 mg/m^3		
Area sampling data:	Histology DepartmentChanging formalin: 0.10 mg/m^3Surgical PathologyGeneral room air sample: 0.30-0.55 mg/m^3Reagent PreparationFirst day chemical mixing: 0.35 mg/m^3Second day chemical mixing: 0.03 mg/m^3Pathology/Morgue Waste DisposalWaste Disposal: 0.30 mg/m^3		
Exposure duration:	Formalin mixing takes about 30 minutes.Work in the surgical pathology room occurs from 9-11 AM and 2-4 PM.Tissue disposal takes about 30 minutes.		
Number of workers:	3-4 employees work in the histology department at any given time.2-3 employees work in the surgical pathology room normally.		
Personal protective equipment:	Rubber gloves		
Engineering control:	Laboratory hoods are used for staining, chemical mixing, mold preparation, and the removal/filling of chemicals used in the tissue processing machine. A local exhaust ventilation system is used in the surgical pathology department.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Report is from more than 20 years ago.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations and worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by comparing personal and area sampling results from different worker activities and areas, uncertainty is not addressed.
Overall Quality Determination		High	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA 83-066-1531. Globe Industry, Lowell, IN.			
HERO ID:	8647540			
Conditions of Use:	Surface active agents in plastic material and resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Press operator, utility person, picker feeder, resin operator, clean-up person, hot press operator (17/18)			
Exposure route:	inhalation, dermal (14/18)			
Physical form:	gas (14/18)			
Personal sampling data:	Workers were exposed to airborne formaldehyde concentrations ranging from 0.02 to 0.30 mg/m3 with a mean of 0.15 mg/m3 (17/18)			
Exposure duration:	8-10 hours (9/18)			
Number of workers:	180 people (4/18)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for surface agents in plastic and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker activity provided, but missing exposure frequency, engineering controls, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different worker activities during different days.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA 84-098-1497. University of Pennsylvania Medical Education Building, Philadelphia, PA.			
HERO ID:	8647542			
Conditions of Use:	Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Worker activity description:	Dental students and instructors during dissection and examination of embalmed cadavers in a gross anatomy course. (3/17)			
Exposure route:	inhalation, dermal (6/17)			
Physical form:	solution (4/17)			
Personal sampling data:	Formaldehyde was detected in 24 air samples with exposure concentrations ranging from 0.43 to 2.01 ppm. (8/17)			
Exposure duration:	4 hours/day (3/17)			
Number of workers:	100 students and instructors (3/17)			
Personal protective equipment:	Aside from cloth lab coats, disposable polyvinyl chloride (PVC) surgical gloves (worn on both hands) were the only other protective equipment used by students and faculty. (10/17)			
Engineering control:	Exhaust and supply air vents were present in the laboratories. (5/17)			
Comments:	Table 1: formaldehyde and Phenol Exposures of Dental Students and Instructors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling on different days and by studying the effects of humidity on the concentrations.
Overall Quality Determination		High		

Study Citation:	NIOSH, (2019). Evaluation of ergonomics, chemical exposures, and ventilation at four nail salons.			
HERO ID:	8683475			
Conditions of Use:	Personal care products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Nail salon technicians provided nail services, including applying, removing, filling, and polishing acrylic nails and providing standard polish, gel and shellac polish manicures and pedicures. Some technicians also provided hair removal waxing services. From 3 to 11 employees worked at each of the four salons.			
Exposure route:	Dermal and inhalation			
Physical form:	Liquid			
Personal sampling data:	Salon B: [0.005]-0.020 (ppm)Salon C: 0.017-0.018 (ppm)Salon D: 0.012-0.018 (ppm)*Discrete sample results given on PDF Pg. 39.[0.005] for salon B which is between the minimum detectable and minimum quantifiable concentrations			
Dermal exposure data:	nan			
Exposure duration:	Shift lengths vary between 2 and 8 hours.			
Exposure frequency:	median hours per week: 30 hrs (range: 12–60 hours)			
Number of workers:	3-11 employees at each salon.			
Personal protective equipment:	Some workers wore nitrile or latex gloves, surgical masks and/or N95 respirators. Survey results on pg. 36			
Engineering control:	General ventilation system and a small direct exhaust system. NIOSH recommends local exhaust ventilation systems to be used.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA (OSHA 1007) method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Uninformative	The data are for an occupational scenario outside of the scope of the risk evaluation (Non-TSCA uses).
	Metric 4:	Temporal Representativeness	High	The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (Discrete samples are available).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled sector. The uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		Uninformative		

Study Citation:	NIOSH, (2006). Niosh health hazard evaluation report- Inova Fairfax Hospital.			
HERO ID:	8684533			
Conditions of Use:	Laboratory chemicals			
EXTRACTION				
Parameter	Data			
Worker activity description:	Performing medical procedures including mastectomy, cystoscopy-transurethral resection of the prostate (TURP), prostatectomy, body cast replacements for scoliosis, spinal fusion, lumbar decompression, two lumbar laminectomies, breast tissue expander insertion, thyroidectomy, and bowel resection.			
Exposure route:	Dermal and inhalation.			
Physical form:	Vapor			
Personal sampling data:	MastectomyAssistant surgeon: 0.005 (ppm)Scrub nurse: 0.005 (ppm)Cystoscopy TURPNurse anesthetist: 0.004 (ppm)Assistant surgeon: 0.006 (ppm)ProstatectomyNurse anesthetist: 0.004 (ppm)Circulating nurse: 0.005 (ppm)Body cast replacementCirculating nurse: 0.01 (ppm)Assistant surgeon: 0.01 (ppm)Spinal FusionScrub nurse: 0.01 (ppm)Lumbar DecompressionCirculating nurse: 0.003 (ppm)Scrub nurse: nondetectLumbar LaminectomyScrub nurse: 0.004 (ppm)Circulating Nurse: 0.002 (ppm)Breast Tissue Expander Nurse anesthetist: 0.004 (ppm)Scrub nurse: 0.004 (ppm)Lumbar LaminectomyNurse anesthetist: 0.003 (ppm)ThyroidectomyAssistant surgeon: 0.004 (ppm)Cysto-TURPCirculating nurse: 0.015 (ppm)Nurse anesthetist: 0.005 (ppm)Small Bowel ResectionAssistant surgeon: 0.006 (ppm)Scrub nurse: 0.006 (ppm)MastectomyNurse anesthetist: 0.005 (ppm)Attending surgeon: 0.013 (ppm)Biopsy and mastectomySurgeon: 0.017 (ppm)Circulating nurse: 0.006 (ppm)			
Area sampling data:	Mastectomy: 0.003-0.004 (ppm)Cystoscopy-TURP: 0.004-0.005 (ppm)Prostatectomy: 0.005 (ppm)Body Cast Replacement: 0.01 (ppm)Spinal Fusion: 0.01 (ppm)Lumbar Decompression: 0.003 (ppm)Lumbar Laminectomy: 0.002 (ppm)Breast Tissue Expander: 0.004 (ppm)Lumbar Laminectomy: 0.003 (ppm)Thyroidectomy: 0.003 (ppm)Small Bowel Resection 0.005 (ppm)biopsy and mastectomy 0.005 (ppm)			
Engineering control:	NIOSH recommends local exhaust ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by taking samples at different dates but uncertainty is not addressed.
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Formaldehyde

Occupational Exposure

HERO ID: 8684533 Table: 1 of 1

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Study Citation:		NIOSH, (2006). Niosh health hazard evaluation report- Inova Fairfax Hospital.		
HERO ID:		8684533		
Conditions of Use:		Laboratory chemicals		
Domain		Metric	EVALUATION Rating	Comments
Overall Quality Determination			High	

Study Citation:	NIOSH, (n.d.). Niosh health hazard evaluation report- Morton Plant Hospital.		
HERO ID:	8684534		
Conditions of Use:	Laboratory chemical		
EXTRACTION			
Parameter	Data		
Worker activity description:	Performing various surgical operations as a surgeon, scrub nurse, circulating nurse, or nurse anesthetist.		
Exposure route:	Dermal and inhalation		
Physical form:	Vapor		
Personal sampling data:	ColostomyScrub nurse: 0.005 (ppm)Circulating nurse: 0.004 (ppm)Laparoscopic cholecystectomyScrub nurse: 0.004 (ppm)Circulating nurse: 0.006 (ppm)Left carotid endarterectomyScrub nurse: 0.006 (ppm)Circulating nurse: 0.005 (ppm)Total hip replacementSurgeon: 0.005-0.006 (ppm)Nurse anes- thetist: 0.006 (ppm)Circulating nurse: 0.005 (ppm)Total knee replacementSurgeon: 0.006 (ppm)Circulating nurse: 0.005 (ppm)Cystoscopy-TURPSurgeon: 0.007 (ppm)Circulating nurse: 0.006 (ppm)MastectomyScrub nurse: nondetect - 0.005 (ppm)Circulating nurse: 0.005 (ppm)Triple bypassSurgeon: 0.008 (ppm)Circulating nurse: 0.008 (ppm)Takedown ColostomyScrub nurse: 0.004 (ppm)Shoulder Bankhart RepairNurse anesthetist: 0.005 (ppm)Anal FistulaSur- geon: 0.005 (ppm)Excision Lipoma Right HipSurgeon: 0.009 (ppm)Left Thyroid LobectomySurgeon: 0.006 (ppm)		
Area sampling data:	Colostomy: 0.004 (ppm)Left Carotid Endarterectomy: 0.003 (ppm)Total Hip Replacement: 0.004-0.005 (ppm)Total Knee Replacement: 0.005 (ppm)Cystoscopy- TURP: 0.008 (ppm)Mastectomy: nondetect-0.004 (ppm)Triple Bypass: 0.006 (ppm)Takedown Colostomy: 0.003 (ppm)Shoulder Bankhart Repair: 0.005 (ppm)Anal Fistula: 0.003 (ppm)Excision Lipoma Right Hip: 0.006 (ppm)Left Thyroid Lobectomy: 0.003 (ppm)Background Outside of OR: 0.008 (ppm)Background in Empty OR: 0.002 (ppm)		
Number of workers:	Approximately 150 employees are on the payroll in the surgery department.		
Engineering control:	NIOSH recommends a combination of local exhaust ventilation and and general room ventilation.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evalu- ated.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The data are more than 10 years but generally, no more than 20 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure durations and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by comparing results from different procedures and worker activi- ties. Uncertainty is not addressed.
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Formaldehyde

Occupational Exposure

HERO ID: 8684534 Table: 1 of 1

...continued from previous page

Study Citation:		NIOSH, (n.d.). Niosh health hazard evaluation report- Morton Plant Hospital.		
HERO ID:		8684534		
Conditions of Use:		Laboratory chemical		
Domain		Metric	EVALUATION Rating	Comments
Overall Quality Determination			High	

Study Citation:	NIOSH, (2006). Niosh health hazard evaluation report- Bower Corporation.			
HERO ID:	8684535			
Conditions of Use:	Processing aids, not otherwise listed			
EXTRACTION				
Parameter	Data			
Worker activity description:	Metal workers in the following departments: heat treating, turning, race grinding, surface grinding, roll grinding, tool and die, maintenance, training, outdoor operations, and cone grinding. (26/28)			
Exposure route:	inhalation, dermal (13/28)			
Physical form:	vapor, fluid (11/28)			
Personal sampling data:	Personal samples for formaldehyde ranged form ND-0.06 ppm. (26/28)			
Area sampling data:	Area samples for formaldehyde ranged from ND-Trace amounts. (26/28)			
Exposure duration:	8 hours (8/28)			
Number of workers:	250 people (8/28)			
Personal protective equipment:	Some employees reported using nitrile gloves, and short sleeves to prevent wicking. (17/28)			
Engineering control:	Exhaust ventilation for the oil quenching operation is provided by a canopy hood located about 10 feet above the quenching oil. (8/28) Most of the metal processing machines have mist collectors. (16/28)			
Comments:	Table 6HETA 2004-0399-3007Formaldehyde Sample Results			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for metalworking fluids, which is similar to the in-scope occupational scenario processing aids not otherwise listed.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different worker activities during different days.
Overall Quality Determination		High		

Study Citation:	NIOSH, (2003). Niosh health hazard evaluation report- Bemis.		
HERO ID:	8684536		
Conditions of Use:	Plastic material and resin manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	Extruding plastic materials together, hardening mat boards in mold-making machines using a heated process, using hardened mat boards to make rubber printing plates, heat-sealing plastic films to make plastic bags for packaging.		
Exposure route:	Dermal and inhalation		
Physical form:	Gas		
Personal sampling data:	Floater: 0.04 ppmBag machine #42: 0.06 ppmBag machine #37: 0.09 ppmBag machine #25: 0.04 ppm		
Area sampling data:	Column 26, near bag machine #10: 0.06 ppm		
Exposure duration:	8 hours/day		
Exposure frequency:	5 days/week		
Number of workers:	600 total employees50 people work in the extrusion department230 people work in the press department170 people work in the bag department		
Engineering control:	The automated bag machines in the bag department are equipped with local exhaust ventilation.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling and analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	U.S. data
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The data was collected in 2002-2003, after the most recent PEL but more than 20 years ago.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sam-pledsite or sector. The uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		High	

Study Citation:	NIOSH, (1976). Health hazard evaluation: Hersey Products Company, Inc.			
HERO ID:	8688008			
Conditions of Use:	Adhesive			
EXTRACTION				
Parameter	Data			
Worker activity description:	Metal pouring, furnace tending			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	The measured concentrations of formaldehyde, evolved from the exothermic curing and thermal decomposition of bonding agents used in the core sand, did not exceed the evaluation criteria (2ppm ceiling).			
Exposure duration:	8-10 hour workday			
Number of workers:	seven core-makers, fourteen molders, and ten utility-men			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Study conducted by NIOSH using their methods to measure formaldehyde.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for formaldehyde from the curing of the adhesive, which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	No values given, just indication that it did not exceed evaluation criteria
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, butlacks additional metadata, such as exact measurement, sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1976). Health hazard evaluation determination: Masonite Corporation.			
HERO ID:	8688419			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Saw operators (21/27)			
Exposure route:	inhalation, dermal (6-7/27)			
Physical form:	exposure to wood dust generated by the woodworking machinery. The gaseous contaminants included formaldehyde and phenolic vapours released during the sawing and sanding of the Masonite board (3/27)			
Area sampling data:	Area samples for formaldehyde ranged from 0.09-0.17 mg/m3. (21/27)			
Exposure duration:	8 hours/day (8/27)			
Number of workers:	Approximately 88 persons are employed in the plant, with 54 of those being classified as production workers; 25 employees are "directly affected" by the alleged hazard. (2/27)			
Engineering control:	All machinery, except punch presses, are ventilated by a typical woodworking extract system. It consists of hoods for the pickup of wood dust and chips at the machines, ductwork, a collection device (cyclone), a storage bin, and a fan blower to supply air for conveying purposes. (3/27)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesives and sealants in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1976). Health hazard evaluation: Rock Hill Printing and Finishing Company.			
HERO ID:	8688438			
Conditions of Use:	Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	One or two operators/shift work at the starting end of the hot frame lines tending the water boxes and dryer cans with an offtake operator working each of the lines or a total of four/shift. The emissions which are the source of employee complaints occur as the fabric leaves the hot frame dryer tunnel at the offtake end of the line. (3/32)			
Exposure route:	inhalation (1/32)			
Physical form:	vapors (4/32)			
Area sampling data:	Area samples for formaldehyde ranged from 0.09-0.21 mg/m3 (21/32)			
Exposure duration:	8 hours/day and three separate shifts/day (2/32)			
Exposure frequency:	day, 5 days/week, days/yr. not specified (2/32)			
Number of workers:	10 administrative, 86 production, and 2 maintenance workers (2/32)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for finishing agents in textile manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data is over 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure duration and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling on different days at different locations.
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 8688540 Table: 1 of 1

Study Citation:	NIOSH, (1976). Health hazard evaluation determination: Rycraft, Inc..			
HERO ID:	8688540			
Conditions of Use:	Likely source is combustion as formaldehyde is not a chemical included in the glaze.			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Kiln Room 0.16 ppmKiln Room 0.07 ppm			
Engineering control:	A local exhaust ventilation system directly over the kilns to capture the gases as they are emitted was recommended.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (ceramic manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1976 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, and sample durations, but lacks additional metadata, such as exposure duration, exposure frequency, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability was not discussed, but results from individual sampling events were provided which could be used to evaluate variability between different sampling days. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1976). Health hazard evaluation determination: Welch Plastics and Manufacturing Company.
HERO ID:	8688557
Conditions of Use:	Plastic material and resin manufacturing

EXTRACTION	
Parameter	Data
Worker activity description:	Press operator, trimming, and relief operator
Exposure route:	Inhalation
Area sampling data:	Top of Press #22: 0.51 mg/m ³ Back Side of Press #22: nondetectFront Side of Press #22: nondetectTop of Press #22: nondetectBack Side of Press #22: nondetectFront Side of Press #22: 0.44 mg/m ³
Exposure duration:	8 hours per day
Number of workers:	120
Engineering control:	Recommendation- Local exhaust ventilation should be used for molding operations.

		EVALUATION		
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Study was done by NIOSH so assumed approved NIOSH method.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	Data are for plastic material and resin manufacturing, which is an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	The data were collected before the most recent PEL establishment.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure frequency.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The uncertainty can be determined from the sampling and analytical method	

Overall Quality Determination	High

Formaldehyde

Occupational Exposure

HERO ID: 8688637 Table: 1 of 1

Study Citation: NIOSH, (1975). Health hazard evaluation determination: The Timken Company.
HERO ID: 8688637
Conditions of Use: Coolant

EXTRACTION

Parameter	Data
Worker activity description:	Operator grinders, maintenance mechanics, process checkers, and inspectors at a railroad bearing plant. (2/16)
Exposure route:	dermal, inhalation (3/16)
Physical form:	coolant mist (1/16)/
Personal sampling data:	Total coolant mist concentrations during personal sampling was 5.49-6.07 mg/m3. (7/16)
Area sampling data:	Formaldehyde was not detected by area sampling/ (7/16).
Number of workers:	100 men worked in the affected area (2/16)
Personal protective equipment:	The grinders were furnished with gloves and aprons on a voluntary but free basis. Respirators were said to be available but were not used. Aprons were said to be changed several times a week . Maintenance men were furnished coveralls. Skin barrier creams (Kerodex and Silicate) were available for use but rarely used. (2/16)
Engineering control:	In the grinding area general room ventilation was in operation but not machine local exhaust ventilation. (2/16)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from the U.S.
	Metric 3: Applicability	Uninformative	Data are for process coolants, which isn't in the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (average) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Exposure type, worker info, and sampling data provided, but missing exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by comparing night vs day shift and different operating machines.

Overall Quality Determination

Uninformative

Formaldehyde

Occupational Exposure

HERO ID: 8688937 Table: 1 of 1

Study Citation:	NIOSH, (1974). Health hazard evaluation determination: Osborne Photographic Laboratories, Inc..			
HERO ID:	8688937			
Conditions of Use:	Photographic Supplies			
EXTRACTION				
Parameter	Data			
Worker activity description:	Preparing batch stock solutions; black and white hand printing			
Exposure route:	Dermal and inhalation			
Physical form:	Vapor			
Area sampling data:	Samples in the loft area and hand printing room were non-detects.			
Exposure duration:	Preparing a batch stock solutions takes 10-15 minutes.			
Number of workers:	3 employees prepare batch stock solutions. 2 employees are engaged in black and white hand printing.			
Personal protective equipment:	Rubber gloves are available in black and white hand print			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Study done by NIOSH, therefore presume methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario (photographic supplies) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty can be addressed by sampling/analytical method but variability not addressed.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1973). Health hazard evaluation: Western Foundry Company.			
HERO ID:	8689187			
Conditions of Use:	Solvents used as industrial processing aids			
EXTRACTION				
Parameter	Data			
Worker activity description:	Creating iron cores (page 2 of 4)			
Exposure route:	Inhalation, dermal (page 2 and 4 of 4)			
Physical form:	Vapor (page 2 of 4) and liquid (page 4 of 4)			
Personal sampling data:	Formaldehyde concentrations during a complete core cycle (ppm):Normal sand: 0.07Warm sand: 0.08Hot sand: 0.33(page 3 of 4. See page 4 of 4 for additional discussion)			
Exposure duration:	One hour per core production cycle (page 4 of 4)			
Number of workers:	Three - "One person works on this process each shift (two shifts), in addition to a cleanup man on the second shift." (page 2 of 4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for solvents used as industrial processing aids, which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a mean with no other statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Limited uncertainty is addressed by sampling methods. Limited variability addressed by considering different work processes.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1973). Health hazard evaluation: Robin Products Company.			
HERO ID:	8689205			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Injection molding machine operators (6/23)			
Exposure route:	inhalation (5 and 10/23)			
Physical form:	vapor (5 and 10/23)			
Personal sampling data:	Results of continuous samples for formaldehyde obtained in the breathing zone of workers ranged from 0.01 to 0.10 ppm while static samples in the area ranged from 0.01 to 0.53 ppm. (5 and 19-20/23)			
Area sampling data:	Results of continuous samples for formaldehyde obtained in the breathing zone of workers ranged from 0.01 to 0.10 ppm while static samples in the area ranged from 0.01 to 0.53 ppm. (5 and 19-20/23)			
Exposure duration:	8 hours/day (13/23)			
Number of workers:	65 employees (8/23)			
Comments:	See page 12 of 23 for description of sampling method; I was unsure whether some of the data tables were personal or area sampling			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1972). Health hazard evaluation: May Foundry.			
HERO ID:	8689271			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Production of no-bake resin cores and molds.			
Exposure route:	Inhalation.			
Personal sampling data:	Core maker: 0.35 (mg/m^3)			
Area sampling data:	No-bake core making operation: 0.24-0.91 (mg/m^3)			
Personal protective equipment:	NIOSH recommends the use of rubber gloves.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The data were collected before the most recent PEL establishment and are more than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site. The uncertainty can be determined from the sampling and analytical method.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1989). HETA-1989-0030-2198: Delco Remy, Olathe, Kansas.			
HERO ID:	8724592			
Conditions of Use:	Fuels and related products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Reportedly, the area whose employees complained most often was the Paste Department. In this department, a series of manufacturing lines place lead paste on the battery plates. The plate molding and pasting process is virtually automatic except at the end of the process line where employees inspect, remove, and stack the plates on pallets to be transported to other areas of the plant. Most of the complaints in the department were reported to come from the employees performing the inspection jobs. (3/16)			
Exposure route:	inhalation (14/16)			
Area sampling data:	Formaldehyde was not detected in the area samples with an LOD of 0.04 ppm. (7/16)			
Exposure duration:	8-10 hours/day (6/16)			
Engineering control:	Air is supplied to the pasting department with large air handling units and supply outside air. (3/16)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for commercial use of fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Exposure type, sampling, and engineering controls provided, but missing worker information, exposure frequency, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 8724595 Table: 1 of 1

Study Citation: NIOSH, (1990). HETA-1990-0048-2253: Haute Nails, Norman, Oklahoma.
HERO ID: 8724595
Conditions of Use: Cosmetics

EXTRACTION

Parameter	Data
Worker activity description:	Nail sculptors and receptionists. (3/19)
Exposure route:	inhalation, dermal (9/19)
Physical form:	dusts, solvents (4/19)
Area sampling data:	Sample results showed a trace concentration of airborne formaldehyde indoors. The sample was collected near the front center of the nail salon and the concentration found was above the analytical limit of detection (LOD) but below the limit of quantitation (LOQ) and is estimated to be about 0.014 ppm. The outdoors formaldehyde concentration in the courtyard of the adjoining building was below the LOD. (11/19)
Number of workers:	6 employees (3/19)
Engineering control:	This nail and tanning salon is served by an air-conditioning system which provides heating and cooling for the business. (3/19)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Uninformative	Data are for cosmetics, a non-TSCA use.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Sampling data, exposure type, and worker activity provided, but missing exposure duration, frequency, and PPE.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.

Overall Quality Determination

Uninformative

Formaldehyde

Occupational Exposure

HERO ID: 8724597 Table: 1 of 1

Study Citation: NIOSH, (1990). HETA-1990-0047-2237: Jags Beauty Salon, Norman, Oklahoma.
HERO ID: 8724597
Conditions of Use: Personal care products

EXTRACTION

Parameter	Data
Worker activity description:	Hair styling and hair care.
Exposure route:	Dermal and inhalation.
Physical form:	Gas
Area sampling data:	The airborne formaldehyde level in the facility was found to be 0.027 (ppm).
Exposure duration:	The salon is open 12 hours a day.
Number of workers:	One full-time and one part-time cosmetologist are employed at the facility.
Engineering control:	NIOSH recommends an exhaust fan to be installed coupled with an outside air supply duct.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH method 3500
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	Uninformative	The data are for an occupational scenario outside the scope of the risk evaluation (NON-TSCA).
	Metric 4: Temporal Representativeness	Low	The data were collected before the most recent PEL establishment
	Metric 5: Sample Size	Medium	Only 2 samples taken with just 1 inside the salon.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The monitoring study does not address variability and uncertainty can be determined from the sampling and analytical method.

Overall Quality Determination

Uninformative

Study Citation:	NIOSH, (1991). HETA-1991-0003-2232: Scott Molders, Kent, Ohio.			
HERO ID:	8724609			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Production workers at a plastic press molding facility. (2/20)			
Exposure route:	inhalation and skin absorption (4/20)			
Physical form:	gas (4/20)			
Area sampling data:	No formaldehyde was detected with an LOD of 1.6 ppm. (7/20)			
Exposure duration:	The length of the average work day was seven hours, with additional time for two 10- minute rest-breaks, a 30-minute lunch, and five minutes at the end of the day for clean-up. (2/20)			
Number of workers:	70 workers (2/20)			
Personal protective equipment:	Several employees used gloves for protection from heat and abrasions. Employees stated that long-sleeve shirts were worn to protect their skin from fibrous glass material and to prevent itching. (7/20)			
Engineering control:	According to company personnel, all presses have exhaust vents and there is a complete room air change every three and one-half minutes in the area that contains only presses. (2/20)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for incorporation during plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1990). In-depth survey report: Evaluation of a ventilation system to control formaldehyde exposures during embalming at Cincinnati College of Mortuary Science, Cincinnati, Ohio.			
HERO ID:	8727994			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Applying formaldehyde-based gel to the face, hands, and feet of the anatomical body.			
Exposure route:	Inhalation			
Physical form:	Gas			
Personal sampling data:	Mean: 0.60 (ppm), n=32			
Area sampling data:	Means-Isolation room: 0.24 (ppm)Hallway: 0.21 (ppm)Laboratory Office: 0.18 (ppm)Exhaust duct outlet: 0.81 (ppm)			
Number of workers:	75,000			
Engineering control:	Local exhaust ventilation.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, butlacks additional metadata, such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site. The uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1984). In-depth survey report: Control technology for formaldehyde emissions at Dixie Furniture Plant, Lexington, North Carolina.			
HERO ID:	8728028			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Glue-urea-formaldehyde resin adhesive, core may be particleboard, fiberboard, or edge glued solid-wood lumber-core. In addition, the core may be banded with solid wood edges prior to veneering, which may use an adhesive containing formaldehyde (6/22)Press loaders and unloaders, core stockers, glue spreaders, glue mixers, stock pullers, and elevator operators. (19/22)			
Exposure route:	inhalation (4/22), dermal (5/22)			
Physical form:	vapor (7/22)			
Personal sampling data:	PBZ samples ranged from 0.12-0.71 ppm. (19/22).			
Area sampling data:	Area samples ranged from 0.11-1.78 ppm. (21/22)			
Dermal exposure data:	nan			
Number of workers:	The plant employed 900-1100 people, 90% of which were hourly production workers. 50 workers were assigned to the glue room, and less than 20 worked close to a hot press.(5/22)			
Engineering control:	The primary control was a row of six wall fans. In addition, the multiple-opening presses were located under canopy hoods and the RF press was surrounded by a ventilated enclosure. Two supply-air outlets had been installed in the unloading area of the large multiple-opening press. (12/22)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesive and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure duration, frequency and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by separating sampling statistics by department.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 8728030 Table: 1 of 2

Study Citation:	NIOSH, (1983). Preliminary survey report: Control technology for formaldehyde emissions at Drexel Heritage Plant 60, Morganton, North Carolina.			
HERO ID:	8728030			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Glue-spreaders, loaders, press operators, glue-mixers. (6/10)			
Exposure route:	inhalation, dermal (3/10)			
Physical form:	vapors (7/10)			
Personal sampling data:	One PBZ measured a concentration of 0.5 ppm formaldehyde [measured by insurance company](8/10)			
Area sampling data:	Area samples ranged from 0.5-3 ppm. (9/10)			
Exposure duration:	8.5 hours (4/10)			
Number of workers:	150 workers (4/10)			
Personal protective equipment:	Some workers in the glue room wear gloves and aprons, and the glue-mix man wears goggles. (8/10)			
Engineering control:	Canopy hoods are installed above the inspection platforms . Wall fans are installed along the wall bordering the panel press. A few ceiling vents are present. (7/10)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesive and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, butlacks additional metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1983). Preliminary survey report: Control technology for formaldehyde emissions at Drexel Heritage Plant 60, Morganton, North Carolina.			
HERO ID:	8728030			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Glue-spreaders, loaders, press operators, glue-mixers. (6/10)			
Exposure route:	inhalation, dermal (3/10)			
Physical form:	vapors (7/10)			
Personal sampling data:	2 measurements of feed through press loader and unloader were all less than 1ppm. Personal sampling for the operator of the large R/F press was 1.1 ppm (9/10)			
Area sampling data:	Area samples ranged from <0.5-3 ppm. (9-10/10)			
Exposure duration:	8.5 hours (4/10)			
Number of workers:	150 workers (4/10)			
Personal protective equipment:	Some workers in the glue room wear gloves and aprons, and the glue-mix man wears goggles. (8/10)			
Engineering control:	Canopy hoods are installed above the inspection platforms . Wall fans are installed along the wall bordering the panel press. A few ceiling vents are present. (7/10)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is P&CAM 354 using solid sorbent tubes as well as passive monitors. Report notes that the passive monitors method had not been validated by NIOSH at that time.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesive and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Preliminary survey report: Control technology for formaldehyde emissions at Hoosier Panel, New Albany, Indiana.			
HERO ID:	8728035			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	The loaders prepare a stack of sandwiched, plate/layer of boards/plate triplets—one triplet for each opening of the press—while the previous load is being pressed. When the press opens, they partially push-out the triplets of pressed panels so the unloaders on the other side of the press can grasp them, remove them from the press, and stack them on a cart. Then the loaders insert the next load into the now-empty openings. After the press is loaded and activated, and information about the current load of boards has been recorded on the production log, they begin preparing the next load. Meanwhile, the unloaders are separating the pressed panels from the caul plates, stacking the panels and standing the plates on edge on a wheeled plate rack. Then they move the stack of boards on roller conveyors towards the finishing area, push the rack of plates into the plate cooling room, and wait for the next load.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Peak formaldehyde concentrations ranging from less than 1 ppm to between 1 and 2 ppm were measured on the loading side of press 1.			
Exposure duration:	Production work hours are from 7:00 a.m. till 3:30 p.m., with a half hour for lunch. [8 hours/day]			
Number of workers:	At the time of the survey, 131 employees were working at the plant, down from a normal work force of 250. Sixteen of these were assigned to the glue room, the department which makes the veneered panels.			
Personal protective equipment:	Some of the workers in the glue room wear gloves and aprons. The glue-mix man wears an apron and, at certain times, goggles and gloves.			
Engineering control:	A canopy hood is installed over each press, extending 10 to 12 inches beyond the sides of the press. Some of the slot openings have baffles, which may have been inserted to increase slot velocity. Each hood is vented through a 14- or 16-inch circular duct to a separate fan on the roof. These hoods have been in place for over 35 years. There are also some fans in the ceiling above the presses. There are six wall fans in the plate cooling room, and some outside air is blown in through a grated floor. Since more air is exhausted from this room than is supplied from below, there is a net flow into the plate cooling room from the press area. Airflow across the glue room is further aided by auxiliary fans positioned throughout the room and open doors and windows along the southwest wall. Some of these fans are hung from the ceiling in fixed positions, generally blowing towards the plate cooling room; the others are set on the floor, often blowing away from the plate cooling room. The fans, intended to cool the workers, may still be operated in cool weather due to the heat given off from a steam-heated press; but the doors and windows are closed when the influx of outside air is no longer desired. Other than in the plate cooling room, there is no make-up air supply.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data are more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 8728035 Table: 1 of 1

...continued from previous page

Study Citation:		NIOSH, (1982). Preliminary survey report: Control technology for formaldehyde emissions at Hoosier Panel, New Albany, Indiana.		
HERO ID:		8728035		
Conditions of Use:		Adhesives and sealant chemicals in wood product manufacturing		
Domain		Metric	EVALUATION	
			Rating	Comments
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	NIOSH, (1974). Survey of Burlington Industries, Inc., Burlington House Finishing Plant, Form Fabrics Plant, Durham Domestics Plant, Brookneal Finishing Plant.			
HERO ID:	8728041			
Conditions of Use:	Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Yarning, weaving, bleaching, heat setting, finishing, cutting, sewing, preparation of distribution, dyeing, screen printing (7-9/26)			
Area sampling data:	Formaldehyde not directly measured, BCME is measured, which formaldehyde assists in forming (5/26)			
Number of workers:	55 to 1050 workers at each of 88 plants in operation. (6 and 8/26) At the Durham NC plant there are 1300 persons with 40 in finishing area (7/26).			
Engineering control:	Most of the plants visited appeared to be properly ventilated. All were said to meet the OSHA requirements of six air changes per hour for manufacturing plants' but time did not permit checking into this. Most were observed to be under slight negative pressure due to the large exhaust fans which are needed to vent the excessive moisture and heat in the drying and curing areas of the finishing frames. (10/26)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for finishing agents in textile manufacturing, an in-scope occupational scenario. However, data reported is not formaldehyde directly.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Only number of workers and engineering controls provided, no formaldehyde sampling or exposure information.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium		

Study Citation:	Nirlo, E.L., Crain, N., Corsi, R.L., Siegel, J.A. (2014). Volatile organic compounds in fourteen U.S. retail stores. Indoor Air 24(5):484-494.			
HERO ID:	2542987			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers in retail stores in Texas and Pennsylvania			
Exposure route:	inhalation			
Area sampling data:	Formaldehyde was detected indoors during every sampling event at concentrations that ranged from 4.6 +/- 0.3 ppb at a home improvement store in Pennsylvania to 67 +/- 8.3 ppb at an office supply store in Texas. Office and furniture stores exhibited the highest formaldehyde concentrations; it is likely that much of the formaldehyde originated from the pressed-wood furniture, displays, and carpet used in these stores. Average formaldehyde concentrations across all test visits in the current investigation (18.1 +/- 13.8 ppb) were significantly higher than concentrations observed in offices (13 +/- 7 ppb), but not significantly different from concentrations in residences (21 +/- 11 ppb). In this investigation, formaldehyde exceeded health guidelines in some stores. Outdoor formaldehyde samples were collected at test visits to a home improvement store and a general merchandise store, where the formaldehyde outdoor concentrations were 3.4 +/- 1.0 ppb (indoor-to-outdoor ratio = 1.4 +/- 0.8) and 2.6 +/- 0.3 ppb (indoor-to-outdoor ratio = 3.2 +/- 0.8), respectively.			
Engineering control:	ventilation with higher air exchange rates			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described methods
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	limited discussion on uncertainties
Overall Quality Determination		High		

Study Citation:	Noisel, N., Bouchard, M., Carrier, G. (2007). Evaluation of the health impact of lowering the formaldehyde occupational exposure limit for Quebec workers. Regulatory Toxicology and Pharmacology 48(2):118-127.			
HERO ID:	655882			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0-3.5 ppm (though Table 2 suggests that no workers are exposed to concentrations >2 ppm 8 hr TWA			
Number of workers:	143491			
Personal protective equipment:	wearing gloves			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - OECD member
	Metric 3:	Applicability	Low	Data are aggregated for all industries with a focus on does response which is not in-scope or similar to an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2007.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics range of values for different concentration bin, discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low		

Study Citation:	Norback, D., Wieslander, G., Edling, C. (1995). Occupational exposure to volatile organic compounds (VOCs), and other air pollutants from the indoor application of water-based paints. Annals of Occupational Hygiene 39(6):783-794.			
HERO ID:	1763128			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Painting newly renovated buildings and the sanding of paint			
Exposure route:	Inhalation			
Personal sampling data:	0.04-0.14 (mg/m^3)			
Number of workers:	12			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD member country
	Metric 3:	Applicability	High	The data are for painting, an in-scope COU
	Metric 4:	Temporal Representativeness	Low	Data was publish in 1995, which is more than 20 years old.
	Metric 5:	Sample Size	Medium	A range with arithmetic and geometric means are presented.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Sample type, exposure type, sample duration, exposure duration and worker activities described.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NRC (2014). Review of the Formaldehyde Assessment in the National Toxicology Program 12th Report on Carcinogens.			
HERO ID:	2526032			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Table 3-2 (Beane 2009) unknown so assuming area sampling:0.35 ppm mean (range 0.01-4.3 ppm) median peak 2 ppm (25% were exposed > 4ppm			
Number of workers:	25,619			
Comments:	Not primary source; data from 627726			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The data are for chemical plant worker exposure which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The study was published in 2014, the NCI study was based on measurements prior to 1980, prior to the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	mean, range and peak values provided along with an estimate of the fraction exposed to concentrations > 4 ppm	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no metadata provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 2526032 Table: 2 of 10

Study Citation:	NRC (2014). Review of the Formaldehyde Assessment in the National Toxicology Program 12th Report on Carcinogens.			
HERO ID:	2526032			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Table 3-2 (Bertazzi 1989) unknown so assuming area sampling: peak >3.0 ppm mean			
Number of workers:	1,332			
Comments:	Not primary source; data is from 1314506			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Italy - an OECD member
	Metric 3:	Applicability	High	The data are for resin manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 2014, the Italian study was published in 1989, before prior to the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	only a peak value was noted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 2526032 Table: 3 of 10

Study Citation:	NRC (2014). Review of the Formaldehyde Assessment in the National Toxicology Program 12th Report on Carcinogens.			
HERO ID:	2526032			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Table 3-2 (Andjelkovich 1995) unknown so assuming area sampling: exposure assignments: high = 1.5 ppm median; medium 0.55 ppm median; Lose 0.05 ppm median			
Number of workers:	8147			
Comments:	Not primary data; Data is from 192405			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The data are for foundry core making which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The study was published in 2014, but the Michigan data are from 1960-1987 prior to the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Low	only median values are provided for three exposure bins.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no metadata provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	NRC (2014). Review of the Formaldehyde Assessment in the National Toxicology Program 12th Report on Carcinogens.			
HERO ID:	2526032			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Garment industry workers			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Table 3-2 (Meyers 2013) 0.15 geometric mean (Range 0.09-0.20 ppm 8-hr TWA geometric mean)			
Number of workers:	549			
Comments:	Not primary source; data is from 93085			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for garment workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The study was published in 2014, the Meyers study was published in 2013 based on measurements from a 2004 study, after the most recent PEL (1992) and greater than 10 and less than 20 years old.
	Metric 5:	Sample Size	Medium	geometric mean, and range of 8 hr TWA geometric means
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	NRC (2014). Review of the Formaldehyde Assessment in the National Toxicology Program 12th Report on Carcinogens.			
HERO ID:	2526032			
Conditions of Use:	Leather Finishing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Tannery workers			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Unknown but as this is a semiquantitative assessment is assumed to be based on area sampling: Table 3-2 (Stern 2003) 2.45 mean (Range 0.5-7.0 ppm)			
Number of workers:	9,352			
Comments:	Not primary source			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for tannery workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 2014, the Stern study was published in 2003 based on measurements from a 1987 study, prior to the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	mean and range data provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 2526032 Table: 6 of 10

Study Citation:	NRC (2014). Review of the Formaldehyde Assessment in the National Toxicology Program 12th Report on Carcinogens.			
HERO ID:	2526032			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Unknown but assumed to be based on area sampling: Table 3-11 (Hosgood 2013) 1.38 ppm mean (Range 0.63-2.51 ppm)			
Number of workers:	43			
Comments:	Not primary source			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown	
	Metric 3: Applicability	High	The data are for workers exposed to melamine resins which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The study was published in 2013, after the most recent PEL (1992) and less than 10 years old.	
	Metric 5: Sample Size	Medium	mean and range data provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no metadata provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.	
Overall Quality Determination		Medium		

Study Citation:	NRC (2014). Review of the Formaldehyde Assessment in the National Toxicology Program 12th Report on Carcinogens.
HERO ID:	2526032
Conditions of Use:	Compressed Wood Product Manufacturing

EXTRACTION	
Parameter	Data
Worker activity description:	Fiberboard manufacture
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	Unknown but assumed to be based on area sampling: Table 3-11 (Aydin 2013) 0.20+/- 0.06 ppm 8 hr TWA (Range 0.10-0.33 ppm)
Number of workers:	46

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for the manufacture of fiberboard which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The study was published in 2013, after the most recent PEL (1992) and less than 10 years old.
	Metric 5:	Sample Size	High	mean, standard error and range data provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range and standard error data that can be used to evaluate variability. Information about uncertainty was not provided.

Overall Quality Determination	Medium

Study Citation:	NRC (2014). Review of the Formaldehyde Assessment in the National Toxicology Program 12th Report on Carcinogens.			
HERO ID:	2526032			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Pathology anatomy workers			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Unknown but assumed to be based on area sampling: Table 3-11 (Costa 2013) 0.36+/- 0.03 ppm 8 hr TWA (Range 0.23-0.69 ppm)			
Number of workers:	35			
Comments:	Not primary source			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Portugal: an OECD member.	
	Metric 3: Applicability	High	The data are for pathology anatomy workers which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The study was published in 2013, after the most recent PEL (1992) and less than 10 years old.	
	Metric 5: Sample Size	High	mean, standard error and range data provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no metadata provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided range and standard error data that can be used to evaluate variability. Information about uncertainty was not provided.	
Overall Quality Determination		Medium		

Study Citation:	NRC (2014). Review of the Formaldehyde Assessment in the National Toxicology Program 12th Report on Carcinogens.			
HERO ID:	2526032			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Unknown but assumed to be based on area sampling: Table 3-11 (Jakab 2010) 0.9 mg/m3 8 hr TWA			
Number of workers:	37 female			
Comments:	Not a primary source.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Hungary: an OECD member.
	Metric 3:	Applicability	High	The data are for female pathology anatomy workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The study was published in 2010, after the most recent PEL (1992) and approximately 10 years old.
	Metric 5:	Sample Size	Medium	only TWA provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 2526032 Table: 10 of 10

Study Citation:	NRC (2014). Review of the Formaldehyde Assessment in the National Toxicology Program 12th Report on Carcinogens.			
HERO ID:	2526032			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Table 3-2 (Hauptmann 2009) unknown so assuming area sampling: 1.5-1.8 ppm average; 8.1-10.5 average peak exposure			
Comments:	Not primary source; data is from 626498			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The study was published in 2009, but focused on deaths that occurred from 1960-1986, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Range of average exposure and average peak values provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 192157 Table: 1 of 5

Study Citation:	NRC, (1981). Formaldehyde and other aldehydes. :1-340.		
HERO ID:	192157		
Conditions of Use:	Textile Finishing		
EXTRACTION			
Parameter	Data		
Area sampling data:	0 - 2.7 ppm (mean 0.68)		
Comments:	Table 5-2 "Formaldehyde Measurements in Occupational Environments" (pg 55 of 384)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	Data are from the U.S.
Metric 3:	Applicability	High	Data are for textile plant, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness	Low	Published in 1981. The completed exposure or risk assessment is more than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics ([state statistics, e.g., min, max, mean]) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low	

Study Citation:	NRC, (1981). Formaldehyde and other aldehydes. :1-340.			
HERO ID:	192157			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.9 - 2.7 ppm			
Comments:	Table 5-2 "Formaldehyde Measurements in Occupational Environments" (pg 55 of 384)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for garment factory, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Published in 1981. The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (e.g., min, max, mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 192157 Table: 3 of 5

Study Citation:	NRC, (1981). Formaldehyde and other aldehydes. :1-340.			
HERO ID:	192157			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.9 - 3.3 ppm			
Comments:	Table 5-2 "Formaldehyde Measurements in Occupational Environments" (pg 55 of 384)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for clothing store, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Published in 1981. The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (e.g., min, max) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 192157 Table: 4 of 5

Study Citation:	NRC, (1981). Formaldehyde and other aldehydes. :1-340.			
HERO ID:	192157			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.04 - 10.9 ppm			
Comments:	Table 5-2 "Formaldehyde Measurements in Occupational Environments" (pg 55 of 384)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for laminating plants, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Published in 1981. The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Low	Sample distribution characterized by limited statistics (e.g., min, max) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 192157 Table: 5 of 5

Study Citation:	NRC, (1981). Formaldehyde and other aldehydes. :1-340.			
HERO ID:	192157			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.09 - 5.26 ppm (mean 0.25 - 1.39)			
Comments:	Table 5-2 "Formaldehyde Measurements in Occupational Environments" (pg 55 of 384)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Published in 1981. The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (e.g., min, max, mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	NRDC, (2020). Comments of the Natural Resources Defense Council on EPA’s draft scope of the risk evaluation for formaldehyde.			
HERO ID:	10370217			
Conditions of Use:	Building/construction materials not covered elsewhere			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation and Dermal.			
Physical form:	Liquid or vapor [PDF Pg. 56].			
Area sampling data:	In several of the studies, indoor air in mobile homes was as high as 5000 ppb (roughly equivalent to 6 thousand ug/cubic meter). [PDF Pg. 28]			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (max) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing sample methods, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: Formaldehyde Manufacture			
Number of sites:	2			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Plant 2 summer 0.6 ppm mean (range 0.03-1.9 ppm geometric means); Plant 10 summer: 0.7 ppm (range 0.6-0.8 ppm geometric means)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for formaldehyde manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1983, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average value and range data for geometric means.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	A range of values was provided that could be used to evaluate variability, but there was no discussion of uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: Paraformaldehyde packaging			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.55 ppm mean (range < 0.25-0.85)			
Area sampling data:	1.17 ppm mean (range 0.28-3.4 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for paraformaldehyde packaging manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1983, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average value and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	A range of values was provided that could be used to evaluate variability, but there was no discussion of uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 3 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: Formaldehyde production			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Production operator 1.4 ppm mean; Laboratory technician 1.31 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for formaldehyde production which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by an average value.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 4 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: Formaldehyde production			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.9 ppm mean (range 0.4-2.8 ppm)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for formaldehyde production which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The data were published in 2002, after the most recent PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average value and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The provided range data can be used to evaluate variability but the study does not address uncertainty.
Overall Quality Determination			Low	

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: Formaldehyde production			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Oxidation 1.0 ppm mean (range 0.01-1.7 ppm); Storage 1.1 ppm mean (range 0.02-1.5 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	China - not an OECD member	
	Metric 3: Applicability	High	The data are for formaldehyde production which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The data were published in 1999, after the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by an average value and range data for two operations.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The provided range data for two different operations which can be used to evaluate variability but the study does not address uncertainty.	
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: Formaldehyde workshops			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1994: 0.8 ppm mean; 1995: range 0-2.3 ppm; 1995: range 0-3.0 ppm; 1996: 2.1 ppm mean (range 0.2-6.5 ppm); 2006: 0.024 ppm mean (range 0.018-0.036 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	China - not an OECD member	
	Metric 3: Applicability	High	The data are for formaldehyde workshops which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The data were published from 1995-2007, after the most recent PEL (1992) and up to 25 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by an average value and/or range data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The provided range data for multiple years which can be used to evaluate variability but the study does not address uncertainty.	
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: Formaldehyde and resin production			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.2 ppm mean (range 0.04-0.4 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - an OECD member
	Metric 3:	Applicability	High	The data are for formaldehyde and resin production which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were from 1979-1985, prior to the most recent PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average value and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The provided range data which can be used to evaluate variability but the study does not address uncertainty.
Overall Quality Determination			Low	

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: Formaldehyde production			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.3 ppm mean			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - an OECD member
	Metric 3:	Applicability	High	The data are for formaldehyde production which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were from 1980s, prior to the most recent PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average value
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: Resin production			
Number of sites:	6			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Plant 1 summer: 3.4 ppm mean (range 0.2-13.2 ppm geometric mean); Plant 6 summer: 0.2 ppm mean (range 0.1-0.2 ppm geometric mean); Plant 7 summer: 0.2 ppm mean (range 0.1-0.3 ppm geometric mean); Plant 7 winter: 0.6 ppm mean (range 0.4-0.9 ppm geometric mean); plant 8 summer: 0.4 ppm mean (range 0.2-0.8 ppm geometric mean); Plant 8 winter: 0.1 ppm mean (range 0.1-0.2 ppm geometric mean); Plant 9 summer: 14.2 ppm mean (range 4.1-30.5 ppm geometric mean); Plant 9 winter: 1.7 ppm mean (range 1.1-2.5 ppm geometric mean); Plant 10 summer: 0.7 ppm mean (range 0.3-1.2 ppm geometric mean)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - an OECD member
	Metric 3:	Applicability	High	The data are for formaldehyde production which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were from 1983-84, prior to the most recent PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average value and range of geometric means
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The average values and range of geometric means for 6 different plants in summer and/or winter can be used to evaluate variability but there was no discussion of uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 10 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: resin and plastic materials production			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1.39 ppm mean			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for resin and plastic materials production which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were from 1980, prior to the most recent PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average value
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 11 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: resin production (1981-82)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Furan resin 2.3 ppm mean (range 1.0-3.4 ppm); maintenance 2.9 ppm mean (range 1.4-5.5 ppm); UF resin 0.7 ppm mean (range 0.6-0.8 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for resin production which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were from 1981-82, prior to the most recent PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average value and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The provided range data which can be used to evaluate variability but the study does not address uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 12 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: Particleboard production			
Process description:	Regardless of the type of fiber used, the manufacturing process is basically the same: (1) the wood fiber is bonded together with a thermosetting resin to form a mat, (2) the mat is hot pressed, and (3) the pressed mat is then cooled and allowed to mature. The wood fibers typically are bonded with UF, MF, MUF, or PF resins. During hot pressing, the mat is heated and compacted to the desired density and thickness, and the resin polymerizes to bind the particles and stabilize the panel.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	particleboard 0.46 ppm median geometric mean; MDF production 0.33 ppm median geometric mean; OSB production 0.04 ppm median geometric mean			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	various unknown locations
	Metric 3:	Applicability	High	The data are for particleboard production which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The study was published in 2007, after the most recent PEL (1992) and over 10 but less than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by the median geometric mean
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: Particleboard worker			
Process description:	Regardless of the type of fiber used, the manufacturing process is basically the same: (1) the wood fiber is bonded together with a thermosetting resin to form a mat, (2) the mat is hot pressed, and (3) the pressed mat is then cooled and allowed to mature. The wood fibers typically are bonded with UF, MF, MUF, or PF resins. During hot pressing, the mat is heated and compacted to the desired density and thickness, and the resin polymerizes to bind the particles and stabilize the panel.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.69 ppm mean (range 0.17-2.93 ppm TWA)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for particleboard worker which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1988, prior to the most recent PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by the mean and range of TWAs
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study included a range of TWAs that can be used to evaluate variability but does not account for uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 14 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: OSB plant			
Process description:	Regardless of the type of fiber used, the manufacturing process is basically the same: (1) the wood fiber is bonded together with a thermosetting resin to form a mat, (2) the mat is hot pressed, and (3) the pressed mat is then cooled and allowed to mature. The wood fibers typically are bonded with UF, MF, MUF, or PF resins. During hot pressing, the mat is heated and compacted to the desired density and thickness, and the resin polymerizes to bind the particles and stabilize the panel.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	< 0.05 ppm mean			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Canada - OECD member	
	Metric 3: Applicability	High	The data are for an OSB plant which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The study is based on data form the 1990’s, prior to the most recent PEL (1992) and over 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a mean value	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: Particleboard sanding			
Process description:	Regardless of the type of fiber used, the manufacturing process is basically the same: (1) the wood fiber is bonded together with a thermosetting resin to form a mat, (2) the mat is hot pressed, and (3) the pressed mat is then cooled and allowed to mature. The wood fibers typically are bonded with UF, MF, MUF, or PF resins. During hot pressing, the mat is heated and compacted to the desired density and thickness, and the resin polymerizes to bind the particles and stabilize the panel.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	range 0.187-0.783 ppm)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for particleboard sanding which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1986, prior to the most recent PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study included range data that can be used to evaluate variability but does not account for uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 16 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: Fiberboard production			
Process description:	Regardless of the type of fiber used, the manufacturing process is basically the same: (1) the wood fiber is bonded together with a thermosetting resin to form a mat, (2) the mat is hot pressed, and (3) the pressed mat is then cooled and allowed to mature. The wood fibers typically are bonded with UF, MF, MUF, or PF resins. During hot pressing, the mat is heated and compacted to the desired density and thickness, and the resin polymerizes to bind the particles and stabilize the panel.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	2003 0.34 ppm (range 0.09-0.7 ppm); 2005 0.33 ppm (range 0.11-2.6 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for fiberboard production which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study data were from 2003 and 2005, after the most recent PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean value and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study included range data that can be used to evaluate variability but does not account for uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 17 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: plywood mill			
Process description:	Regardless of the end product, the process generally consists of five steps: gluing, pressing, drying, finishing, and storage. Adhesives used in this industry can be made of UF, MF, MUF, or PF resins.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Patching 0.06 ppm mean (range 0.02-0.08 ppm); feeding of drying machine 0.05 ppm mean (range 0.01-0.12 ppm); Forklift driving 0.06 ppm mean (range 0.02-0.16 ppm); Scaring 0.11 ppm mean (range 0.06-0.2 ppm); Assembly Machine 1 0.24 ppm mean (range 0.08-0.66 ppm); Assembly Machine 2 0.12 ppm mean (range 0.08-0.22 ppm); Hot pressing 0.11 ppm mean (range 0.07-0.19 ppm); Glue preparation 0.12 ppm mean (range 0.06-0.19 ppm); Finishing 0.07 ppm mean (range 0.06-0.11 ppm); Carrying plywood piles 0.05 ppm mean (range 0.04-0.06 ppm); Finishing 0.04 ppm mean (range 0.01-0.06 ppm);			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD member
	Metric 3:	Applicability	High	The data are for plywood mill which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study is derived from data from 1996-97. After the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average value and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study included range data that can be used to evaluate variability but uncertainty was not documented
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 18 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: paper manufacturing- paper and paper board manufacture and coating preparations			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.51 & 1.0 ppm means for two datasets (range <0.01-3ppm)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for the manufacture of paper and paper products which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1980, prior to the latest PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by mean, median, and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The study includes range data that can be used to assess variability uncertainty probably considered in the NIOS method.
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 19 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	commercial			
EXTRACTION				
Parameter	Data			
Life cycle description:	Furnishing, Cleaning, and Treatment/Care products: Cabinetmaking			
Process description:	Most furniture is manufactured from either wood-based composite or hardwood, and the manufacturing process can be generalized into four steps: (1) processing (sawing, sanding, assembly, inspection), (2) painting, staining, or varnishing (mixing, applying, drying, sanding, repair), (3) upholstery and installation of hardware, and (4) packaging and shipping			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	max < 0.1 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - an OECD member
	Metric 3:	Applicability	High	The data are for furniture manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1986, prior to the latest PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by a maximum value
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substance in products not described by other codes: Pathology Autopsy room			
Process description:	Embalming is a procedure that delays the decomposition of a cadaver. To accomplish this, the embalmer injects into either the common carotid or femoral artery usually 12 to 18 L of an aqueous solution of formaldehyde at a concentration ranging from about 1.25% to 32%, depending on how much the body has changed since death			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	4.8 ppm mean (range 0.06-7.9 ppm)			
Personal protective equipment:	General work practices that will reduce exposure include closing jars promptly when not in use, prompt disposal of formaldehyde soaked rags, proper storage and disposal of products, and periodic equipment inspections. Personal protective equipment should be used during procedures involving high formaldehyde concentrations.			
Engineering control:	Methods to reduce formaldehyde exposure include product substitution and modifications of work areas and work practices. Work-station modifications that can reduce exposure include confining difficult embalming cases; physically separating embalming tasks from restoration tasks; installation and proper use of capture equipment at the source, such as hoods over the injection equipment; and design of work stations to ensure adequate ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Unknown
	Metric 3:	Applicability	High	The data are for pathology autopsy rooms which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1979, prior to the PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean value and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.				
HERO ID:	1041161				
Conditions of Use:	commercial				
EXTRACTION					
Parameter	Data				
Life cycle description:	Furnishing, Cleaning, and Treatment/Care products: Furniture Factory, Varnishing				
Process description:	Most furniture is manufactured from either wood-based composite or hardwood, and the manufacturing process can be generalized into four steps: (1) processing (sawing, sanding, assembly, inspection), (2) painting, staining, or varnishing (mixing, applying, drying, sanding, repair), (3) upholstery and installation of hardware, and (4) packaging and shipping				
Number of sites:	1				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	0.7 ppm mean				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.		
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden- an OECD member		
	Metric 3: Applicability	High	The data are for furniture manufacture which is an occupational scenario within the scope of the risk evaluation.		
	Metric 4: Temporal Representativeness	Low	The study was derived using data from 1980's, prior to the latest PEL (1992) and more than 20 years old.		
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a mean value.		
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No meta data were provided		
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.		
Overall Quality Determination		Low			

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 22 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	commercial			
EXTRACTION				
Parameter	Data			
Life cycle description:	Furnishing, Cleaning, and Treatment/Care products: Furniture Factories			
Process description:	Most furniture is manufactured from either wood-based composite or hardwood, and the manufacturing process can be generalized into four steps: (1) processing (sawing, sanding, assembly, inspection), (2) painting, staining, or varnishing (mixing, applying, drying, sanding, repair), (3) upholstery and installation of hardware, and (4) packaging and shipping			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Gluing: 0.3 ppm mean (range 0.07-1.0 ppm); Machining in finishing department: 0.3 ppm mean (range 0.1-0.9 ppm); Varnishing: 0.1.1 ppm mean (range 0.1-6.3 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Finland - an OECD member	
	Metric 3: Applicability	High	The data are for furniture manufacture which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The study was derived from data from 1981-1986 prior to the latest PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by an average value and range data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No meta data were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The data include range information which be used to evaluate variability, but uncertainty is not quantified	
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: wood based composite blocking			
Process description:	Regardless of the type of fiber used, the manufacturing process is basically the same: (1) the wood fiber is bonded together with a thermosetting resin to form a mat, (2) the mat is hot pressed, and (3) the pressed mat is then cooled and allowed to mature. The wood fibers typically are bonded with UF, MF, MUF, or PF resins. During hot pressing, the mat is heated and compacted to the desired density and thickness, and the resin polymerizes to bind the particles and stabilize the panel.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	2002 0.9 ppm (range 0.3-2.1 ppm); 2005 0.15 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for wood based composite blocking which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study data were from 2002 and 2005, after the most recent PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean value and range data for the 2002 data and just a mean values for the 2005 data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study included range data that can be used to evaluate variability but does not account for uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 24 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.				
HERO ID:	1041161				
Conditions of Use:	processing				
EXTRACTION					
Parameter	Data				
Life cycle description:	reactant: plywood production				
Process description:	Regardless of the end product, the process generally consists of five steps: gluing, pressing, drying, finishing, and storage. Adhesives used in this industry can be made of UF, MF, MUF, or PF resins.				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	0.3 ppm mean				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.		
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden - an OECD member		
	Metric 3: Applicability	High	The data are for plywood production which is an occupational scenario within the scope of the risk evaluation.		
	Metric 4: Temporal Representativeness	Low	The study was derived from data from 1980s, prior to the most recent PEL (1992) and more than 20 years old.		
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by an average value and range data		
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No meta data were provided		
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.		
Overall Quality Determination		Low			

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: plywood paneling manufacture			
Process description:	Regardless of the end product, the process generally consists of five steps: gluing, pressing, drying, finishing, and storage. Adhesives used in this industry can be made of UF, MF, MUF, or PF resins.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Winter 0.2 ppm geometric mean (range 0.08- 0.4 ppm); Summer 0.08 ppm geometric mean (range 0.01- 0.5 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for plywood manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study is based on data from 1983-84, prior to the most recent PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a geometric average value and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study included range data that can be used to evaluate variability but does not account for uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 26 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Incorporation into an article: paper manufacturing- Lamination and impregnation of paper with MF and PF resins			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	summer: 0.7 ppm geometric mean (range <0.01-7.4 ppm); Winter 0.3 ppm geometric mean (range 0.05-0.7 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for the manufacture of paper and paper products which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study is based on data from 1983, prior to the latest PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a geometric mean and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study includes season range data that can be used to assess variability but does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: Pulp and Paper industry			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Pulping 0.5 ppm mean (range 0.0 - 3.1 ppm); Newspring and uncoated paper 0.15 ppm mean (range 0.04 - 0.46 ppm); Final and coated paper 1.1 ppm mean (range 0.01 - 9.9 ppm); Paperboard 0.5 ppm mean (range 0.2 - 2.2 ppm); Paper/paperboard 0.4 ppm mean (range 0.0 - 6.6 ppm); Calendering or on-machine coating 4.2 ppm mean (range 0.0 - 50 ppm); Winding, cutting and grading 0.2 ppm mean (range 0.0 - 1.1 ppm); Repulping 0.2 ppm mean (range 0.05 - 0.4 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	12 unspecified countries
	Metric 3:	Applicability	High	The data are for the manufacture of paper and paper products which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was based on data from 1950-94, more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study includes range data that can be used to assess variability, uncertainty was not quantified.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 28 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	commercial			
EXTRACTION				
Parameter	Data			
Life cycle description:	Furnishing, Cleaning, and Treatment/Care products: Manufacture of Furniture			
Process description:	Most furniture is manufactured from either wood-based composite or hardwood, and the manufacturing process can be generalized into four steps: (1) processing (sawing, sanding, assembly, inspection), (2) painting, staining, or varnishing (mixing, applying, drying, sanding, repair), (3) upholstery and installation of hardware, and (4) packaging and shipping			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Painting: 0.16 ppm geometric mean SD 2.25; Gluing: 0.12 ppm geometric mean SD 2.87			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Denmark - an OECD member
	Metric 3:	Applicability	High	The data are for furniture manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1993 after the latest PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a geometric average value and standard deviation.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The data include standard deviation data which be used to evaluate variability, but uncertainty is not quantified
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 29 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Other Commercial uses: Map printing			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.52 ppm mean (range 0.03-1.46 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for the printing onto paper which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was based on data from 1985, prior to the latest PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study includes range data that can be used to evaluate variability, though uncertainty not provided.
Overall Quality Determination			Low	

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: particleboard mill			
Process description:	Regardless of the type of fiber used, the manufacturing process is basically the same: (1) the wood fiber is bonded together with a thermosetting resin to form a mat, (2) the mat is hot pressed, and (3) the pressed mat is then cooled and allowed to mature. The wood fibers typically are bonded with UF, MF, MUF, or PF resins. During hot pressing, the mat is heated and compacted to the desired density and thickness, and the resin polymerizes to bind the particles and stabilize the panel.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	2.4 ppm mean (range 1.2-3.5 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Indonesia - not an OECD member
	Metric 3:	Applicability	High	The data are for a particleboard mill which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1990, prior to the most recent PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean value and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study included range data that can be used to evaluate variability but does not account for uncertainty.
Overall Quality Determination			Low	

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substance in products not described by other codes: Pathology autopsy room			
Process description:	Embalming is a procedure that delays the decomposition of a cadaver. To accomplish this, the embalmer injects into either the common carotid or femoral artery usually 12 to 18 L of an aqueous solution of formaldehyde at a concentration ranging from about 1.25% to 32%, depending on how much the body has changed since death			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	4.35 ppm mean (range 2.2 - 7.9 ppm)			
Personal protective equipment:	General work practices that will reduce exposure include closing jars promptly when not in use, prompt disposal of formaldehyde soaked rags, proper storage and disposal of products, and periodic equipment inspections. Personal protective equipment should be used during procedures involving high formaldehyde concentrations.			
Engineering control:	Methods to reduce formaldehyde exposure include product substitution and modifications of work areas and work practices. Work-station modifications that can reduce exposure include confining difficult embalming cases; physically separating embalming tasks from restoration tasks; installation and proper use of capture equipment at the source, such as hoods over the injection equipment; and design of work stations to ensure adequate ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for a pathology lab which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1979, prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean value and range data for the raw data and TWAs
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The study provided range data that can be used to evaluate variability. Uncertainty was probably considered in the NIOSH methods used.
Overall Quality Determination		Medium		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: Fiberboard sawing and sanding			
Process description:	Regardless of the type of fiber used, the manufacturing process is basically the same: (1) the wood fiber is bonded together with a thermosetting resin to form a mat, (2) the mat is hot pressed, and (3) the pressed mat is then cooled and allowed to mature. The wood fibers typically are bonded with UF, MF, MUF, or PF resins. During hot pressing, the mat is heated and compacted to the desired density and thickness, and the resin polymerizes to bind the particles and stabilize the panel.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.03-0.10 ppm mean (range 0.01-0.14 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	UK - OECD member
	Metric 3:	Applicability	High	The data are for Fiberboard sawing and sanding which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study is based on data form the 1990’s, prior to the most recent PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range of means and a range of values
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study included range data that can be used to evaluate variability but does not account for uncertainty.
Overall Quality Determination			Low	

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Other commercial uses: Manufacture of Textiles and Garments- use of fabric treated with formaldehyde-based resins			
Process description:	The finishing process involves impregnating the fabric in an aqueous solution and then pressing it to remove the excess solution (IRSST 2006). The main factors that affect worker exposure to formaldehyde include the types of processes and products used, the presence and efficiency of fume hoods and emission collection systems, and the level of general ventilation. Jobs that may result in formaldehyde exposure include resin preparer, process operators (various types), colorist, and maintenance worker. The main means of controlling exposure include use of formaldehyde-free finishes, the use of fume hoods at the source of emissions, sufficient general ventilation, and the use of personal protective equipment where formaldehyde levels are high.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.2 ppm mean (range < 0.1-0.4 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for the textile and garment industries which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1987, prior to the latest PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range data is provided that can be used to evaluate variability. Information on uncertainty not included.
Overall Quality Determination		Medium		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: plywood factory			
Process description:	Regardless of the end product, the process generally consists of five steps: gluing, pressing, drying, finishing, and storage. Adhesives used in this industry can be made of UF, MF, MUF, or PF resins.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Warehouse 0.32 ppm mean (range 0.17-0.49 ppm); Shearing press 0.08 ppm mean (range 0.07-0.11 ppm); Sawmill 0.07 ppm mean			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Italy - OECD member	
	Metric 3: Applicability	High	The data are for plywood storage and use which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The study was published in 1992 the same year as the most recent PEL (1992) and over 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by an average value and range data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The monitoring study included range data that can be used to evaluate variability but uncertainty was not documented	
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	commercial			
EXTRACTION				
Parameter	Data			
Life cycle description:	Furnishing, Cleaning, and Treatment/Care products: Wood Processing			
Process description:	Most furniture is manufactured from either wood-based composite or hardwood, and the manufacturing process can be generalized into four steps: (1) processing (sawing, sanding, assembly, inspection), (2) painting, staining, or varnishing (mixing, applying, drying, sanding, repair), (3) upholstery and installation of hardware, and (4) packaging and shipping			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1995: 2.5 ppm mean (range 0.6-15.6 ppm); 1990-1998: 0.75 ppm mean; 1990-98: 0.71 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	China - Not an OECD member	
	Metric 3: Applicability	High	The data are for furniture manufacture which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The study was derived from data from 1990 to 1998, which is more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by an average value and range data (for the 1995 data)	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No meta data were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The 1995 data include range information which be used to evaluate variability, but uncertainty is not quantified	
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: chipboard production			
Process description:	Regardless of the type of fiber used, the manufacturing process is basically the same: (1) the wood fiber is bonded together with a thermosetting resin to form a mat, (2) the mat is hot pressed, and (3) the pressed mat is then cooled and allowed to mature. The wood fibers typically are bonded with UF, MF, MUF, or PF resins. During hot pressing, the mat is heated and compacted to the desired density and thickness, and the resin polymerizes to bind the particles and stabilize the panel.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1.5 ppm mean (range <0.01-8.4 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Germany - an OECD member	
	Metric 3: Applicability	High	The data are for chipboard production which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The study was published in 1989, prior to the most recent PEL (1992) and over 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a mean value and range data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study included range data that can be used to evaluate variability but does not account for uncertainty.	
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: plywood mill			
Process description:	Regardless of the end product, the process generally consists of five steps: gluing, pressing, drying, finishing, and storage. Adhesives used in this industry can be made of UF, MF, MUF, or PF resins.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	dryers 0.06 ppm geometric mean; composers 0.02 ppm geometric mean; pressing 0.13 ppm geometric mean; Finishing end 0.03 ppm geometric mean			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	New Zealand- OECD member	
	Metric 3: Applicability	High	The data are for plywood production which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The data are from 2000 after the most recent PEL (1992) and approximately 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by an average value	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 38 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: cork compression			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	2.5 ppm mean (range 0.3-37.5 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for cork compression which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study is based on data from 85, prior to the most recent PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average value and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study included range data that can be used to evaluate variability but does not account for uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 39 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: construction materials - Fiberglass & mineral wool insulation manufacturing- Synthetic vitreous fiber plant			
Process description:	Fiberglass insulation manufacturing involves six general steps: melting glass, spinning the molten glass into fibers, cooling and coating the fibers with a binder, forming the fibers into a pad, curing the binder (i.e., heating at 400°F to 600°F to set the binder), and packaging the insulation.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	production 0.15 ppm mean; form-pressing operations 0.16 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden- an OECD member
	Metric 3:	Applicability	High	The data are for fiberglass manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was derived from data from 1980s, prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean values for two different operations.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 40 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant -production of plastic products: Particleboard and molded plastics plant			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.69 ppm mean (TWA range 0.17-2.93 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The data are for plastic products manufacture which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The study was published in 1988, prior to the latest PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by mean value and range of TWAs.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No meta data were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The study provided TWA range data what can be used to evaluate variability. Information about uncertainty was not provided.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 41 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	reactant: plywood panel and laminates production			
Process description:	Regardless of the end product, the process generally consists of five steps: gluing, pressing, drying, finishing, and storage. Adhesives used in this industry can be made of UF, MF, MUF, or PF resins.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Plywood panels production 0.075 ppm mean; Laminates production 0.062 ppm mean			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown	
	Metric 3: Applicability	High	The data are for plywood and laminates production which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The study was published in 2006 after the most recent PEL (1992) and less than 20 but greater than 10 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by an average value	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substance in products not described by other codes: Autopsy			
Process description:	Embalming is a procedure that delays the decomposition of a cadaver. To accomplish this, the embalmer injects into either the common carotid or femoral artery usually 12 to 18 L of an aqueous solution of formaldehyde at a concentration ranging from about 1.25% to 32%, depending on how much the body has changed since death			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.7 ppm mean (range <0.1 - 1.4 ppm)			
Personal protective equipment:	General work practices that will reduce exposure include closing jars promptly when not in use, prompt disposal of formaldehyde soaked rags, proper storage and disposal of products, and periodic equipment inspections. Personal protective equipment should be used during procedures involving high formaldehyde concentrations.			
Engineering control:	Methods to reduce formaldehyde exposure include product substitution and modifications of work areas and work practices. Work-station modifications that can reduce exposure include confining difficult embalming cases; physically separating embalming tasks from restoration tasks; installation and proper use of capture equipment at the source, such as hoods over the injection equipment; and design of work stations to ensure adequate ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland- an OECD member
	Metric 3:	Applicability	High	The data are for autopsy which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was derived from data form 1981-86 prior to the PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean values and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study included range data that could be used to evaluate variability, but nothing was provided for uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 43 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	commercial			
EXTRACTION				
Parameter	Data			
Life cycle description:	Furnishing, Cleaning, and Treatment/Care products: Woodworking shop			
Process description:	Most furniture is manufactured from either wood-based composite or hardwood, and the manufacturing process can be generalized into four steps: (1) processing (sawing, sanding, assembly, inspection), (2) painting, staining, or varnishing (mixing, applying, drying, sanding, repair), (3) upholstery and installation of hardware, and (4) packaging and shipping			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Ventilate workshop: 0.42 ppm mean (range 0.28-0.54 ppm); Unventilated workshop: 0.64 ppm mean (range 0.48-0.84 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Egypt - Not an OECD member
	Metric 3:	Applicability	High	The data are for furniture manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was derived from data from 1990s prior to the latest PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average value and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The data include range information which be used to evaluate variability, but uncertainty is not quantified
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Metal products not covered elsewhere: Iron Foundry Core Machine Operator			
Process description:	The foundry process consists of pouring molten metal into a mold to obtain a cast product of specific shape. The mold can also contain a core that determines the dimensions of any internal cavity of the final product. Formaldehyde-based resins (both UF and PF) are commonly blended with sand to produce the molds and cores used in foundries. Important manufacturing steps in the foundry process include manufacturing and assembling the molds and cores, melting the metal, pouring the metal into the mold, cooling the molded part, removing the mold and core (shake-out), and dressing and deflashing.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.43 ppm median (range <0.02-18.3 ppm)			
Personal protective equipment:	Recommended use of personal protective equipment for tasks where the formaldehyde concentration is high.			
Engineering control:	The main means of controlling formaldehyde exposure include use of mold and core-making materials that do not contain formaldehyde, replacement of hot-mold production processes with cold hardening processes, using resins with lower emission rates, confinement of production steps that produce formaldehyde emissions, installation of fume hoods at emission sources, and sufficient general ventilation.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for foundries which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1979, prior to the latest PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a median value and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Range data were provided that can be used to evaluate variability, uncertainty was likely considered in the NIOSH methodology.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 45 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: paper and paperboard manufacture, resin impregnation			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.05-0.08 ppm range of means (range <0.01-0.28 ppm)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for the manufacture of paper and paper products which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1980, prior to the latest PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by mean, median, and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The study includes range data that can be used to assess variability it is assumed that uncertainty was addressed in the NIOSH methods.
Overall Quality Determination		High		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: blockboard mill			
Process description:	Regardless of the type of fiber used, the manufacturing process is basically the same: (1) the wood fiber is bonded together with a thermosetting resin to form a mat, (2) the mat is hot pressed, and (3) the pressed mat is then cooled and allowed to mature. The wood fibers typically are bonded with UF, MF, MUF, or PF resins. During hot pressing, the mat is heated and compacted to the desired density and thickness, and the resin polymerizes to bind the particles and stabilize the panel.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.5 ppm mean (range 0.4-0.6 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Indonesia - not an OECD member
	Metric 3:	Applicability	High	The data are for a blockboard mill which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1990, prior to the most recent PEL (1992) and over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean value and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study included range data that can be used to evaluate variability but does not account for uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 47 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.				
HERO ID:	1041161				
Conditions of Use:	commercial				
EXTRACTION					
Parameter	Data				
Life cycle description:	Furnishing, Cleaning, and Treatment/Care products: Furniture Factory				
Process description:	Most furniture is manufactured from either wood-based composite or hardwood, and the manufacturing process can be generalized into four steps: (1) processing (sawing, sanding, assembly, inspection), (2) painting, staining, or varnishing (mixing, applying, drying, sanding, repair), (3) upholstery and installation of hardware, and (4) packaging and shipping				
Number of sites:	1				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	0.20 ppm median (range 0.16-0.4 ppm)				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.		
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown		
	Metric 3: Applicability	High	The data are for furniture manufacture which is an occupational scenario within the scope of the risk evaluation.		
	Metric 4: Temporal Representativeness	Low	The study was published in 1989 prior to the latest PEL (1992) and more than 20 years old.		
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a median value and range data		
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No meta data were provided		
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The data include range information which be used to evaluate variability, but uncertainty is not quantified		
Overall Quality Determination		Low			

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 48 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant -production of plastic products: Plastics manufacture			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Max< 0.1 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - an OECD member
	Metric 3:	Applicability	High	The data are for plastic products manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1995, after the PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by a max value
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substance in products not described by other codes: Anatomy laboratory - Dissecting			
Process description:	Embalming is a procedure that delays the decomposition of a cadaver. To accomplish this, the embalmer injects into either the common carotid or femoral artery usually 12 to 18 L of an aqueous solution of formaldehyde at a concentration ranging from about 1.25% to 32%, depending on how much the body has changed since death			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	a) 0.4 ppm mean (range 0.06 - 1.04 ppm) b) 2.4 ppm mean			
Personal protective equipment:	General work practices that will reduce exposure include closing jars promptly when not in use, prompt disposal of formaldehyde soaked rags, proper storage and disposal of products, and periodic equipment inspections. Personal protective equipment should be used during procedures involving high formaldehyde concentrations.			
Engineering control:	Methods to reduce formaldehyde exposure include product substitution and modifications of work areas and work practices. Work-station modifications that can reduce exposure include confining difficult embalming cases; physically separating embalming tasks from restoration tasks; installation and proper use of capture equipment at the source, such as hoods over the injection equipment; and design of work stations to ensure adequate ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for anatomy labs which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The studies were published in 1998 and 1999, after the PEL (1992) but over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean values and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study included range data that could be used to evaluate variability, but nothing was provided for uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 50 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Building and construction materials: Insulating buildings with UFFI			
Worker activity description:	Construction workers who varnish floors can have high exposures, these workers are also potentially exposed to wood dust and various solvent vapors from varnishes, putties, and adhesives. Working with UFFI or fiberglass insulation manufactured using formaldehyde-based resins also can result in formaldehyde exposure. Since the 1980s, glass-fiber mats have become an important material for roof shingles, asphalt roofing tiles, and roll roofing. UF and occasionally PF resins are used as binders to hold the glass fibers together until an asphalt coating is applied. Machining of wood-based composites and other formaldehyde-containing wood products are other sources of exposure in the construction industry.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.1 ppm mean			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Sweden - an OECD member	
	Metric 3: Applicability	High	The data are for construction-related exposure which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The study was derived from data from the 1980s, prior to the PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a mean value	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no meta data were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Metal products not covered elsewhere: Bronze foundry, core machine operator.			
Process description:	The foundry process consists of pouring molten metal into a mold to obtain a cast product of specific shape. The mold can also contain a core that determines the dimensions of any internal cavity of the final product. Formaldehyde-based resins (both UF and PF) are commonly blended with sand to produce the molds and cores used in foundries. Important manufacturing steps in the foundry process include manufacturing and assembling the molds and cores, melting the metal, pouring the metal into the mold, cooling the molded part, removing the mold and core (shake-out), and dressing and deflashing.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.39 & 0.53 ppm means (range 0.12-0.80 ppm)			
Personal protective equipment:	Recommended use of personal protective equipment for tasks where the formaldehyde concentration is high.			
Engineering control:	The main means of controlling formaldehyde exposure include use of mold and core-making materials that do not contain formaldehyde, replacement of hot-mold production processes with cold hardening processes, using resins with lower emission rates, confinement of production steps that produce formaldehyde emissions, installation of fume hoods at emission sources, and sufficient general ventilation.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for foundries which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1976, prior to the latest PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by means for two data sets and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Range data were provided that can be used to evaluate variability, uncertainty was likely considered in the NIOSH methodology.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 52 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Other commercial uses: Manufacture of Textiles and Garments- Retail dress shops			
Process description:	The finishing process involves impregnating the fabric in an aqueous solution and then pressing it to remove the excess solution (IRSST 2006). The main factors that affect worker exposure to formaldehyde include the types of processes and products used, the presence and efficiency of fume hoods and emission collection systems, and the level of general ventilation. Jobs that may result in formaldehyde exposure include resin preparer, process operators (various types), colorist, and maintenance worker. The main means of controlling exposure include use of formaldehyde-free finishes, the use of fume hoods at the source of emissions, sufficient general ventilation, and the use of personal protective equipment where formaldehyde levels are high.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	range 0.1-0.5 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for the textile and garment industries which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was derived from data from 1959, prior to the latest PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range data were provided that can be used to evaluate variability, uncertainty not presented.
Overall Quality Determination		Medium		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substance in products not described by other codes: Embalming			
Process description:	Embalming is a procedure that delays the decomposition of a cadaver. To accomplish this, the embalmer injects into either the common carotid or femoral artery usually 12 to 18 L of an aqueous solution of formaldehyde at a concentration ranging from about 1.25% to 32%, depending on how much the body has changed since death			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	2.2-2.6 ppm mean (range 0.2-8.7 ppm)			
Personal protective equipment:	General work practices that will reduce exposure include closing jars promptly when not in use, prompt disposal of formaldehyde soaked rags, proper storage and disposal of products, and periodic equipment inspections. Personal protective equipment should be used during procedures involving high formaldehyde concentrations.			
Engineering control:	Methods to reduce formaldehyde exposure include product substitution and modifications of work areas and work practices. Work-station modifications that can reduce exposure include confining difficult embalming cases; physically separating embalming tasks from restoration tasks; installation and proper use of capture equipment at the source, such as hoods over the injection equipment; and design of work stations to ensure adequate ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for embalming which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1992, around the time of the PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range of mean value and range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data what can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 54 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant -production of plastic products: Hexamine Workshop			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.6 ppm mean			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for plastic products manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1999, after the PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean value
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances in products not covered by other codes: forestry			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Chain sawing 0.05 ppm means (range 0.02-0.11 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden- an OECD member
	Metric 3:	Applicability	High	The data are for forestry workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1985, prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean value and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 56 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances in products not covered by other codes: agriculture and aquaculture			
Process description:	In agricultural settings, formaldehyde has been used as a preservative for fodder, a disinfectant in brooding houses, a sterilant in mushroom houses, and a preservative for produce			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Mushroom farming 2.68 ppm mean (range non detect - >10 mg/m3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for fmushroom farming which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1980, prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean value and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The study provided range data that can be used to evaluate variability. Uncertainty was likely addressed in the NIOSH methods used.
Overall Quality Determination		Medium		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances in products not covered by other codes: office workers			
Process description:	There are numerous sources of formaldehyde in office buildings, restaurants, commercial buildings, and other nonindustrial work places. These sources include paint and varnish, carpeting, wallpaper, insulation, furniture, and laser printers			
Number of sites:	5			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Office buildings: 8 hr average concentrations 0.11-0.97 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	China - not an OECD member	
	Metric 3: Applicability	High	The data are for office workers which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The study was published in 2003, after the PEL (1992) and more than 10 but less than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by range of 8 hour average concentrations.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no meta data were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.	
Overall Quality Determination		Low		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances in products not covered by other codes: agriculture and aquaculture			
Process description:	In agricultural settings, formaldehyde has been used as a preservative for fodder, a disinfectant in brooding houses, a sterilant in mushroom houses, and a preservative for produce			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Disinfecting eggs 2.6 ppm mean (range 0.2-7.8 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - and OECD member
	Metric 3:	Applicability	High	The data are for agricultural workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was derived from data from 1981-86, prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean value and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 59 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.				
HERO ID:	1041161				
Conditions of Use:	commercial uses				
EXTRACTION					
Parameter	Data				
Life cycle description:	Chemical substances in products not covered by other codes: office workers				
Process description:	There are numerous sources of formaldehyde in office buildings, restaurants, commercial buildings, and other nonindustrial work places. These sources include paint and varnish, carpeting, wallpaper, insulation, furniture, and laser printers				
Number of sites:	23				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	Office buildings:0.009 ppm mean (max = 0.036 ppm)				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.		
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Finland - an OECD member		
	Metric 3: Applicability	High	The data are for office workers which is an occupational scenario within the scope of the risk evaluation.		
	Metric 4: Temporal Representativeness	Medium	The study was derived from data from 2001-2006, after the PEL (1992) and more than 10 but less than 20 years old.		
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a mean value and a max value		
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no meta data were provided		
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.		
Overall Quality Determination		Low			

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 60 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	incorporation into formulation, mixture or reaction product: photographic film production			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.9 ppm peak			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	The data are for photographic film production which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	unknown
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by a peak value
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 1041161 Table: 61 of 62

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Other commercial uses: Manufacture of Textiles and Garments- Permanent-press clothing production			
Process description:	The finishing process involves impregnating the fabric in an aqueous solution and then pressing it to remove the excess solution (IRSST 2006). The main factors that affect worker exposure to formaldehyde include the types of processes and products used, the presence and efficiency of fume hoods and emission collection systems, and the level of general ventilation. Jobs that may result in formaldehyde exposure include resin preparer, process operators (various types), colorist, and maintenance worker. The main means of controlling exposure include use of formaldehyde-free finishes, the use of fume hoods at the source of emissions, sufficient general ventilation, and the use of personal protective equipment where formaldehyde levels are high.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.31 & 0.74 ppm means for two data sets (range 0.0-2.7 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for the textile and garment industries which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1966 & 68, prior to the latest PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by mean and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range data is provided that can be used to evaluate variability, uncertainty not presented.
Overall Quality Determination		Medium		

Study Citation:	NTP (2010). Final report on carcinogens. Background document for formaldehyde. (10-5981):i-512.			
HERO ID:	1041161			
Conditions of Use:	Commercial uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substance in products not described by other codes: Anatomy laboratory - Dissecting			
Process description:	Embalming is a procedure that delays the decomposition of a cadaver. To accomplish this, the embalmer injects into either the common carotid or femoral artery usually 12 to 18 L of an aqueous solution of formaldehyde at a concentration ranging from about 1.25% to 32%, depending on how much the body has changed since death			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	range 0.11-0.62 ppm			
Personal protective equipment:	General work practices that will reduce exposure include closing jars promptly when not in use, prompt disposal of formaldehyde soaked rags, proper storage and disposal of products, and periodic equipment inspections. Personal protective equipment should be used during procedures involving high formaldehyde concentrations.			
Engineering control:	Methods to reduce formaldehyde exposure include product substitution and modifications of work areas and work practices. Work-station modifications that can reduce exposure include confining difficult embalming cases; physically separating embalming tasks from restoration tasks; installation and proper use of capture equipment at the source, such as hoods over the injection equipment; and design of work stations to ensure adequate ventilation.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Japan - an OECD member
	Metric 3:	Applicability	High	The data are for anatomy labs which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The study was published in 2003, after the PEL (1992) but more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by range data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No meta data were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study included range data that could be used to evaluate variability, but nothing was provided for uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Nunn, A.J., Craigen, A.A., Darbyshire, J.H., Venables, K.M., Newman, T.A. (1990). Six year follow up of lung function in men occupationally exposed to formaldehyde. Occupational and Environmental Medicine 47(11):747-752.			
HERO ID:	6629			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Exposure was assumed to be high: greater than 2.0 ppm 8-hour time weighted average; medium: 0.6-2.0 ppm or low: 0.1 to 0.5 ppm			
Number of workers:	164 exposed workers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	UK OCED member
	Metric 3:	Applicability	Uninformative	The data are from an occupational or non-occupationalscenario that does not apply to any occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The study was published in 1990 based on data from 1979 to 1987, before the most recent PEL (1992) and greater than 20 years old.
	Metric 5:	Sample Size	Medium	Graph of average and geometric mean exposure for the period from Oct 1979 to Sept 1987 is provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	It is assumed that the monitoring data were for area sampling though they do mention personal sampling as well, but no other metadata were provided such as sampling and analytic methods, number of sites, sample durations, worker activities, and exposure frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Graphic presentation of the data allows an appreciation of temporal variation, but nothing is provided about uncertainty.
Overall Quality Determination		Uninformative		

Study Citation:	NZ DEPT OF HEALTH, (1981). Review of occupational health problems associated with formaldehyde exposure (26).			
HERO ID:	5908861			
Conditions of Use:	Particleboard manufacturing			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.1 - 1.1 ppm (Table 6, pg 16/27)			
Exposure duration:	Varies, see Figure 1, pg 10/27			
Personal protective equipment:	Most workers wore gloves			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			Medium	

Study Citation:	NZ DEPT OF HEALTH, (1981). Review of occupational health problems associated with formaldehyde exposure (26).			
HERO ID:	5908861			
Conditions of Use:	Furniture manufacturing - veneer bonding			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.5-6.9 ppm (total aldehydes, Table 6, pg 16/27)			
Exposure duration:	Varies, see Fig 1, pg 10/27			
Personal protective equipment:	Most workers wore gloves			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	Medium	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination				
Medium				

Study Citation:	NZ DEPT OF HEALTH, (1981). Review of occupational health problems associated with formaldehyde exposure (26).			
HERO ID:	5908861			
Conditions of Use:	Pathology labs			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.14 ppm (Total Aldehyde concentration)			
Exposure duration:	Varies, see Fig 1, pg 10/27			
Personal protective equipment:	Most workers wore gloves			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Study Citation:	NZ DEPT OF HEALTH, (1981). Review of occupational health problems associated with formaldehyde exposure (26).			
HERO ID:	5908861			
Conditions of Use:	Mortuaries			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.1 - 0.16 ppm (total aldehydes)			
Exposure duration:	Varies, see Figure 1, pg 10/27			
Personal protective equipment:	Most workers wore gloves			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			Medium	

Study Citation:	NZ DEPT OF HEALTH, (1981). Review of occupational health problems associated with formaldehyde exposure (26).			
HERO ID:	5908861			
Conditions of Use:	Joinery - particleboard cutting			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.76 ppm (total aldehydes)			
Exposure duration:	Varies, see Figure 1, pg 10/27			
Personal protective equipment:	Most workers wore gloves			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			Medium	

Study Citation:	NZ DEPT OF HEALTH, (1981). Review of occupational health problems associated with formaldehyde exposure (26).			
HERO ID:	5908861			
Conditions of Use:	Formulation chemist			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.5-3.2 ppm (total aldehydes)			
Exposure duration:	Varies, see Figure 1, pg 10/27			
Personal protective equipment:	Most workers wore gloves			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country. other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.	
Overall Quality Determination		Medium		

Study Citation:	Nørgaard, A.W., Kofoed-Sørensen, V., Mandin, C., Ventura, G., Mabilia, R., Perreca, E., Cattaneo, A., Spinazzè, A., Mihucz, V.G., Szigeti, T., Kluizenaar, Y.D., Cornelissen, H.J., Trantallidi, M., Carrer, P., Sakellaris, I., Bartzis, J., Wolkoff, P. (2014). Ozone-initiated terpene reaction products in five European offices: Replacement of a floor cleaning agent. Environmental Science and Technology 48(22):13331-13339.			
HERO ID:	2534532			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	office worker			
Area sampling data:	Two-hour average concentrations (ug/m3) of formaldehyde in offices, before and after replacement of cleaning agent or deep cleaning: in France – before – 7 – 7.5, after – 1 – 3.5; in Germany – before – 2.5 – 20, after – 2 – 10; in Hungary – before – 10.5 – 16, after – 4.5 – 8; in Italy – before – 10 – 13, after – 7 – 10; in Netherlands – before – 7 – 10, after – 5 – 8. Replacement of the regular cleaning agents with the selected low-emitting agent resulted in the following: in France - average and maximum levels of formaldehyde were more than halved; in Germany - average and max levels of formaldehyde were halved; in Hungary - average and maximum levels of formaldehyde were about halved; in Italy - average and maximum levels of formaldehyde were similar; in Netherlands - no significant difference in formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described methods
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD countries
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	Low	no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 4038581 Table: 1 of 1

Study Citation:	O’Brien, D. M., Froehlich, P. A., Hall, R. M. (1989). Walk-Through Survey Report: Control Technology Support for SENSOR at General Foundry Company, Flagtown, New Jersey, CT-171-16a. NIOSH(CT-171-16a):171-16.			
HERO ID:	4038581			
Conditions of Use:	Industrial Adhesives and sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	can occur in mold and core-making processes involving formaldehyde based resins and from decomposition during pouring and casting.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Shakeout, near breathing zone <0.2 ppm			
Exposure duration:	1 shift per day (8 hours)			
Exposure frequency:	6 days per week			
Number of workers:	28-30			
Personal protective equipment:	safety shoes and glasses are required in all areas of the plant. NIOSH-approved disposable dust respirators are required in no-bake areas and during sand loading in the coremaking area.			
Engineering control:	Shakeout, sand screening, and sand mulling operations are conducted form brief periods, therefore no local exhaust is suggested at this time;			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study -
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (foundary) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1984 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range though uncertain statistics were not provided. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type and location but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no data were provided regarding variability also uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination		Medium		

Study Citation:	Ochs, S., Grotz, L., Factorine, L.S., Rodrigues, M.R., Netto, A.D. (2011). Occupational exposure to formaldehyde in an institute of morphology in Brazil: a comparison of area and personal sampling. Environmental Science and Pollution Research 19(7):2813-2819.			
HERO ID:	2566605			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Worker activity description:	Personnel in morphology department of an university in Brazil			
Exposure route:	inhalation			
Personal sampling data:	The average personal exposure of the monitors was 3.44 +/- 0.94 mg/m3 and ranged from 1.89 to 4.82 mg/m3. The average personal exposure levels were approximately 0.4 to 2.3 fold higher than the area levels of formaldehyde in the anatomy laboratory.			
Area sampling data:	The average concentration of formaldehyde found in the corridor that links the teachers’ rooms (second floor) (0.20 mg/m3) and in the entrance hall (first floor) (0.18 mg/m3) were less than those detected in other study areas. Concentrations in these areas varied between 0.03 and 0.37 mg/m3 in the corridor that links the teachers’ rooms and 0.09 and 0.35 mg/m3 in the entrance hall. In general, the concentrations of formaldehyde in the basement were higher than in the other floors. The average concentration found in the anatomy laboratory was 0.93±0.62 mg/m3 and ranged from 0.22 to 2.07 mg/m3. The concentration of formaldehyde in the air of the embalming room showed a nearly constant value between 2.21 to 2.52 mg/m3. The lowest formaldehyde concentrations were those found in the entrance hall (first floor) and corridor of the second floor, but despite this fact, the observed values are higher than the exposure limits established by the World Health Organization and NIOSH. In contrast, the concentrations found in the anatomy laboratory exceeded all international guideline limits, except those of the Brazilian PEL, which represents the most permissive guideline. The very high formaldehyde concentration found in the embalming room was higher than the values found in the other sampling areas and also exceeds the Brazilian guidelines.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methods well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	non-OECD country
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	the publication was in 2012 and data is probably less than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
Overall Quality Determination		Medium		

Study Citation:	Odkvist, L.M., Edling, C., Hellquist, H. (1985). Influence of vapours on the nasal mucosa among industry workers. Rhinology 23(2):121-127.			
HERO ID:	5867			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapors			
Area sampling data:	range 0.1-1.1 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden - OECD country	
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1985, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range though uncertain statistics were not provided.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	It is assumed that the monitoring data were for area sampling, but no other metadata were provided such as sampling and analytic methods, number of sites, sample durations, exposure durations, worker activities, and exposure frequency.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	OECD, (2002). SIDS Initial Assessment Report: Formaldehyde (CAS no: 50-00-0).			
HERO ID:	5348397			
Conditions of Use:	Production and Processing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation, dermal exposure			
Physical form:	Formaldehyde is a colorless gas with pungent odor			
Personal sampling data:	Site 1 (1998 –2000; 8 h TWA, personal sampling; BASF AG):- Production (30 measurements): 0.32 mg/m³ (90-percentile)- Processing (268 measurements): 0.19 mg/m³ (90-percentile)Site 2 (1991 –1998; 8 h TWA, personal sampling; ISP GmbH):- Production and processing (117 measurements): <0.02 – 0.37 mg/m³Site 3 (Methanova):- Production: 0.01– 0.08 mg/m³- Processing: 0.02 – 0.25 mg/m³Pages 10-11, Sites located in Germany			
Area sampling data:	In more recent monitoring campaigns conducted in various countries (1992 –1998), mean indoor concentrations of formaldehyde in a range between 20.2 µg/m³ (greater Boston) and 68.5 µg/m³ (New Jersey) have been measured. (page 10)			
Dermal exposure data:	Dermal exposure data			
Personal protective equipment:	Respiratory protection: Suitable respiratory protection for lower concentrations or short-term effect: Suitable respiratory protection for higher concentrations or long-term effect: Gas filter EN 141 Type B for gases/vapours of inorganic compounds. Self-contained breathing apparatus. Hand protection: Chemical resistant protective gloves (EN 374) Suitable materials also with prolonged, direct contact (Recommended: Protective index 6, corresponding > 480 minutes of permeation time according to EN 374): butyl rubber (butyl) - 0.7 mm coating thickness nitrile rubber (NBR) - 0.4 mm coating thickness Eye protection: Tightly fitting safety goggles (splash goggles) (EN 166) Body protection: chemical-protection suit (according to DIN-EN 465)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is from Germany and US
	Metric 3:	Applicability	High	The data are for occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old
	Metric 5:	Sample Size	Medium	Discrete samples are not provided but number of samples taken, range, and limited percentile info provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Ogawa, M., Kabe, I., Terauchi, Y., Tanaka, S. (2019). A strategy for the reduction of formaldehyde concentration in a hospital pathology laboratory. Journal of Occupational Health 61(1):135-142.			
HERO ID:	5946168			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers (doctors and technicians) in a hospital pathology laboratory in Japan			
Exposure route:	inhalation			
Area sampling data:	Change in the formaldehyde concentrations (ppm) before and after the interventions in points (1)-(5) are as follows: before the interventions - (1) 0.34, (2) 0.03, (3) 0.02, (4) 0.02, (5) 0.06; after the engineering and software interventions - (1) 0.13, (2) 0.07, (3) 0.03, (4) 0.03, (5) 0.08; after the intervention with video camera - (1) 0.11, (2) <0.01, (3) <0.01, (4) <0.01, (5) 0.07. Following the engineering interventions and asking the workers not to block the ventilation systems or keep the waste fluid tank open, the formaldehyde concentrations in points (1)-(5) improved.			
Engineering control:	First, engineering controls were implemented, and workers were asked not to block the ventilation system and not to keep waste fluid tanks open. The first step in working environment control is the measurement of the working environment, which entails three processes. First, the airborne concentrations of chemicals in the workplace atmosphere must be measured. Second, the indices (1st evaluation value and 2nd evaluation value) must be calculated by statistical treatment of the measurement results. The 1st evaluation value (EA1) is the estimated value suited to 5% of the highest level among the actual value of the airborne substances while the 2nd evaluation value (EA2) is the estimated value of the arithmetic mean concentration. Third, the calculated values must be compared with the “administrative levels” that are stipulated for each hazardous chemical by the government, and the control class is then determined. Next, using a video camera and a formaldehyde detector, the authors attempted to visually educate workers about how much formaldehyde is emitted from the sample container based on the type of action undertaken.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	methodology is well described	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	data are from an OECD country. other than the U.S.	
	Metric 3: Applicability	High	data are for an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	High	data is less than 10 years old	
	Metric 5: Sample Size	Low	characterized by no statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	has no discussion on uncertainties	
Overall Quality Determination		Medium		

Study Citation:	Ohmichi, K., Komiyama, M., Matsuno, Y., Sawabe, Y., Miyaso, H., Fukata, H., Ohmichi, M., Kadota, T., Nomura, F., Moria, C. (2006). Relationship between exposure to formaldehyde and immunoglobulin E (IgE) production during the gross anatomy laboratory. Journal of Health Science 52(5):642-647.			
HERO ID:	626399			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	dissection			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Subject 1 0.52 ppm; Subject 2 - 0.43 ppm; Subject 3 - 1.47 ppm; Subject 4 - 0.68 ppm; Subject 5 - 0.33 ppm; Subject 6 - 0.98 ppm; Subject 7 - 1.17 ppm; Subject 8 - 0.16 ppm			
Area sampling data:	Average indoor concentration in gross anatomy lab at Chiba University in Japan: 0.23 - 1.03 (see page 1/6 for individual data points). Exposure concentration of someone close to the cadaver is 2 to 3 fold higher than this.			
Exposure duration:	1.1-6 hrs (average 3)			
Number of workers:	8			
Engineering control:	general ventilation of 60m^3/min.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH 2016
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Japan - OECD member
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2006 data were from 2003
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but unclear about the frequency and duration of exposure
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability addressed by providing results for individuals, uncertainty addressed in the sampling methodology
Overall Quality Determination		High		

Study Citation:	Okawa, M. T., Apol, A. G. (1978). Health Hazard Evaluation Determination Report 77-56-467, Johns-Manville Products Corporation, Pittsburg, California.			
HERO ID:	8442004			
Conditions of Use:	Asphalt, paving, roofing, and coating materials manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	A splicer and a splicer helper are responsible for feeding and splicing the rolls of paper or fiberglass matte. One worker handles the coater and one employee tends the pressroll and cooling section areas of the shingle line. One person handles the slate granules. (3/19)			
Exposure route:	inhalation (9/19)			
Physical form:	gas (9/19)			
Area sampling data:	No formaldehyde was detected in two area samples. (12/19)			
Number of workers:	Approximately 12 employees (3/19)			
Engineering control:	The saturators and the coater have mechanical ventilation systems called High Efficiency Air Filters. The saturators are enclosed and under negative pressure. (4/19)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for incorporation into asphalt and roofing materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker activity provided, but missing exposure duration, frequency, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination			High	

Study Citation:	Okawa, M. T., Apol, A. G. (1978). Health Hazard Evaluation Determination Report 77-57-460, Johns-Manville Products Corporation, Vernon, California.			
HERO ID:	8442101			
Conditions of Use:	Asphalt, paving, roofing, and coating materials manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	A "splicer" and "splicer helper" are responsible for feeding and splicing the rolls of paper or fibrous glass matte. One worker ("coaterman") handles the coater and one employee tends the pressroll and cooling section areas of the shingle line. One employee handles the slate granules and other minerals used in the shingles. This "slateman" is responsible for monitoring the flow of granules and/or loading the minerals into ventilated hoppers in the slateroom which is located above the coater. (4/18)			
Exposure route:	inhalation (9/18)			
Physical form:	vapor (8/18)			
Area sampling data:	Two area samples were 0.03 and 0.07 ppm. (11/18)			
Number of workers:	12 employees handle the main shingle line (4/18)			
Personal protective equipment:	NIOSH recommends certified respirators in certain areas of the plant. (12/18)			
Engineering control:	The saturators and the coater have mechanical ventilation systems are known as "HEAF" units (High Efficiency Air Filters). The saturators are enclosed and under negative pressure. Employees only enter the saturator during breakdowns and spot checks and the greatest exposures to asphalt fumes plus any substances contained in the fumes occur at this time. The coater has partial enclosure and this HEAF unit captured most of the fumes and smoke. (4/18)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the manufacture of asphalt roofing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		High		

Study Citation:	Olin Corp (1983). Industrial hygiene survey with attachments.			
HERO ID:	5467300			
Conditions of Use:	Unknown- Paint shop and storage area			
EXTRACTION				
Parameter	Data			
Worker activity description:	Glue used in wood (pg 11); fleece rolls (pg 12)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.07 ppm in storage area, 4.4 ppm when surrounded by ”fleece” rolls at the receiving warehouse (pg 12)			
Engineering control:	LEV (pg 12)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for occupational scenario that cannot be clearly ascertained (some information redacted
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics (unsure number of samples, if reported values are averages, etc).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing most other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	Olin Corp, (1983). Environmental hygiene survey with attachments.				
HERO ID:	3118399				
Conditions of Use:	Compressed Wood Product Manufacturing				
EXTRACTION					
Parameter	Data				
Worker activity description:	Odors (and exposure levels) in the receiving area where newly opened packages containing rolls of "fleece" material are opened and unpacking newly unpacked.				
Exposure route:	inhalation				
Area sampling data:	storage area = 0.07 ppm; near rolls of "fleece" material 4.40 ppm				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.	
	Metric 3:	Applicability	High	Data are for incorporated glue, an in-scope occupational scenario.	
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.	
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by samples collected at multiple locations at the same site, but uncertainty is not addressed.	
Overall Quality Determination			Low		

Study Citation:	Oosthuizen, J.D. (1998). The control of formaldehyde vapour in the human anatomy laboratory of a traditionally disadvantaged South African medical school. International Journal of Environmental Health Research 8(1):47-57.			
HERO ID:	1316918			
Conditions of Use:	Laboratory use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Dissection			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Individual values are provided - prior to modification of ventilation system - Mean values 1993: 0.3 ppm; Jan 1994: 0.5 ppm; March 1994: 0.6 ppm; July 1994 1.5 ppm (range 0.19-2.29 ppm). Post modification: mean <0.1 ppm (range <0.03-0.08 ppm)			
Exposure duration:	3 hr			
Engineering control:	Ventilation controls was implemented and proved to be effective in reducing formaldehyde vapor levels.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified, though it was noted that formaldehyde samples were collected by passive diffusion with the aid of 3M monitors. The monitors were used as personal samplers and were clipped onto the collars of individuals as close to their breathing zone as possible. All chemical samples were taken and analyzed in accordance with 3M Analytical Method 4D (3M 1985), this being the prescribed method for 3M monitor #3720 or #3721, by an independent SABS approved laboratory in Johannesburg. A control monitor or ‘field blank’ was subjected tothe same environmental conditions as the other formaldehyde monitors by placing an unopened monitor in the laboratory environment. The blanks were sent together with the batches ofsamples to the laboratory where they were also analyzed, as specified by the manufacturer. Temperature and humidity levels were monitored to ensure that the equipment was used within manufacture specified limits.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	South Africa - not an OECD member
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The study was based on data from 1993-1995, after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	High	Actual results for each sampling event were provided noting the dates of the sample, location and section of the body being dissected.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, exposure durations, and worker activities, but did not include exposure frequency.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 1316918 Table: 1 of 1

...continued from previous page

Study Citation:	Oosthuizen, J.D. (1998). The control of formaldehyde vapour in the human anatomy laboratory of a traditionally disadvantaged South African medical school. International Journal of Environmental Health Research 8(1):47-57.		
HERO ID:	1316918		
Conditions of Use:	Laboratory use		
Domain	Metric	EVALUATION Rating	Comments
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	As actual samples are presented for different days and sections of the body it is possible to use these data to evaluate data variability in the study. Regarding uncertainty, bias, and attempts to reduce bias are specifically discussed in the report.
Overall Quality Determination		Medium	

Study Citation:	Orsiere, T., Sari-Minodier, I., Iarmarcovai, G., Botta, A. (2006). Genotoxic risk assessment of pathology and anatomy laboratory workers exposed to formaldehyde by use of personal air sampling and analysis of DNA damage in peripheral lymphocytes. Mutation Research: Genetic Toxicology and Environmental Mutagenesis 605(1-2):30-41.			
HERO ID:	626419			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	macroscopic examination, sample reception, formaldehyde dilution, screening and elimination of anatomical figures, and filling and draining of automated inclusion apparatus.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	15 minute sampling 2.0 ppm mean (range <0.1-20.4 ppm) 8 hrs sampling 0.1 ppm (range <0.1-0.7 ppm)			
Exposure duration:	15 min ot 8 hrsd			
Exposure frequency:	0.5 to 34 years (mean 13.2 +/- yrs)			
Number of workers:	59 or twice this value to include 15 or 8 hr sampling - hard to tell			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it was noted that ACS monitoring badges were used
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	France - OECD member
	Metric 3:	Applicability	High	Data for pathology workers is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2006
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics mean and range but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	The sample type provided but sampling and analysis methods were not provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	OSHA, (1979). Update on progress of information relating to chemical fertilizer plant with attachments.			
HERO ID:	4158111			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation (26/27)			
Personal sampling data:	employee exposure level of 0.176 ug/m3; (26/27)			
Area sampling data:	3ppm, 3.7 ug/m3 TWA measured in the resin room (26/27)			
Exposure duration:	309 minutes/day (26/27)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are form the U.S.
	Metric 3:	Applicability	High	Data are for use as an intermediate in the manufacture of fertilizers, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	OSHA, (2019). Chemical exposure health data (CEHD) sampling results: CASRNs 75-34-3, 85-68-7, 84-74-2, 78-87-5, 117-81-7, 106-93-4, 50-00-0, 95-50-1, 85-44-9, 106-46-7, 79-00-5, and 115-86-6.			
HERO ID:	6499659			
Conditions of Use:	Commercial use			
EXTRACTION				
Parameter	Data			
Personal sampling data:	average concentration is 0.34			
Area sampling data:	average sample concentration = 0.20			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	OSHA data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability but has no discussion on uncertainty
Overall Quality Determination		Medium		

Study Citation:	Ostojić, L., Bradarić, A., Mise, K., Ostojić, Z., Lovrić, J., Petrović, P., Ujević, A., Erceg, M., Janković, S., Tocilj, J. (2006). Pulmonary function in persons who are professionally exposed to formaldehyde fumes. Collegium Antropologicum 30(3):507-511.			
HERO ID:	626448			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Personal sampling data:	mean of 0.16 (ppm) (0.10–0.12 mg/m3) (pg 1/5)			
Comments:	The monitoring data pertain to the production of resinembedded fibreglass, chemicals, furniture, and wood products, or through employment in the funeral services industry			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	methods not specified but references to primary sources given.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Geographical association not specified but references to primary sources given.
	Metric 3:	Applicability	High	data pertain to COU
	Metric 4:	Temporal Representativeness	Low	The dates in the citations of the primary data are more than 20 years old.
	Metric 5:	Sample Size	Low	Sample size not stated but references to primary data sources given.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Meta data not given but references to primary data sources given.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty not given but references to primary data given.
Overall Quality Determination			Low	

Study Citation:	Pabst, R. (1987). Exposure to formaldehyde in anatomy: an occupational health hazard?. Anatomical Record 219(2):109-112.			
HERO ID:	1314603			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Area sampling data:	Several studies cited provide a range of 0.2-20 (mg/m^3)			
Engineering control:	gloves are recommended			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Provides a range based on other published literature, methods may be specified in original sources
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	N/A	No samples
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sources of original data provided but no other information except a concentration range for each study is provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability and uncertainty are addressed by providing data from multiple studies and also by discussing the causes of variation and uncertainty.
Overall Quality Determination			Medium	

Study Citation: Page, E., Couch, J. (2014). Evaluation of employee health concern and suspected contamination at an office complex.
HERO ID: 8684522
Conditions of Use: General Population - Office Buildings

EXTRACTION

Parameter	Data
Worker activity description:	Workers in a federal complex of office buildings and warehouse space. No worker activities related to formaldehyde.
Exposure route:	Inhalation.
Personal sampling data:	< 0.05 ppm
Number of workers:	The complex has employed thousands of people since opening in the 1940s. At the 50th anniversary of the complex more than 10,000 individuals were employed.
Engineering control:	Forced ventilation in buildings.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	Uninformative	Data are for formaldehyde exposures within an office complex, where activities are unrelated to formaldehyde.
	Metric 4: Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected no more than 10 years ago.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination

Uninformative

Study Citation:	Pala, M., Ugolini, D., Ceppi, M., Rizzo, F., Maiorana, L., Bolognesi, C., Schilirò, T., Gilli, G., Bigatti, P., Bono, R., Vecchio, D. (2008). Occupational exposure to formaldehyde and biological monitoring of Research Institute workers. Cancer Detection and Prevention 32(2):2008.		
HERO ID:	626085		
Conditions of Use:	Laboratory Use		
EXTRACTION			
Parameter	Data		
Worker activity description:	Anatomy and Pathology, Experimental Oncology, Toxicological Pharmacology, Data Elaboration Centre, and Environmental Epidemiology.		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	Range from 4.9 ug/m3 to 268.7 ug/m3 also it was noted that residential exposure is about 30 ug/m3		
Number of workers:	36 workers- Anatomy and Pathology (7), Experimental Oncology (8), Toxicological Pharmacology (1), Data Elaboration Centre (6), and Environmental Epidemiology (14).		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it was noted that diffusive radial samplers containing mesh coated with 2,4-dinitrophenylhydrazine, analyzed by HPLC equipped with an UVdetector were used.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Italy - OECD member
	Metric 3: Applicability	High	Data are for laboratory worker, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5: Sample Size	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Sample type and exposure type not provided along with sampling and analysis methods, number of samples, number of sites, exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination		Medium	

Study Citation:	Pang, S.K., Cho, H., Sohn, J.Y., Song, K.D. (2007). Assessment of the emission characteristics of VOCs from interior furniture materials during the construction process. Indoor and Built Environment 16(5):444-455.			
HERO ID:	1513097			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Worker activity description:	Construction of kitchens and living rooms			
Exposure route:	Inhalation			
Physical form:	Solid			
Area sampling data:	15-135 (g/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	South Korea is an OECD member country
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2007)
	Metric 5:	Sample Size	High	Discrete sample results included.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Discussed sample type and sample duration, but it included no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Only provided a limited discussion of the variability and uncertainty of the results.
Overall Quality Determination		Medium		

Study Citation:	Pang, X., Mu, Y. (2007). Characteristics of carbonyl compounds in public vehicles of Beijing city: Concentrations, sources, and personal exposures. Atmospheric Environment 41(9):1819-1824.			
HERO ID:	2095287			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Number of sites:	12 taxis, 9 buses, 8 subways			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Taxi A driver 212 ug/day mean (257 ug/day 95th percentile); Taxi B driver 181 ug/day mean (226 ug/day 95th percentile); Bus A driver 181 ug/day mean (227 ug/day 95th percentile); Bus B driver 121 ug/day mean (151 ug/day 95th percentile); Bus C driver 304 ug/day mean (710 ug/day 95th percentile)Taxi A driver 212 ug/day mean (257 ug/day 95th percentile);			
Area sampling data:	Taxi A 28 ug/m3 mean (range 15-34 ug/m3); Taxi B 24 ug/m3 mean (range 13-30 ug/m3); Bus A 24 ug/m3 mean (range 19-30 ug/m3); Bus B (LNG) 16 ug/m3 mean (range 13-20 ug/m3); Bus C (LNG) 40 ug/m3 mean (range 14-94 ug/m3); subway (electric) 19 ug/m3 mean (range 15-27 ug/m3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	The methodology was not specified, but it was noted that carbonyls were sampled by Sep-Pak cartridges (Waters) coated with 2,4-dinitrophenylhydrazine. The sampled cartridges were eluted by 5.0 mL acetonitrile and analyzed by a HPLC system(HP1050).
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for taxi, bus, and subway drivers, which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The study was published in 2006, after the most recent PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range data were provided for area sampling and mean and 95th percentile values were provided for personal sampling.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range and percentile data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 626500 Table: 1 of 1

Study Citation:	Partanen, T., Kauppinen, T., Hernberg, S., Nickels, J., Luukkonen, R., Hakulinen, T., Pukkala, E. (1990). Formaldehyde exposure and respiratory cancer among woodworkers - an update. Scandinavian Journal of Work, Environment and Health 16(6):394-400.
HERO ID:	626500
Conditions of Use:	Use of Floor coverings

EXTRACTION	
Parameter	Data
Worker activity description:	particle board plants, plywood plants, construction carpentry, furniture manufacture, saw mills glue manufacture plants
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	less than 0.1 to 3 ppm - the study does not provide any additional details, instead the health impact component of the study considers exposure concentrations in bins < 0.1 ppm, 0.1-1 ppm, and >1.0 for different latency periods.
Number of workers:	408 out of 7307 retrospective cohort

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	data are from Finland - OECD member country
	Metric 3: Applicability	Low	Data are for woodworking, is in-scope occupational scenario but the detailed data for specific subgroups considered are not provided
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL - Published in 1990
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Sample type and exposure type not provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by and uncertainty are discussed in a qualitative manner

Overall Quality Determination **Uninformative**

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Use of Floor coverings			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.04-1.25 pp,			
Number of workers:	47			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	Data for carpentry is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics rrange but discrete sample distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 2 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Non-TSCA			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	vapor			
Personal sampling data:	10-15 mg per cigarette; 0.38 mg per pack per day; second hand smoke 0.23-0.27			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	Data for smoking is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics mean and range but discrete sample distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Mostly missing everything: Sampling/analysis methodology, number of samples, number of sites, worker activities, type of sampling, exposure duration and frequency, number of workers, and sampling location
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 3 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.4 ppm			
Exposure duration:	15 minutes			
Number of workers:	38			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Unknown
	Metric 3:	Applicability	High	Data for acid hardened lacquers is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 4 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.13-0.45			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH method 125 (chromotropic acid)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	Data for dress shop workers is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics, range but discrete sample distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability addressed by range and uncertainty was discussed in the conclusions.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 5 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.4-3.0 PPM			
Number of workers:	109			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Analytical methodology is not specified though it was noted that passive dosimeters were used	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Unknown	
	Metric 3: Applicability	High	Data for particle board / modeling is an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics, range but discrete sample distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 6 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	2.36 ppm average (range 1.6-3.48 ppm)			
Particle size characterization:	0.6 mg/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	Data for plywood workers is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics mean and range but discrete sample distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 7 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.4-0.8 ppm peak concentrations 8.8-13.6 ppm			
Number of workers:	63			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Analytical methodology is not specified though it was noted that draeger tubes were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	Data for resin manufactures is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics range and peaks but discrete sample distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 8 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	average 0.051 ppm			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	Data for off gassing of furnishings is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics mean but discrete sample distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 9 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.02-2.7 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown	
	Metric 3: Applicability	High	Data for pathology laboratories is an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics, range but discrete sample distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 10 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Consumer Use- Residential Home			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.10-0.80 ppm			
Number of workers:	65 households 208 mobile homes			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Analytical methodology is not specified though it was noted that chromotropic acid method with collection in sodium bisulfite absorbing reagent was used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	Data for off gassing of furnishings is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics , range but discrete sample distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination		Low		

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	converntional home 0.03-0.05 ppm (WHO); 0.02-0.15 ppm (CARB); 0.05-0.6 ppm NRC et al); mobile homes 0.10-0.8 ppm (NRC/WHO); mean indoor concentration 0.03 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Analytical methodology is not specified though it was noted that 2,4-DNF / liquid chromatography were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Unknown
	Metric 3:	Applicability	High	Data for off gassing of furnishings is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics mean and range but discrete sample distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Mostly missing everything: Sampling/analysis methodology, number of samples, number of sites, worker activities, type of sampling, exposure duration and frequency, number of workers, and sampling location
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 12 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.2-1.9 ppm			
Exposure duration:	4 years			
Number of workers:	280 women			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	unknown
	Metric 3:	Applicability	High	Data for histology laboratories is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics, range but discrete sample distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 13 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	mean 0.35 ppm			
Number of workers:	70 employees mobile and 3 stationary centers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Analytical methodology is not specified though it was noted that 1% sodium bisulfite solution with evaluation by the chromotropic acid method were used	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	unknown	
	Metric 3: Applicability	High	Data for day care centers is an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics mean but discrete sample distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	neither variability or uncertainty were addressed	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 14 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.				
HERO ID:	192964				
Conditions of Use:	Embalming				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	Area 0.36 +/- 0.19 ppm				
EVALUATION					
Domain	Metric	Rating		Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Unknown	
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4:	Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997	
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics mean and range but discrete sample distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.	
Overall Quality Determination			Low		

Formaldehyde

Occupational Exposure

HERO ID: 192964 Table: 15 of 15

Study Citation:	Paustenbach, D., Alarie, Y., Kulle, T., Schachter, N., Smith, R., Swenberg, J., Witschi, H., Horowitz, S.B. (1997). A recommended occupational exposure limit for formaldehyde based on irritation. Journal of Toxicology and Environmental Health 50(3):217-263.			
HERO ID:	192964			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.2-1.2 ppm			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Unknown
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data greater than 20 years but collected after most recent PEL - Published in 1997
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics , range but discrete sample distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling and analytic methods used, exposure duration, location of sampling, worker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination			Low	

Study Citation:	Pellizzari, M., Marshman, G. (2007). Formaldehyde-induced urticarial vasculitis. Australasian Journal of Dermatology 48(3):174-177.			
HERO ID:	1313653			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Anatomy lab student			
Exposure route:	Inhalation			
Personal sampling data:	1000-2000 (ppb)			
Exposure duration:	2 hours			
Exposure frequency:	2 times/weekly			
Comments:	Environmental concentrations of formaldehyde vary between 0.8 and 16 parts per billion.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old. (2007)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Perkins, J.L., Kimbrough, J.D. (1985). Formaldehyde exposure in a gross anatomy laboratory. Journal of Occupational Medicine 27(11):813-814.			
HERO ID:	1986762			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Injecting cadavers with embalming fluid and dissecting the cadavers.			
Exposure route:	Inhalation			
Personal sampling data:	Instructors: Range is 0.24-5.87 (ppm), Mean is 1.69 (ppm); Students: Range is 0.31-6.77 (ppm) Mean is 1.53 (ppm)			
Area sampling data:	Range: 0.18-1.29 (ppm) Mean: 0.50 (ppm)			
Exposure duration:	Maximum 5 hours/day			
Number of workers:	8-10 instructors and 150 students			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data from the 1980s.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed in the form of area and personal monitoring data but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Peteffi, G.P., Silva, L.B., Antunes, M.V., Wilhelm, C., Valandro, E.T., Glaeser, J., Kaefer, D., Linden, R. (2015). Evaluation of genotoxicity in workers exposed to low levels of formaldehyde in a furniture manufacturing facility. Toxicology and Industrial Health 32(10):1763-1773.		
HERO ID:	2849798		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	machining and drilling centers, board cutting, packaging, edge lamination, lamination/press, edge painting, and ultraviolet (UV) painting		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	UV painting 0.03 ppm TWA; Lamination/press 0.03 ppm TWA; Packaging 0.03 ppm TWA; Edge lamination 0.04 ppm TWA; Edge painting 0.06 ppm TWA; Machining and drilling center 0.07 ppm TWA; Board cutting 0.09 ppm TWA.		
Number of workers:	46		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Environmental concentrations of formaldehyde were determined using the UMEx 100 Passive Sampler (SKC Inc., Eighty Four,Pennsylvania, USA) according to the EU ISO 16000-4-2004. The samplers were placed in fixed positions at the height of the workers’ and controls’ breathing zone for 8 h.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Brazil - not an OECD member
	Metric 3: Applicability	High	The data are for furniture manufacturing facilities which is an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The study was published in 2015, after the most recent PEL (1992) and less than 10 years old.
	Metric 5: Sample Size	Medium	TWAs for different furniture operations .
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Metadata included such as sample type, exposure type, sample durations, but lacked exposure durations, exposure frequency, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided TWA for different woodworking operations that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium	

Study Citation:	Pexe, M.E., Marcante, A., Luz, M.S., Fernandes, P.H., Neto, F.C., Sato, A.P., Olympio, K.P. (2019). Hairdressers are exposed to high concentrations of formaldehyde during the hair straightening procedure. Environmental Science and Pollution Research 26(26):27319-27329.				
HERO ID:	5954094				
Conditions of Use:	Use				
EXTRACTION					
Parameter	Data				
Worker activity description:	Hairdressers (1/11)				
Exposure route:	inhalation (1/11)				
Physical form:	liquid products (1/11)				
Personal sampling data:	Using the NIOSH method, concentrations ranged from 0.00 to 4.12 ppm. During the IPT method, concentrations ranged from 0.00 to 4.17 ppm. (5/11)				
Area sampling data:	For the passive samples, formaldehyde vapor concentrations ranged from 0.06 to 1.92 ppm according to the UMEX method. Using the IPT method, values ranged from 0.07 to 1.79 ppm. (5/11)				
Exposure duration:	”The work shift averaged 9.1 h, 5 days a week, almost 2 h of which was dedicated to performing hair straightening procedures. (7/11)”				
Exposure frequency:	”The work shift averaged 9.1 h, 5 days a week, almost 2 h of which was dedicated to performing hair straightening procedures. (7/11)”				
Personal protective equipment:	Method developed by the Chemical Analyses Laboratory of the IPT, NIOSH 2016, and UMEX 100				
EVALUATION					
Domain	Metric	Rating		Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Brazil, a non-OECD country.	
	Metric 3:	Applicability	High	Data are for the commercial use of personal care products, an in-scope occupational scenario.	
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.	
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at 23 hair salons with different ventilation conditions.	
Overall Quality Determination		High			

Formaldehyde

Occupational Exposure

HERO ID: 93085 Table: 1 of 1

Study Citation:	Pinkerton, L.E., Hein, M.J., Stayner, L.T. (2004). Mortality among a cohort of garment workers exposed to formaldehyde: an update. Occupational and Environmental Medicine 61(3):193-200.			
HERO ID:	93085			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	geometric mean 8 hr TWA 0.15 ppm (range 0.09-0.2 ppm) geometric SD 1.9)			
Number of workers:	11,309			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for garment workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were published in 2004 but the actual monitoring data ws from 1955 to 1998, more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Posniak, M., Makhniashvili, I., Koziel, E. (2005). Volatile organic compounds in the indoor air of warsaw office buildings. Indoor and Built Environment 14(3-4):269-275.			
HERO ID:	3860006			
Conditions of Use:	Building/construction materials			
EXTRACTION				
Parameter	Data			
Number of sites:	5 office buildings, 50 total rooms in study (pg 2-4)			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	spring-summer: 2.3-32.3 $\mu\text{g}/\text{m}^3$; autumn-winter: 2-6.6 $\mu\text{g}/\text{m}^3$ (pg. 5) (weigh averaged concentrations)			
Engineering control:	Newly constructed buildings vs. old buildings equipped with mechanical or natural ventilation systems (pg. 2)			
Comments:	Number of samples: 100 total (50 rooms, two different times of year) (pg 2-4). Sampling location: middle of every room, workplace of every room, once in spring-summer and once in autun-winter (pg 2). For the determination of carbonyl compounds a GynkoteK HPLC system was used equipped with a UV/VIS detector (pg. 3)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Poland, an OECD country.
	Metric 3:	Applicability	High	Data are for building/consturction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure dura- tion and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling in different times of year, but uncertainty is not ad- dressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 4077368 Table: 1 of 1

Study Citation:	Pośniak, M., Koziel, E., Jezewska, A. (2001). Occupational exposure to harmful chemical substances while processing phenol-formaldehyde resins. International Journal of Occupational Safety and Ergonomics 7(3):263-276.			
HERO ID:	4077368			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers using phenol-formaldehyde resins, and include various branches of domestic industry for production molding forms, thermo-insulation materials, glues, lacquers, laminates as well as abrasive and frictional materials in which phenol-formaldehyde resins are used as a bonding agent.			
Exposure route:	Inhalation			
Area sampling data:	Formaldehyde concentrations in workplace air during the production of friction linings and abrasive materials were 0.5 mg/m3. Formaldehyde concentrations (mg/m3) during the production of abrasive materials at 13 workplaces were as follows: presses (4 total) - 0.070–0.197, hot presses (4 total) - 0.017–0.088, sand-mills (5 total) - 0.048–0.11. Formaldehyde concentrations (mg/m3) during the production of friction linings at 11 workplaces: presses (8 total) - 0.028—0.100, others (3 total) - 0.004–0.11.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country. other than the U.S.
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	data are more than 10 years but no more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5904647 Table: 1 of 1

Study Citation:	PPG, (1984). Industrial hygiene sampling results.			
HERO ID:	5904647			
Conditions of Use:	Glass manufacture			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.02-1.49 ppm			
Personal protective equipment:	Respirators			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for glass manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include critical data
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by collecting samples at multiple locations at the site and at multiple times throughout the year.
Overall Quality Determination			High	

Study Citation:	Price, J. H. (1978). Health Hazard Evaluation Determination, Report No. HE 77-41-505, General American Transportation Corporation, Masury, Ohio, July 1978.
HERO ID:	1317279
Conditions of Use:	Installation/Demolition of Building Materials

EXTRACTION	
Parameter	Data
Worker activity description:	General activities for site: Plasma arc cutting, welding, air arc repairing, chipping, gouging, tank cleaning, and grinding. Source of formaldehyde: Fibrous glass insulation used to seal the furnace doors. The doors were re-sealed with new insulation upon completion of each heating cycle. Typically these insulations are made with phenol-formaldehyde resins, which is the assumed source for formaldehyde emissions.
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	Plant 3 - Annealing FurnaceWest Burner Room - Near door leading into Panel Room >10 ppmWest Burner Room - Near door leading into Panel Room 2 ppmPanel Room <0.5 ppmWest Burner Room - Near door leading into Panel Room 0.5 ppmWest Burner Room - Near door leading into Panel Room 0.5 ppmF&D Annealing FurnacesWest Burner Room 0.5 - 0. 7 ppmWest Burner Room 2 ppmSouth Door - Around seal of south door of furnace 2 - 4 ppmNorth Door - Around seal of north door of furnace NDPanel Room NDSouth Door - Around seal of south door of furnace > 10 ppm
Exposure duration:	3 shifts per day
Number of workers:	1030 production personnel and 80 administrative staff
Personal protective equipment:	air supplied respirators, self-contained breathing apparatus, and a variety of air purifying respirators. A written respirator program. Processes which used respirators were tank cleaning, application of urethane foam, and rarely when welding.
Engineering control:	"Contaminant generation was primarily controlled through means of mechanical dilution ventilation and natural air movements. Occasionally, local exhaust ventilation was employed when processes involved welding, chipping, gouging, and/or grinding inside the tanks... The exhaust velocity at the face of a typical air ejector duct, with a two inch diameter, was approximately 6000 ft/min and decreased to approximately 100ft/min one foot from the duct. Since ducts were observed to be placed anywhere from one to several feet from the contaminant source, the efficiency of the system varied considerably."; waterbed to contained emissions released during the cutting of shell plates.

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling methodology is provided but does not cite the NIOSH method but does report that the tubes used were not NIOSH certified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (tank car manufacture) within the scope of the risk evaluation. The source of the formaldehyde exposure was investigated and assumed to come from the fibrous glass insulation(phenol-formaldehyde resin used in the insulation) used to seal the furnace doors.
	Metric 4:	Temporal Representativeness	Low	1977 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Medium	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed
Domain 3: Accessibility/ Clarity				

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 1317279 Table: 1 of 1

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Study Citation:	Price, J. H. (1978). Health Hazard Evaluation Determination, Report No. HE 77-41-505, General American Transportation Corporation, Masury, Ohio, July 1978.			
HERO ID:	1317279			
Conditions of Use:	Installation/Demolition of Building Materials			
Domain		Metric	EVALUATION Rating	Comments
	Metric 6:	Metadata Completeness	Medium	Monitoring data include some but not all associated metadata, including sample types, exposure types, sample durations, worker activities, but not exposure duration or frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations.As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination			Medium	

Study Citation:	Price, J. H. (1979). Health Hazard Evaluation Determination, report HE 78-13-577, Equitable Bag Company, Inc, Florence, Kentucky.			
HERO ID:	63750			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	lift truck operator (personal sampling)			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.14-0.90 ppm			
Area sampling data:	0.5-1 (40% of samples) 1 greater than 1.0 ppm			
Comments:	Missing half of the pages. Temperature and Humidity Measured.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Methods 125
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (paper warehouse operations) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	study implemented in 1979 prior to PEL proposed in 1992
	Metric 5:	Sample Size	High	Actual concentrations for each sample provided, summarized as range of values.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include most critical metadata, such as sample type, exposure type, and sampling duration, but lacks additional metadata, such as exposure durations, exposure frequency, and/orworker activities (other than lift driver). Report may have missing pages so a lack of clarity on the additional information that may have been written on those pages.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability was addressed by measuring personal and area samples, sampling on different dates and different locations. Assumed that uncertainty was addressed in the NIOSH methodology.
Overall Quality Determination		Medium		

Study Citation:	Price, J. H. (1977). Health Hazard Evaluation Determination Report No. HHE-77-31-432, Inland Steel Corporation, East Chicago, Indiana.			
HERO ID:	8442687			
Conditions of Use:	abrasive grinding			
EXTRACTION				
Parameter	Data			
Worker activity description:	activities involve abrasive grinding of steel billets and bloom			
Exposure route:	inhalation			
Physical form:	gas			
Personal sampling data:	No formaldehyde was detected			
Area sampling data:	No formaldehyde was detected			
Number of workers:	38			
Engineering control:	no engineering control implemented			
Comments:	Table VI.Lower range of measurement for Indicator Tube: Formaldehyde 0.5 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling methodology is well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Report is more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Priha, E., Ahonen, I. (1986). Field comparison of two personal formaldehyde monitoring methods. Analytical Chemistry 58(6):1195-1196.			
HERO ID:	5957863			
Conditions of Use:	Processing, Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in the furniture industry (three plants), in an iron foundry, in a plywood and particleboard factory, and in a paper products factory.			
Exposure route:	inhalation			
Personal sampling data:	The range of the measured formaldehyde concentrations was 0.03-4.2 mg/m3 (average 1.0 mg/m3) according to the CTA method.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected from 1980s.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, range, graphs) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by comparing two detection methods at 6 sites.
Overall Quality Determination		Medium		

Study Citation:	Priha, E., Riipinen, H., Korhonen, K. (1986). Exposure to formaldehyde and solvents in Finnish furniture factories in 1975-1984. Annals of Occupational Hygiene 30(3):289-294.			
HERO ID:	1320786			
Conditions of Use:	Use of Furniture and Furnishings			
EXTRACTION				
Parameter	Data			
Worker activity description:	spray or curtain painting processes.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Report indicates both personal and area sampling was conducted, but no distinction was provided in results. Assume that the results are a mix of personal or area: Range of all samples <0.1 - 6.1 ppm; Spray painting: 0.97 ppm mean, geometric mean 0.82 ppm (range 0.2-4.0 ppm); Spray painting assistance: 1.02 ppm mean, geometric mean 0.84 ppm (range 0.2-1.6 ppm); Operation of curtain painting machine: 1.11 ppm mean, geometric mean 0.73 ppm (range 0.2-6.1 ppm); Feeding of painting machine: 1.11 ppm mean, geometric mean 0.82 ppm (range 0.3-2.7 ppm); Receiving of painted pieces of furniture (before drying oven): 1.48 ppm mean, geometric mean 1.09 ppm (range 0.1-4.2 ppm); Receiving of painted pieces of furniture (after drying oven): 0.94 ppm mean, geometric mean 1.39 ppm (range 0.2-5.4 ppm). Total number of samples 161; Sampling duration: 15-30 min.			
Engineering control:	replacement of acid-cured coatings with acrylate-based lacquers and lacquers cured by UV light & improved ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	modified NIOSH method used - a 1% sodium bisulphite solution and analyzed according to the chromatropic acid method - The method suffers from interferences and a special evaporation procedure was used to address this issue.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - and OECD member
	Metric 3:	Applicability	High	The data are for Furniture factory exposure, which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data used for this publication was from 1975-1984, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Mean, geometric mean and range are provided for 6 different activities
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data includes supporting information on the activity/operations associated with data but does not distinguish on sample type (personal vs. area), and lacks additional metadata, such as exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study includes range data for six different operations which can be used to evaluate variability. Study has little to no discussion on uncertainty .
Overall Quality Determination		Medium		
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1320786 Table: 1 of 1

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Study Citation:	Priha, E., Riipinen, H., Korhonen, K. (1986). Exposure to formaldehyde and solvents in Finnish furniture factories in 1975-1984. Annals of Occupational Hygiene 30(3):289-294.		
HERO ID:	1320786		
Conditions of Use:	Use of Furniture and Furnishings		
		EVALUATION	
Domain	Metric	Rating	Comments

Study Citation:	Pryor, P. (1985). Health hazard evaluation report: HETA-84-427-1613 - Pike Peak Dialysis Center, Colorado Springs, Colorado.
HERO ID:	8632689
Conditions of Use:	Laboratory Chemicals

EXTRACTION	
Parameter	Data
Worker activity description:	Patients are connected to an artificial kidney (dialyzer) and dialysis console. Once the patient is disconnected from the dialyzer, the nurse 'or technician send the unit to reuse/sterilization for cleaning in a 4% formalin solution. Here one person will spend approximately 1 1/2 to 2 hours sterilizing all the dialyzers. On the weekends, employees are required to pack and sterilize all the consoles. Normally 3 to 5 employees are in the room during this procedure although only 2 to 3 are required to perform the actual process. This process requires the complete draining of each unit followed by filling and packing with a 10% formalin solution. This solution sets in the individual units for the entire weekend and is drained early Monday morning.
Exposure route:	inhalation & dermal
Physical form:	vapors and liquid
Personal sampling data:	Formaldehyde levels measured at the dialysis center ranged from 0.28 to 1.0 mg/M3 for personal samples. Formalin Mixing 0.79 mg/m3Reuse/Sterilization 1.0 mg/m3 & 0.75 mg/m3Dialysis Unit Packing 0.32 mg/m3; 0.90 mg/m3 & 0.42 mg/m3Nurses/Technicians 0.32 mg/m3; 0.37 mg/m3; 0.28 mg/m3 & 0.35 mg/m3
Area sampling data:	Reuse/Sterilization 0.42 mg/m3 & 0.75 mg/m3Dialysis Console Area Number 3 0.47 mg/m3 Number 4 0.50 mg/m3 Number 5 0.33 mg/m3Other Areas Directors Office ND Reception/Clerical Office ND Nurses Desk ND
Number of workers:	20 - including director/manager, technicians, nurses, dietitian, social worker, and clerical workers.
Personal protective equipment:	The employees on the main floor normally wear a lab coat or smock while attending to the patient during treatment. These employees also wear surgical gloves during weekend packing procedures.The employees who performed the reuse/sterilization procedures wore surgical gloves, a NIOSH/MSHA approved formaldehyde type disposable respirator, and goggles during the reuse process. Rubber aprons were an optional garment that could be worn by the employee while performing this activity.
Engineering control:	The slot exhaust is positioned along the back portion of the sink, directly below the dialyzer holders and is actually flush with the top of the sink. This system is designed to draw air across the front of the sink to the back and thus remove the formaldehyde contaminant from the workers breathing zone. The face velocity across the slot averaged between 30 to 40 feet per minute (fpm) and the capture velocity at the front of the sink, averaged between. 5 to 10 fpm. This is inadequate and should be redesigned. Local exhaust ventilation should be improved in areas where formaldehyde will be used extensively. A capture velocity of at least 100 fpm is required in order to exhaust the formaldehyde vapors at the source of generation and away from the operatorbreathing zone. This exhaust system will also require appropriate make-up air for the system to work properly. General room ventilation allowing for a minimum of five air changes per hour should be maintained in the general work areas. This would assist in lowering the formaldehyde levels found in all those areas tested.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method 250
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	1984-85 - prior to PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics.
Domain 3: Accessibility/ Clarity				

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Formaldehyde

Occupational Exposure

HERO ID: 8632689 Table: 1 of 1

...continued from previous page

Study Citation:	Pryor, P. (1985). Health hazard evaluation report: HETA-84-427-1613 - Pike Peak Dialysis Center, Colorado Springs, Colorado.			
HERO ID:	8632689			
Conditions of Use:	Laboratory Chemicals			
		EVALUATION		
Domain		Metric	Rating	Comments
	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Results from individual sampling events were provided which could be used to evaluate variability between locations and workers. Uncertainty is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 8637392 Table: 1 of 1

Study Citation:	Pryor, P. (1983). Health hazard evaluation report: HETA 83-048-1347. National Jewish Hospital, Denver, CO.			
HERO ID:	8637392			
Conditions of Use:	Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Worker activity description:	Laboratory workers remove animal lungs from formalin tanks, section the lungs, photograph the lungs, and place them back into formalin jars. Maintenance is performed on the formalin tank once a month, which requires draining, flushing, and refilling the tank. (4/11)			
Exposure route:	inhalation, dermal (6/11)			
Physical form:	vapors (4/11)			
Personal sampling data:	Personal samples ranged from 0.46-1.45 mg/m3. (11/11)			
Area sampling data:	Area samples ranged from 0.18-0.70 mg/m3. (11/11)			
Personal protective equipment:	The lab has three types of gloves available: latex, rubber, and polyvinyl. Lab coats are also worn during the majority of activities. The only respiratory protection are surgical masks. (5/11)			
Engineering control:	The one box/exhaust fan arrangement used for tissue slicing was pulling less than 30 feet per minute. (7/11)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected more than 20 years ago.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker description provided, but missing exposure duration, frequency, and number of workers.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is not addressed. Variability is addressed by including both personal and area samples at different locations.
Overall Quality Determination			High	

Study Citation:	Pryor, P., Gunter, B. J. (1988). Health Hazard Evaluation Report HETA 85-436-1886, Roaring Fork Transit Agency, Aspen, Colorado, April 1988.			
HERO ID:	4057870			
Conditions of Use:	Chemical substances in automotive and fuel products-Automotive care products; Lubricants and greases; Fuels and related products			
EXTRACTION				
Parameter	Data			
Worker activity description:	employees who work in the bus repair and storage area from diesel emissions from buses as they were first started in the morning, during idling periods, driven from and into the storage area and during maintenance procedures. (pdf pg 5)			
Exposure route:	Inhalation			
Physical form:	Vehicle exhaust			
Area sampling data:	Area formaldehyde concentrations were also slightly higher during the winter survey (range 0.01 - 0.10 mg/m3) than during the summer survey (range 0.004 - 0.01 mg/m3).(pdf pg 11)Twelve area samples were collected for determination of formaldehyde concentrations. . The samples were collected in impingers containing sodium bisulfite and analyzed according to NIOSH Method P&CAM 125. (pdf pg 9)			
Engineering control:	Any engine running in a repair stall requires that the bus be hooked up to the tail pipe exhaust system. (pdf pg 6)The ventilation system was designed to either conform to or exceed requirements of 1 cubic foot per minute (CFM) of outside air per square foot of floor area. The 1 CFM/ft2 outside air is designed as the level of ventilation needed to maintain exhaust pollutants below OSHA recommended criteria. This is based upon gasoline engines, and is conservative for diesel engines. The overall ventilation scheme is to introduce the outside air in the zones of primary worker exposure, and then let it migrate through the areas of progressively greater tail pipe emissions, tending to keep the more offensive air in the zones that are occupied only intermittently by workers. Stage 2 ventilation operated simultaneously with Stage 1 makeup during the hours of considerable bus activity in the storage and circulation areas. A second make-up air unit, adds a second 20,000 CFM of outside air which is introduced in the occupied bus repair area and migrates through the unoccupied storage area where it is exhausted to the outdoors from the west end by running at high speed (20,000 CFM). The anticipated hours of operation were from 5:00 a.m. until about 9:00 a.m., and from about 6:00 p.m. until 11:00 a.m. This second stage is started either manually by the supervisor, or by automatic oxygen sensors that measure the reduction of oxygen in the space. Stage 3 ventilation operates when the paint booth is turned on. When its 25,000 CFM exhaust fan, EF-4, is started, MUA-2 runs at high speed, delivering 30,000 CFM, and EF-1 operates at low speed, exhausting 10,000 CFM. An underfloor engine exhaust system with 5 inch diameter retractable tail pipe adaptor hoses is furnished. Outlets are located at each end of each repair stall. The vehicles with high tail pipe outlets require the use of 5 inch diameter "cane" adaptor. Exhaust volume is 400 CFM per outlet based upon 3 outlets in simultaneous use. (pdf pg 6-8)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling uses NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent PEL establishment or update and are more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
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Formaldehyde

Occupational Exposure

HERO ID: 4057870 Table: 1 of 1

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Study Citation:	Pryor, P., Gunter, B. J. (1988). Health Hazard Evaluation Report HETA 85-436-1886, Roaring Fork Transit Agency, Aspen, Colorado, April 1988.		
HERO ID:	4057870		
Conditions of Use:	Chemical substances in automotive and fuel products-Automotive care products; Lubricants and greases; Fuels and related products		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	The monitoring study addresses variability(winter vs summer) in the determinants of exposure for the sampled site. Uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		High	

Study Citation:	Pryor, P., Thoburn, T. W., Koons, R. K. (1985). Health hazard evaluation report: HETA-83-313-1534 - Municipal court section, City Of Englewood, Englewood, Colorado.			
HERO ID:	1316838			
Conditions of Use:	Use of photographic supplies			
EXTRACTION				
Parameter	Data			
Worker activity description:	In addition to the judge, this section consists of seven (7) employees whose job functions include: typing, answering phones, handling ticket payments and warrants, using a photocopier, and filing.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Top shelf left side 0.04 mg/M3 (12/16/83) 0.042 mg/m3 (3/15/84) 0.046 (3/17/84)Third shelf left side 0.029 mg/M3 (12/16/83) 0.033 mg/m3 (3/15/84) 0.041 (3/17/84)Top shelf Rich side 0.029 mg/M3 (12/16/83) 0.036 mg/m3 (3/15/84) 0.046 (3/17/84)Third shelf left side 0.018 mg/M3 (12/16/83) 0.024 mg/m3 (3/15/84) Desk by shelves 0.0296mg/M3 (12/16/83) 0.0246 mg/m3 (3/15/84) 0.031 (3/17/84)Desk by computers 0.024 mg/m3 (3/15/84) Desk by window 0.031 (3/17/84)Jury room 0.020 mg/m3 (3/15/84)			
Dermal exposure data:	nan			
Number of workers:	8			
Personal protective equipment:	cotton gloves			
Engineering control:	Enhance HVAC ventilation and increase air flow in office			
Comments:	Results indicate some dependence on the formaldehyde exposure to the carbonless paper but it also was noted that there was plywood shelves and plastic laminated counter tops. The report also indicates sources could also be from cigarette smoke, glues in carpeting and fabricated materials.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study - Method 125
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario(office worker) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1983 prior to PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Medium	Results from individual sampling events and locations were provided. No other statistical summaries were included
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	results for each sampling event were provided such that variabilty for different days and locations can be estimated. As the results are derived from a NIOSH methology, it is assumed that uncertainty was considered.
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Formaldehyde

Occupational Exposure

HERO ID: 1316838 Table: 1 of 1

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Study Citation:	Pryor, P., Thoburn, T. W., Koons, R. K. (1985). Health hazard evaluation report: HETA-83-313-1534 - Municipal court section, City Of Englewood, Englewood, Colorado.		
HERO ID:	1316838		
Conditions of Use:	Use of photographic supplies		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Quémérais, B. (2013). Occupational exposure to atmospheric emissions produced during live gun firing. Environment and Pollution 2(4):57-69.			
HERO ID:	6018402			
Conditions of Use:	Explosive materials (live gun firing)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Weapon operators - the C3 105 mm howitzer, the M777 155 mm howitzer, and the Carl Gustav 84 mm anti-tank			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	”Table 6 (pg 9): M777 Howitzer, two different sampling locations: Table 1: 7.1 µg/m3; Table 2: 3.6 µg/m3 Carl Gustav, two different sampling locations: Station 1: 8.2 µg/m3; Station 2: 5.8 µg/m3”			
Comments:	Sampling info: Trial 1 (C3 Howitzer): 35-43 min sampling (pg 3); Trial 2 (M777 Howitzer): 170 minute sampling (pg 4); Trial 3 (Carl Gustav): 105 minute sampling (pg 4). M777 Howitzer: Table 1 (8m left of gun, pg 4); Table 2 (in firing direction 22m from gun, pg 4)Carl Gustav: both in line with firing bay - Station 1 (8m from firing bay, pg 4); Station 2 (13m from firing bay, pg 4)Parameters were sampled and analyzed according to standardized NIOSH and OSHA methods using appropriate filters and sorbent tubes (pg 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved OSHA/NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3:	Applicability	High	Data are for explosive materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty addressed by discussing that PBZ and/or area samples closer to gun weren’t possible for safety reasons. Variability addressed by sampling for multiple guns.
Overall Quality Determination			High	

Study Citation:	Radian Engineering, (1997). General Electric Engine Services Test Cell Complex - AB 2588 air toxic ”hot spots” 1991 health risk assessment, with cover letter dated 10/21/1997.			
HERO ID:	5665035			
Conditions of Use:	Jet fuel in aircraft engines			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	Max hourly concentration: 1.0 x 10^1 ug/m^3. Annual average: 1.9 x 10^-3			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Data is TSCA submission for EPA so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to use in aircraft engines as fuel.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by large range of data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes exposure route, release quantities and emission factors.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by testing different types of jet engines. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Rahman, M.A., Rossner, A., Hopke, P.K. (2017). Occupational exposure of aldehydes resulting from the storage of wood pellets. Journal of Occupational and Environmental Hygiene 14(6):417-426.			
HERO ID:	3870738			
Conditions of Use:	Commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers involved in wood pellets production and storage			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Air sampling was performed in a wood pellet warehouse at a pellet mill, and in controlled laboratory experiments. Sampling was conducted in five locations in the warehouse from April–June 2016 when it contained varying quantities of bagged pellets. In April 2016, the warehouse was about 30% full of bags of softwood and blended wood pellets. By May, it was 50% full. Finally, by the June sampling day, the warehouse was full of the pellet bags. Formaldehyde concentrations in the warehouse ranged from 0.15–0.44 ppm Formaldehyde concentrations in the warehouse are above the NIOSH REL (0.02 ppm, 8 hr), NIOSH REL-C (0.10 ppm, 15 min), and ACGIH TLV-C (0.30 ppm, ceiling) when the warehouse was filled to 50–100% of its capacity for pallets of bagged wood pellets. The laboratory studies of the aldehydes off-gassing were conducted by using softwood and blended wood pellets. In the laboratory, formaldehyde concentrations in the drums ranged from 0.13–0.15 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling and analytical methodology well described.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	Data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	Data less than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty
Overall Quality Determination		Medium		

Study Citation:	Reeves, W.A., Day, M.O., McLellan, K.R., Vigo, T.L. (1981). Formaldehyde release in formaldehyde-finished and resin-finished fabrics. Textile Research Journal 51(7):481-485.			
HERO ID:	5960898			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in finishing plants, fabric storage and cutting rooms, and retail stores. (1/5)			
Exposure route:	inhalation (1/5)			
Area sampling data:	Five finishing agents were tested with cotton and polyester/cotton fabric. Initially, formaldehyde releases ranged from 560-12,800 ppm. After one wash, formaldehyde releases ranged from 18-1,128 ppm. (Full data available in text). (4/5)			
Engineering control:	"One approach [to reduce formaldehyde emissions] has been to develop N-methylol compounds that resist hydrolysis. One of the best and most frequently used compounds is dimethylol 4,5-dihydroxyethyleneurea. This reduced free formaldehyde to about 1100 ppm... Another approach to reduce formaldehyde release is to wash and dry fabrics after treatment. This approach has reduced free formaldehyde to about 800 ppm... A less expensive approach is to steam the treated fabrics for several seconds. This leaves about 1000 ppm on formaldehyde in the fabric." (1/5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for textile finishing and the use of fabric, which are in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling two fabric types with five different finishing agents.
Overall Quality Determination		High		

Study Citation:	Regazzoni, L.G., Grigoryan, H., Ji, Z., Chen, X., Daniels, S.I., Huang, D., Sanchez, S., Tang, N., Sillé, F.C., Iavarone, A.T., Williams, E.R., Zhang, L., Rappaport, S.M. (2017). Using lysine adducts of human serum albumin to investigate the disposition of exogenous formaldehyde in human blood. Toxicology Letters 268:26-35.			
HERO ID:	4454115			
Conditions of Use:	Formaldehyde Production Factory			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Exposed subjects worked in a formaldehyde-production factory and control workers were employed in a nearby medical school and other local institutions in jobs that did not involve use of formaldehyde. The formaldehyde exposure levels in the production factory were assessed with air samples collected annually at three locations representing the range of formaldehyde air concentrations in the workplace. Between 2012 and 2014 the estimated air concentrations ranged from a low value of 0.3 ppm to a high value of 10 ppm, which were at the upper end of reported exposure concentrations in Chinese factories. Based on all measurements, the authors estimated that workers in this factory were exposed to formaldehyde at the median air concentration of 1.5 ppm.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data from a non-OECD country
	Metric 3:	Applicability	High	Data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data is no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Reh, B. D. (1995). Health hazard evaluation report HETA-95-0153-2549, Fort Wayne Foundry Machining Division, Fort Wayne, Indiana. GRA and I(GRA and I):95-0153.			
HERO ID:	1320737			
Conditions of Use:	Use of metal products			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	The formaldehyde samples were all less than 0.06 ppm (minimum quantifiable concentration was 0.05 ppm and minimum detectable concentration was 0.02 ppm). This is not surprising since the last addition of Grotan® (biocide added to the MWF - noted formaldehyde releaser) occurred over three weeks before the survey. The fact that is was still detectable suggests that the concentrations might be higher when the Grotan® is first added.			
Dermal exposure data:	nan			
Exposure duration:	8-10 hours per day			
Exposure frequency:	40 hours per week			
Personal protective equipment:	NIOSH investigators recommend that each employee have uniforms and that they be required to shower and change before leaving work. Used uniforms should not be stored in contact with clean ones or with personal clothing. Employees should also beencouraged to change clothes that have become soaked with MWFs. The uniforms should be laundered at the facility.			
Engineering control:	Local exhaust ventilation (LEV) should be installed for each operation.			
Comments:	Formaldehyde concentrations were low, so the ultimate source may be cigarette smoke.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method 2541
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (aluminum metal work) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1995 - after PEL (1992) but more than 20 years old
	Metric 5:	Sample Size	Medium	Only maximum value provided, no statistical analysis. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, exposure durations, exposure frequency, but lacks additional metadata, such as sample durations, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability could not be assessed as only one maximum value was provided. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1320737 Table: 1 of 1

...continued from previous page

Study Citation:	Reh, B. D. (1995). Health hazard evaluation report HETA-95-0153-2549, Fort Wayne Foundry Machining Division, Fort Wayne, Indiana. GRA and I(GRA and I):95-0153.		
HERO ID:	1320737		
Conditions of Use:	Use of metal products		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Reh, C. M. (1989). Health Hazard Evaluation Report No. HETA-87-370-1973, Native Textiles, Glenn Falls, New York. :87-370.			
HERO ID:	1319215			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Spoolers and thread drawers.			
Exposure route:	Inhalation			
Area sampling data:	Threader concentrations range: 0.07-0.28 (ppm)ARTOS Frame: 0.06 (ppm)Spooler concentrations range: 0.11-0.13 (ppm)			
Exposure duration:	8-10 hours per workday			
Number of workers:	Native Textiles is a manufacturer of lace, tricot, and specialtyfabrics, employing approximately 400 people at its Glens Falls, NewYork facility.			
Personal protective equipment:	Workers in the ARTOS frame area who handle the melamine-formaldehyde resin should wear respirators, face shields, goggles, gloves, and impervious clothing			
Engineering control:	Ventilation			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for Manufacture of Textiles, Apparel, and Leather (including fabric/textile finishing), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by multiple areas being sampled.
Overall Quality Determination		High		

Study Citation:	Reinhardt, T.E. (1992). Monitoring firefighter exposure to air toxins at prescribed burns of forest and range biomass.			
HERO ID:	84100			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	lighting , lin holding, direct attack, and mop up			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	lighting ranged from 0.01-0.08 ppm; lighting and direct attack 0.16 ppm; holding line ND to 0.10 ppm; holding line and direct attack 0.015 ppm; direct attack 0.11-0.20 ppm.			
Area sampling data:	4 prescribed burn sites			
Number of workers:	20-30 firefighter per event with 5 fitted with samplers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it was noted that C-18 cartridge impregnated with 2,4-dinitrophenylhydrazine/ liquid chromatography were used
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Washington state US
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after the PEL- Published 1992
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics - results provided in a bar chart
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing: sampling and analysis methods, number of samples, exposure duration and frequency,
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	variance and uncertainty not addressed.
Overall Quality Determination		Medium		

Study Citation:	Reinhold, K. (2006). Chemical risk assessment in manufacturing. Proceedings and Monographs in Engineering Water and Earth Sciences :823-828.			
HERO ID:	1631188			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	likely to be area sampling: 0.5 mg/m3 8 hr mean			
Number of workers:	1000			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Estonia - an OECD member	
	Metric 3: Applicability	High	The data are for application of varnish on wood products which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The data used in this study were from 2004-2005, after the most recent PEL (1992) and more than 10 but less than 20 years old.	
	Metric 5: Sample Size	Medium	only a 8 hr mean value was provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The study did not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	Reisen, F., Brown, S.K. (2009). Australian firefighters’ exposure to air toxics during bushfire burns of autumn 2005 and 2006. Environment International 35(2):342-352.			
HERO ID:	1058185			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Worker activity description:	Supervision, Ignition, Patrolling, Suppression, Research			
Personal sampling data:	Mean:<0.14 (ppm), Range: ND –0.57 (ppm)			
Area sampling data:	Mean: <0.20 (ppm), Range: ND–0.52 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved OSHA/NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	Medium	Data are for bushfire burning (firefighters), which is similar to the in-scope occupational scenario agriculture, forestry, fishing, and hunting.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure frequency, exposure duration.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by both personal and area sampling.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 6018167 Table: 1 of 1

Study Citation:	Ricciardone, T. L. (1998). Case study: The Brigham and women’s hospital experience. :227-256.				
HERO ID:	6018167				
Conditions of Use:	Laboratory Chemical: Hospital exposure/use for nurses				
EXTRACTION					
Parameter	Data				
Exposure route:	inhalation				
Physical form:	gas, vapor				
Personal sampling data:	Personnel exposure to absorbed formaldehyde in the dust from the paper products and garments represented approximately 1/200th of the exposure to the lowest median concentration of gas-based formaldehyde.				
Area sampling data:	Formaldehyde levels were generally less than 1/100th of the occupational health standard of 750 parts per billion (ppb) for an eight-hour time-weighted average.				
Personal protective equipment:	Gloves, gown				
Engineering control:	Ventilation System				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.	
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1998).	
	Metric 5:	Sample Size	Low	Not characterized by statistics.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes exposure route, physical form, sampling data, and some engineering controls.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.	
Overall Quality Determination			Low		

Formaldehyde

Occupational Exposure

HERO ID: 2460077 Table: 1 of 1

Study Citation:	Rios, J., Boechat, J., Ramos, M., Luiz, R., Neto, F.A., Silva, J.L. (2010). Asthma prevalence in workers of two office buildings and exposure to total volatile organic compounds and formaldehyde. Allergy 65(Suppl. 92):122.				
HERO ID:	2460077				
Conditions of Use:	Office Environment				
EXTRACTION					
Parameter	Data				
Area sampling data:	>100 (ug/m^3)				
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from the Brazil, non-OECD country.	
	Metric 3:	Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupational scenario.	
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on current industry conditions and data more than 10 years old. (2010)	
	Metric 5:	Sample Size	Low	characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., area) but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at multiple buildings but uncertainty is not addressed.	
Overall Quality Determination			Low		

Study Citation:	Rivera, R. (1976). Health Hazard Evaluation Report No. 75-143-333, Unitog Company, Warrensburg, Missouri.
HERO ID:	1317903
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product

EXTRACTION	
Parameter	Data
Worker activity description:	The pants, service suits, shop coats, and some of the jackets are pressed by one of twelve operators. The machines used by these operators are oriented in two rows and in such a manner that permits the operator to control two machines. After these items have been pressed, one of two employees places them on hangers so that a third employee may place them on a conveyor (chain) which travels through the curing oven. One employee removes the items cured in the oven and folds and sizes the pants. Other items are sent to two other employees for folding and packaging. Shirts are pressed on the opposite side of the room by utilizing a sleeve presser, a collar presser, and a body presser. Each of five "shirt pressers" operates two machines; a collar presser and a sleeve presser. The remaining three "shirt pressers" operate single machines which press the body of the shirts. In addition to the employees mentioned above, there are two employees who fold shirts, one "bundle boy" who delivers bundles of clothes to be pressed to the operators, one utility person, and one supervisor in this room.
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	November 12-13, 1975 Pants Presser (a) Machine 604 & 605: 53.4 ug/m3 and 77.7 ug/m3 Pants Presser (b) Machine 608 & 609: 54.9 ug/m3 and 133.9 ug/m3 Pants Presser (c) Machine 600 & 601: 59.9 ug/m3 and 8.5 ug/m3 Presser (d) removing cured clothing from the conveyor: 93.0 ug/m3 and 67.0 ug/m3 Pants Presser (e) Machine 616 & 617: 72.8 ug/m3 and 16.7 ug/m3 Pants Presser (f) Machine 622 & 623: 5.9 ug/m3 and 73.3 ug/m3 Shirt Presser (g) Machine 629: 6.6 ug/m3 and 11.9 ug/m3 Shirt Presser (h) Machine 631: 112.4 ug/m3 and 9.1 ug/m3 Shirt Presser (i) Machine 636 & 637: 1188.4 ug/m3 and 73.2 ug/m3 Presser (j) removing cured clothing from the conveyor: 36.0 ug/m3 and 74.1 ug/m3 Pants Presser (f) Machine 622 & 623: 81.3 ug/m3 Pants Presser (k) Machine 606 & 607: 83.9 ug/m3 November 13, 1975 Pants Presser (a) Machine 604 & 605: 50.9 ug/m3 and 70.1 ug/m3 Pants Presser (c) Machine 600 & 601: 28.4 ug/m3 and 137.3 ug/m3 Pants Presser (l) Machine 614 & 615: 319.9 ug/m3 and 35.0 ug/m3 Pants Presser (m) Machine 618 & 619: 41.3 ug/m3 and 76.8 ug/m3 Pants Presser (n) Machine 610 & 611: 53.9 ug/m3 and 48.2 ug/m3 Jacket Presser (o): 14.7 ug/m3 and 118.4 ug/m3 Pants Presser (f) Machine 622 & 623: 67.2 ug/m3 and 72.7 ug/m3 Shirt Presser (h) Machine 631: 88.8 ug/m3 and 121.8 ug/m3 Folder & Boxer (p) 50.5 ug/m3 and 63.2 ug/m3
Number of workers:	30
Personal protective equipment:	Long sleeve shirts.
Engineering control:	Increase air supply to cool the pressers.

		EVALUATION		
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study -
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (fabric pressing and curing) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1975 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity				

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Formaldehyde

Occupational Exposure

HERO ID: 1317903 Table: 1 of 1

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Study Citation:		Rivera, R. (1976). Health Hazard Evaluation Report No. 75-143-333, Unitog Company, Warrensburg, Missouri.		
HERO ID:		1317903		
Conditions of Use:		Incorporation into a formulation, mixture, or reaction product		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, worker activities, and sample durations, but lacks additional metadata, such as exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1320884 Table: 1 of 1

Study Citation:	Rivera, R. O. (1976). Health Hazard Evaluation Determination, Report No. 74-110-306, Morris Bean and Company, Yellow Springs, Ohio.			
HERO ID:	1320884			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	In addition to the employees who operate the core blowing machines, two employees trim, piece the cores together, and inspect them.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	There was no significant difference between the formaldehyde samples and the blanks.			
Number of workers:	300 Production workers - 30 work in the core department			
Personal protective equipment:	Provide appropriate protective gloves to reduce skin contact withorganic binders during mixing in Department 13.			
Engineering control:	- Upgrade the local exhaust systems in Departments 13 and 68 by balancing the systems and assuring that the capture velocities are adequate.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (foundry) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1976 - prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Non detect
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Non detect
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 3421306 Table: 1 of 1

Study Citation:	Roberts, L.G., Dabbs, G.R., Spencer, J.R. (2016). An update on the hazards and risks of forensic anthropology, Part II: Field and laboratory considerations. Journal of Forensic Sciences 61(Suppl. 1):S14-S21.			
HERO ID:	3421306			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Forensic anthropologists			
Area sampling data:	Studies report pathologists, anatomists, and individuals working in biological teaching laboratories are exposed to levels of formaldehyde that routinely exceed 0.3 ppm. The highest concentration noted was 5.02 ppm during macroscopic examination of preserved specimens in pathology and anatomy laboratories.			
Personal protective equipment:	If PEL and STEL are exceeded, respirators are required.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	Report is less than 10 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 2453832 Table: 1 of 1

Study Citation:	Robinson, C. F., Waxweiler, R. J., Fowler, D. P. (1986). Mortality among production workers in pulp and paper mills. Scandinavian Journal of Work, Environment and Health 12(6):552-560.			
HERO ID:	2453832			
Conditions of Use:	Paper manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Mentions urea and melamine formaldehyde for wet pulp paper additives and bleaching and additives. These resins were used in some of the sizing agents and pigments added to the slurry. They were also contained in some of the coatings applied to finished paper.			
Area sampling data:				
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	Data are for paper manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1986)
	Metric 5:	Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data lacks critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Robinson, J. N., Echt, A. (1995). Health hazard evaluation report No. HETA-93-1084-2500, Reliance Electric, Madison, Indiana. :93-1084.			
HERO ID:	1498812			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	Vapor			
Area sampling data:	Table by Scratch Brush, Winding Area 0.023 ppm 0.017 ppm 8-hr TWA Top of Scratch Brush by Young Brothers Machine 0.016 ppm 0.011 ppm 8-hr TWA On Desk by Hand Dip Varnish Tanks 0.019 ppm 0.013 ppm 8-hr TWA			
Exposure duration:	2 shifts per day			
Exposure frequency:	7 days per week			
Number of workers:	430			
Personal protective equipment:	Respiratory mask			
Engineering control:	A varnish which does not release formaldehyde during the curing process might be substituted for the Isonel 32-RF varnish now in use. If this is not feasible, the effectiveness of local exhaust ventilation on the Young Brothers machine and around the hand-dip tanks might be improved. Finally, additional tempered replacement air could be introduced into the areas where the varnish cures to dilute the concentration of formaldehyde to acceptable levels.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method 2541
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (electric motor/ generator manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1994 - After the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, exposure durations, and exposure frequency but lacks worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1498812 Table: 1 of 1

...continued from previous page			
Study Citation:	Robinson, J. N., Echt, A. (1995). Health hazard evaluation report No. HETA-93-1084-2500, Reliance Electric, Madison, Indiana. :93-1084.		
HERO ID:	1498812		
Conditions of Use:	Use of Paints/Coatings		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Romanazzi, V., Pirro, V., Bellisario, V., Mengozzi, G., Peluso, M., Pazzi, M., Bugiani, M., Verlato, G., Bono, R. (2013). 15-F2t isoprostane as biomarker of oxidative stress induced by tobacco smoke and occupational exposure to formaldehyde in workers of plastic laminates. Science of the Total Environment 442:20-25.			
HERO ID:	1579017			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	210 (ug/m^3)			
Number of workers:	51			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Italy is an OECD country
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2013)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean and standard deviation).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include personal breathing zone and sample durations but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Occupational Exposure

Study Citation:	Roper, C. P., Jr (1976). Health Hazard Evaluation Determination, Report No. 74-120-260, Goodyear Tire and Rubber Company, Gadsden, Alabama.			
HERO ID:	1009699			
Conditions of Use:	Rubber Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Three employees per shift (the Banbury operator, the batch builder, and the rubber opener) add the raw ingredients to the top of the Banbury. Each batch of sleeve stock is run through a series of rolling mills and then cut into 3x4 ft. sheets and stacked by the cutter man. Four employees per shift are exposed at the mill line and 8-inch tuber, a milling and extrusion operation. The mill man loads the sleeve stock which has come from the Banbury area onto a warm-up mill where the stock is heated slightly and milled. One person operates the tuber where the stock is cut into lengths after extrusion and two bookers layoff the slugs into trays. One operator (cure man) per shift works in the sleeve curing area. His duties include (1) cutting slugs of previously extruded sleeve stock to the proper length and weight, (2) curling the slugs into a circular shape, (3) placing the slugs into a pre-heating oven at 125 degrees F, (4) inserting the pre-heated slugs into the mold presses and removing the molded sleeves, and (5) inspecting the sleeves. The operator removes the sleeves manually from the presses and throws them onto metal tables to cool.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Range from ND to 0.55 ppm, data for each sampling event are provided in Table 2			
Area sampling data:	One area sample was taken which found concentration of 0.01 ppm			
Exposure duration:	varies by job, for example milling sleeve stock is done for 2 hours per batch.			
Exposure frequency:	varies based on task for example the Banbury mixer is operated 1 shift per week compared to cure man who operate three shifts per day.			
Number of workers:	varies by job			
Engineering control:	- improve exhaust system- find substitute resins			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Study was implemented in 1975 prior to the PEL (1992)
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Samples were taken for different operators and locations, thus addressing variability. Uncertainty is not addressed.
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Formaldehyde

Occupational Exposure

HERO ID: 1009699 Table: 1 of 1

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Study Citation:		Roper, C. P., Jr (1976). Health Hazard Evaluation Determination, Report No. 74-120-260, Goodyear Tire and Rubber Company, Gadsden, Alabama.		
HERO ID:		1009699		
Conditions of Use:		Rubber Product Manufacturing		
Domain		Metric	EVALUATION Rating	Comments
Overall Quality Determination			High	

Study Citation:	Roper, P. (1976). Health Hazard Evaluation Determination Report No. 74-86-269, Owens-Corning Fiberglass Corporation, Newark, Ohio.			
HERO ID:	8489748			
Conditions of Use:	adhesive and sealant chemicals in resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Operators are exposed to phenol, formaldehyde, and ammonia during the addition of chemicals to the reactor vessel, unloading of raw materials into storage tanks, and from leaking valves and connections. (7/24)			
Exposure route:	inhalation, dermal (5/24)			
Physical form:	vapor (1/24)			
Personal sampling data:	No formaldehyde was detected in personal or area samples. (16/24)			
Area sampling data:	No formaldehyde was detected in personal or area samples. (16/24)			
Number of workers:	Three employees per shift in the resin production area. (7/24)			
Engineering control:	The reactor vessels are local exhaust vented so that most of the dust and fumes from additions and mixing are drawn away from the operator, into the reactor vessel, and out through the ventilation ducts. (7/24)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesives and sealant chemicals in resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but missing exposure duration, frequency and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination			High	

Study Citation:	Rossiter, W.J., Mathey, R.G. (1985). Urea-formaldehyde foam insulations: a review of their properties and performance.			
HERO ID:	6020303			
Conditions of Use:	Commercial use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	The CPSC analyzed data on formaldehyde levels in 1,164 residences which contained urea-formaldehyde foam and 103 residences without foam. Data included measurements in foam-insulated houses from a few weeks after installation to 9 years after installation. The data analyzed by CPSC indicated that the average level of formaldehyde in residences with urea-formaldehyde foam was 0.12 ppm, while that in residences without foam was 0.03 ppm. The analysis also indicated that the level of formaldehyde in foam insulated residences declined relatively rapidly in about the first 40 weeks after installation and more slowly after that time. For example, within 40 weeks after installation, the formaldehyde levels were generally in range of 0.2 - 0.3 ppm, while about 1 year after installation they dropped to slightly less than 0.1 ppm on the average. A limited study was conducted in the United States whereby formaldehyde levels were determined in 3 control residences, one mobile home having urea-formaldehyde foam, 10 residences having urea-formaldehyde foam, and 2 residences from which foam had been removed. These homes were located in Colorado and the age of the foam was greater than 2 years. The average formaldehyde level in the foam insulated homes was 0.039 ppm. That in the control homes averaged 0.019 ppm. For two of the homes in the Colorado area, the formaldehyde measurements were made in both the winter and following spring. These results in general showed the levels to increase in the spring time. This study also included measurements of formaldehyde levels of 11 foam-insulated residences located in Wisconsin. Nine of these residences had urea-formaldehyde foam insulation with a minimum age of 2 years; the foam age of the other two residences was a year or less. The average formaldehyde concentration was 0.079 ppm, which was higher than that for the residences surveyed in Colorado.			
Personal protective equipment:	PPEs during foam removal: wearing of protective equipment (e.g., masks, respirators) and clothing during removal, handling of chemicals.			
Engineering control:	Some engineering controls are as follows: (1) Reducing moisture levels in wet cavities through drying, and keeping the cavities as dry as possible. (2) Sealing air leakage paths both where outside air enters the structural walls, and where it finally enters the building. (3) Ventilation to reduce the formaldehyde gas concentration. (4) Removal of the Urea-Formaldehyde Foam Insulation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the United States
	Metric 3:	Applicability	Low	The data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation. The area sampling data are for exposures to the residents
	Metric 4:	Temporal Representativeness	Low	More than 20 years old
	Metric 5:	Sample Size	Low	Characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
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Study Citation:	Rossiter, W.J., Mathey, R.G. (1985). Urea-formaldehyde foam insulations: a review of their properties and performance.		
HERO ID:	6020303		
Conditions of Use:	Commercial use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Low	

Formaldehyde

Occupational Exposure

HERO ID: 4157290 Table: 1 of 1

Study Citation:	Rothman, N., Lan, Q., Smith, M.T., Vermeulen, R., Zhang, L. (2017). Response to letter to the editor of Carcinogenesis by Pira et al., 2017. Carcinogenesis 38(12):1253-1255.			
HERO ID:	4157290			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in factories that manufacture plastic plates and light utensils using a formaldehyde based resin.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	The median exposure was 1.38 ppm and the 10th to the 90th percentile was 0.78 to 2.61 ppm			
Number of workers:	43			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is from China.
	Metric 3:	Applicability	High	Data are for formaldehyde use in factories, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (median, percentiles) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing most other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by pairing individuals and excluding potential confounding subjects, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1314193 Table: 1 of 1

Study Citation:	Roto, P., Sala, E. (1996). Occupational laryngitis caused by formaldehyde: A case report. American Journal of Industrial Medicine 29(3):275-277.			
HERO ID:	1314193			
Conditions of Use:	Use of food packaging			
EXTRACTION				
Parameter	Data			
Worker activity description:	During the packing process. milk boxes (Pure-Pack TM) are closed thermally and aldehydes are emitted in low quantities.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Likely area sampling: 0.03 mg/m3			
Number of workers:	1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for food packaging (milk carton) which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were published in 1996, after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Low	only a single value was provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 3362355 Table: 1 of 1

Study Citation:	Rovira, J., Roig, N., Nadal, M., Schuhmacher, M., Domingo, J.L. (2016). Human health risks of formaldehyde indoor levels: An issue of concern. Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances & Environmental Engineering 51(4):357-363.			
HERO ID:	3362355			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Area sampling data:	Indoor air levels of formaldehyde from study (ug/m^3): 27.3 [10.7-47.7] for indoor air; 22.5 [9.6-37.2] in bedrooms and living rooms; 21.8 [5.9-40.4] for offices; 1.6 [1.0-3.4] for outdoor terraces or balconies; Figure 1 provides graphical depiction of formaldehyde levels of what was previously described. Long series of indoor air levels of formaldehyde shown in Table 3 for various studies as referenced literature sources. Typical indoor concentrations range form 10 to 50 ug/m^3 being 46 and 37 ug/m^ in bedrooms and living rooms. Northern Europe have levels of 29.8 [4.8-115]; Southern Europe have levels of 12.7 [5.2-32.9]; Usual US levels between 20-40 with outdoor ranges between 1 and 4.			
Exposure duration:	Sample duration of 8 hours			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Unclear if source is peer reviewed but appears to contain high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for Spain, an OECD country.
	Metric 3:	Applicability	Low	Data not applicable to most COUs as it is for indoor homes and offices.
	Metric 4:	Temporal Representativeness	High	Less than 10 years old (2016)
	Metric 5:	Sample Size	Medium	Characterized by a range of data with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes sampling duration, area sampling and exposure route.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Roy, D.R. (1999). Histology and pathology laboratories. Chemical hazard prevention and medical/health surveillance. American Association of Occupational Health Nurses Journal 47(5):199-205.			
HERO ID:	1986779			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Hospital workers			
Exposure route:	Inhalation			
Area sampling data:	In postmortem rooms and specimen dissection areas, average exposures in the 1980s have been reported in the range of 0.6 to 1.3 ppm, with occasional levels up to 8 ppm.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Rudell, B., Sandstrom, T., Hammarstrom, U., Ledin, M.L., Horstedt, P., Stjernberg, N. (1994). Evaluation of an exposure setup for studying effects of diesel exhaust in humans. International Archives of Occupational and Environmental Health 66(2):77-83.			
HERO ID:	77214			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Worker activity description:	light work, riding and ergometer-bicycle			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.5 mg/m3 median during 1 hr exposure (interquartile range 0.3-0.8 mg/m3; TLV-TWA 0.6 mg/m3)			
Number of workers:	8 participants			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling and analysis methods not provided, though it was noted that samples were collected on glass fiber filters impregnated with 2,4-dinitrofenylhydrazine and analyzed with HPLC
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Appears that study was implemented in Sweden - OECD member
	Metric 3:	Applicability	High	The data are for vehicle exhaust which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old -Published in 1994
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - Median and Interquartile rang e provided along with TLV-TWA
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	nothing additional provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	variability could be estiamted from the interquartile range but no discussion of uncertainty
Overall Quality Determination		Medium		

Study Citation:	Ruhe, R. L. (1985). Health hazard evaluation report: HETA-84-151-1544 - Nutrun Corporation, New Castle, Indiana.			
HERO ID:	8632586			
Conditions of Use:	adhesives and sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	Mixer operators, manual preform operators (20/21)			
Exposure route:	inhalation, dermal (8/21)			
Physical form:	gas (8/21)			
Personal sampling data:	A personal and an area sample for formaldehyde both were below the limit of detection of 2 ug. (20/21)			
Area sampling data:	A personal and an area sample for formaldehyde both were below the limit of detection of 2 ug. (20/21)			
Exposure duration:	8-10 hours (6/21)			
Number of workers:	135 production workers and 35 salaried workers. (4/21)			
Engineering control:	Personal and environmental monitoring should be performed every 6 months. Periodic maintenance of ventilation equipment should be performed to prevent malfunction. Areas where employees are allowed to eat or drink should be kept free of toxic material. (13/21)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for industrial use of adhesives and sealants, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker activity provided, but missing exposure frequency and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		High		

Study Citation:	Ruhe, R. L., Ehrenberg, R. (1985). Health hazard evaluation report: HETA-84-172-1573 - Philadelphia Limerick Power Plant, Pottstown, Pennsylvania.			
HERO ID:	1322380			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	The insulation workers use a power saw to cut cured Thermo-Lag 330-1 insulation to the contour of the pipes and conduits. In this procedure the material becomes airborne. Joints are sealed with uncured Thermo-Lag 330-1 applied with a trowel. (Page 4 of 22)			
Personal sampling data:	Formaldehyde concentrations from six personal air samples ranged from 0.03 to 0.08 mg/m3 8-hour TWA. (Page 9 of 22). See Table 2 on page 17 for all data and locations of each data point.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method 354
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (Construction activity) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1984 - prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 5939012 Table: 1 of 1

Study Citation:	Rumph, P. F. (1981). Formaldehyde: Review of adverse-effects and report of air concentrations in a gross-anatomy laboratory. Anatomia, Histologia, Embryologia 10(1):92.			
HERO ID:	5939012			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Anatomy lab workers			
Exposure route:	inhalation			
Physical form:	vapor, gas			
Area sampling data:	Samples were between 1.5 - 3.5 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	From a peer reviewed source so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Medium	Only characterized by a range but no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes worker activity, exposure route, physical form, and area sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Rumph, P.F. (1987). Formaldehyde vapor levels in a gross anatomy laboratory during dissection of the dog. Anatomia, Histologia, Embryologia 16(2):144-149.			
HERO ID:	5945158			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Veterinary medical students and their mentors during dissection of specimens.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	The overall mean time weighted average was 0.197 ppm, with a maximum of 0.31 ppm and a minimum of 0.09 ppm.			
Exposure duration:	100 minutes			
Exposure frequency:	average of 3.25 days/week			
Number of workers:	89 students and 5 faculty members			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, maximum, minimum, range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling the laboratory during different weeks while students were performing different tasks.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1230593 Table: 1 of 1

Study Citation:	Ryan, T.J., Burroughs, G.E., Taylor, K., Kovein, R.J. (2003). Video exposure assessments demonstrate excessive laboratory formaldehyde exposures. Applied Occupational and Environmental Hygiene 18(6):450-457.			
HERO ID:	1230593			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Laboratory instructor/student			
Exposure route:	Inhalation			
Personal sampling data:	0.07-6.77 (ppm)			
Area sampling data:	<0.05-10.91 (ppm)			
Number of workers:	14-68			
Comments:	This data source contains a summary of previous studies of formaldehyde in labs			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1983-2001)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by data from multiple studies over multiple years, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Salem, M.Z., Boehm, M., Srba, J. (2013). Evaluation of Mechanical Properties and Formaldehyde Emission of Plywood Manufactured for Construction Applications. Drvna Industrija 64(2):87-93.			
HERO ID:	2872646			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Table 3 provides formaldehyde emission data (mg/m^3): 0.01 +/- 0.001; 0.013 +/- 0.0008; 0.014 +/- 0.0005; 0.015 +/- 0.0009; 0.019 +/- 0.0017; 0.027 +/- 0.0018; mean - 0.016 (0.013 ppm) Figure 3 provides Box-Whiskers plots of different formaldehyde concentration variation among plywood panels (ranges from 0.10 up to 0.33 mg/m^3)			
Comments:	Formaldehyde emission was measured by European small-scale chamber method (EN 717-1, 2004). Two test pieces with the dimensions of 0.2m x 0.28m x 15., and a total area of 0.225 m^2 were used with a loading factor of 1m^2/1m^3. Temp and RH were 23 +/- 0.5 C and 45 +/- 3 %. In the factory quality control method (EN 717-2) was measured for formaldehyde.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is for Egypt, a non-OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Provides sample type, exposure type, physical form, concentration of formaldehyde in the resin.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at different plywood samples with some various conditions. Does not address uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Salthammer, T. (2019). Data on formaldehyde sources, formaldehyde concentrations and air exchange rates in European housings. Data in Brief 22:400-435.			
HERO ID:	6039334			
Conditions of Use:	Personal care products (covered by TSCA)			
EXTRACTION				
Parameter	Data			
Area sampling data:	Formaldehyde Concentrations in Sauna Cabins using scented essence [PDF PG. 408]. *Note: results were summarized - full results available on PDF Pg. 408*Sauna before operation: 0.01 - 0.04 (mg/m^3)Sauna during operation: 0.05 - 0.37 (mg/m^3)Sauna with eucalyptus essence: 0.05-0.79 (mg/m^3)Sauna with birch essence: 1.1 (mg/m^3)Sauna with citrus essence: 0.004 - 2.1 (mg/m^3)Sauna with mint essence: 0.03-0.95 (mg/m^3)Sauna with herbs essence: 0.35-2 (mg/m^3)Sauna with menthol essence: 0.56 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	Low	Data are for air care products (essence) which is not a scope within the risk evaluation. In addition, exposure is likely address under consumer or general population assessments. Information may be useful for occupational scenarios within the scope.
	Metric 4:	Temporal Representativeness	High	Monitoring data are no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling different types of essences used in saunas, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Saowakon, N., Ngernsoungnern, P., Watcharavitoon, P., Ngernsoungnern, A., Kosanlavit, R. (2015). Formaldehyde exposure in gross anatomy laboratory of Suranaree University of Technology: a comparison of area and personal sampling. Environmental Science and Pollution Research 22(23):19002-19012.			
HERO ID:	3001567			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Students, professors, embalming and dissection of cadavers			
Exposure route:	inhalation			
Physical form:	vapor, dermal			
Personal sampling data:	The FA concentrations of personal exposure ranged between 0.126 and 0.770 ppm (mean±SD=0.448±0.322 ppm) for medical students and 0.216 to 1.176 ppm (mean±SD= 0.696±0.480 ppm) for instructors, as shown in Table 2. Means of personal FA samplings in breathing zone were 0.193±0.120, 0.271±0.159, and 0.828±0.182 ppm for medical students and 0.219±0.140, 0.438±0.229, and 1.144± 0.374 ppm for instructors in the muscular system, thoracic organ system, and abdominal organ system sessions, respectively. The average of FA concentration of personal breath in Fig. 1 come from means of the students and the instructors was 0.57 ppm.			
Area sampling data:	The mean of FA concentrations in indoor air ranged between 0.117 and 0.415 ppm (mean±SD=0.266± 0.149 ppm). Individual indoor exposure to FA (means±SD) in muscular system, thoracic organ system, and abdominal organ system classes were 0.137±0.063, 0.226±0.063, and 0.435±0.104 ppm, respectively. The FA concentration in indoor air before observation was at 0.098±0.047 ppm.			
Exposure duration:	Exposure duration of 3 hours.			
Number of workers:	36 students and 4 instructors sampled.			
Engineering control:	10 air conditioning systems were attached to the ceiling of the lab and there were three exhausts opening for general ventilation during the period of session. Absolute ventilation of dissection room was 52.5 m³/min. There were 8 air cleaners turned on for 30 minutes before class and switched off 30 minutes after class.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so data is likely high quality.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is for Thailand, a non-OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2014)
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Provides worker/student activities, exposure route, physical form, personal and area sampling, number of students/workers, and engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by sampling over 3 different months (January, August, October). Does not address uncertainty.
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Formaldehyde

Occupational Exposure

HERO ID: 3001567 Table: 1 of 1

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Study Citation:	Saowakon, N., Ngernsoungnern, P., Watcharavitoon, P., Ngernsoungnern, A., Kosanlavit, R. (2015). Formaldehyde exposure in gross anatomy laboratory of Suranaree University of Technology: a comparison of area and personal sampling. Environmental Science and Pollution Research 22(23):19002-19012.		
HERO ID:	3001567		
Conditions of Use:	Laboratory Use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Sass-Kortsak, A.M., Holness, D.L., Pilger, C.W., Nethercott (1986). Wood dust and formaldehyde exposures in the cabinet making industry. American Industrial Hygiene Association Journal 47(12):747-753.			
HERO ID:	1317726			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Cabinet Making Workplace; Activities: Sawing, sanding, assembly, laminating graphics, glueing; Type of woods: hard-or soft-wood, the former including birch, cherry, oak and walnut, and the latter including cedar, poplar, fir, pine, spruce, chipboard, particleboard and fir plywood. Potential sources of formaldehyde exposure: When particleboard and chipboard are sawed or sanded, formaldehyde release from the resin is expected to increase as a result of the exposure of fresh resin surface; from inhaled particles which are deposited in the respiratory tissue[only gaseous HCHO measured]. Formaldehyde-based adhesives used in sandpaper production.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Sawing, Sanding, and Assembly - 0.06 (ppm) +/- 0.01; Laminating graphics and gluing- 0.03 (ppm) +/- 0.01, miscellaneous (e.g., foreman, shipping/receiving areas) - 0.09 (ppm) +/- 0.02. Soft-wood-0.1 (ppm) +/- 0.04, hard-wood- 0.06 (ppm) +/- 0.1, mixture- 0.06 (ppm) +/- 0.08, neither- 0.07 (ppm) +/- 0.02			
Area sampling data:	mean 0.06. Fig. 2 graphically displays sample values.			
Exposure duration:	Sampling time 3- 8.5 hrs			
Number of workers:	48			
Engineering control:	"3 of the 4 plants studied, all table saws and stationary sanders were equipped with local exhaust systems. Generally, down-drafted systems were installed on table saws and, on visual inspection, appeared to be similar in design to ACGIH recommendations. The stationary sanders utilized in these plants-were principally belt sanders. The design of the local exhaust hoods for these sanders was less uniform throughout the plants and, for the most part, consisted of a receiving hood at one end of the sander:" pp.5			
Comments:	"The mean relative humidity (RH) in each of the four plants studied ranged from 24% to 49%. Of the 48 workers investigated, 31 worked in areas with approximately 24% RH, 12 at 34% RH and 5 at 49% RH. The mean temperatures in each plant ranged from 17 to 22° C. " pp.5			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling and analytical methodology is provided but article notes the following issues: use of expired 3750 monitors by 30 days and samples below limit of detection for passive sampling. However these issues only effect some of the samples taken, not all per article.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3:	Applicability	High	Data are for furniture and furnishings not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1986)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity				
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Formaldehyde

Occupational Exposure

HERO ID: 1317726 Table: 1 of 1

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Study Citation:	Sass-Kortsak, A.M., Holness, D.L., Pilger, C.W., Nethercott (1986). Wood dust and formaldehyde exposures in the cabinet making industry. American Industrial Hygiene Association Journal 47(12):747-753.			
HERO ID:	1317726			
Conditions of Use:	Furniture Manufacturing			
		EVALUATION		
Domain	Metric	Rating	Comments	
	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty				
	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling multiple worker activities but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Scheepers, P.T., Graumans, M.H., Beckmann, G., Dael, M.v., Anzion, R.B., Melissen, M., Pinckaers, N., Wel, L.v., Werdt, L.M., Gelsing, V., Linge, A.v. (2018). Changes in Work Practices for Safe Use of Formaldehyde in a University-Based Anatomy Teaching and Research Facility.			
HERO ID:	5944973			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Gross anatomy teachers and students			
Exposure route:	Inhalation			
Personal sampling data:	Geometric mean concentrations (range) of FA (ug/m3) of full work-shift measurements in the breathing zone: 10.6-1120Geometric mean concentrations (range) of FA (ug/m3) of task-based 15 min measurements in the breathing zone: 20.4-2769.2			
Area sampling data:	7.7-554 (ug/m^3)			
Exposure duration:	8 hr full shift and 15 min task based measurements			
Number of workers:	Varied from 12 to 26			
Personal protective equipment:	During these tasks, a full face mask was used with an organic vapor and FA filter class A1 organic vapors and FA filter (6075, 3M Nederland, Delft, The Netherlands).			
Engineering control:	The technical mitigations (T-1 to T-4) were aimed at a reduction of emissions from leakage (leak prevention, T-1, Figure 3) and emissions from the use of absorbent materials used to collect any residualdraining of formalin from the anatomical specimens while they were put on display in TR-1 or TR-2. A jerry can was installed under the dissection table (T-2). So, instead of collecting the leak drainedfluid in the absorbent disposable tissue and an open bucket to collect any formalin dripping from the table, (allowing the FA to evaporate from this secondary source) the drained liquid would be removedand collected in a closed containment (Figure 4). Emissions were further reduced by introducing an LEV at the workbench that was used to flush the smaller specimens (e.g. brains, extremities) priorto putting them on display on the section tables on the day of the training (T-3). This LEV system was installed in a Perspex cover that completely sealed off the process from the room and created anunder pressure (Figure 5). The cover would only have to be opened for introduction or removal of specimens. In the storage room a down flow ventilation system was installed to introduce fresh air into the breathing zone of the worker and keep down any FA vapors from opening storage tanks and taking out specimens out of it. For this a plenum was installed above the location where an electrically powered lift was used to heave complete cadavers or body parts from the storage tank. Optimization involved a free flow of air from the plenum down to an extraction ventilation installed in the wall.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	Data collected in the last 10 years.
	Metric 5:	Sample Size	Medium	Contains sample size, mean and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, worker activities.

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Formaldehyde

Occupational Exposure

HERO ID: 5944973 Table: 1 of 1

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Study Citation:	Scheepers, P.T., Graumans, M.H., Beckmann, G., Dael, M.v., Anzion, R.B., Melissen, M., Pinckaers, N., Wel, L.v., Werdt, L.M., Gelsing, V., Linge, A.v. (2018). Changes in Work Practices for Safe Use of Formaldehyde in a University-Based Anatomy Teaching and Research Facility.		
HERO ID:	5944973		
Conditions of Use:	Laboratory chemical		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	The monitoring study addresses variability by comparing different years and groups of people. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 4913577 Table: 1 of 1

Study Citation:	Schieweck, A., Delius, W., Fuhrmann, F., Lohrengel, B., Siwinski, N., Salthammer, T. (2005). Organic and inorganic pollutants in the Lower Saxony State Museum Hanover, Germany. :782-786.			
HERO ID:	4913577			
Conditions of Use:	Laboratory chemical (specimen preservation)			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Zoology: 28-90 µg/m3; Prehistory: 20-110 µg/m3; art gallery: 63 µg/m3 (pg 2)			
Comments:	sampling locations: zoology, geology, prehistory, ethnology, and art gallery departments (pg 5). Sampling/analysis method via Acetylacetone method (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	Data are for specimen preservation, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Schlink, K., Janssen, K., Nitzsche, S., Gebhard, S., Hengstler, J.G., Klein, S., Oesch, F. (1999). Activity of O6-methylguanine DNA methyltransferase in mononuclear blood cells of formaldehyde-exposed medical students. Archives of Toxicology 73(1):15-21.			
HERO ID:	1314061			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Medical students in dissecting room at the Universities of Mainz and Frankfurt			
Personal sampling data:	Mainz: mean +/- SD: 0.2 +/- 0.05 mg/m3; Frankfurt: mean +/- SD: 0.8 +/- 0.6 mg/m3 - see also Figs 3 & 4.			
Exposure duration:	Mainz: 6 hours per week.			
Exposure frequency:	Mainz: 111 days; Frankfurt: 98 days			
Number of workers:	Mainz: 57; Frankfurt: 16			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	method not described but reference with information about method is cited.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1998)
	Metric 5:	Sample Size	High	fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but other meta data not complete.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability not addressed.
Overall Quality Determination			Low	

Study Citation:	Schoenberg, J.B., Mitchell, C.A. (1975). Airway disease caused by phenolic (phenol-formaldehyde) resin exposure. Archives of Environmental Health 30(12):574-577.			
HERO ID:	21233			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	impregnating filter material with phenol-formaldehyde resin, repair and maintenance of equipment			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	initial testing 0.5-1 mg/m3, follow-up testing 10.6 to 16.8 mg/m3			
Number of workers:	53			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling and analytic methods not noted, but it was documented that Four breathing zone samples used Drager colorimetric indicator tubes. On another occasion, three breathing zonesamples were collected in sodium bisulfite and measured by_ titration with a standard iodine solution.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for a filter manufacturing facility which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1975, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized only by a range of values, uncertain statistics not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Key metadata were not provided such as sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range values what could be helpful in assessing variability. The study did not provide any information on uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Schupp, T., Bolt, H.M., Hengstler, J.G. (2005). Maximum exposure levels for xylene, formaldehyde and acetaldehyde in cars. Toxicology 206(3):461-470.			
HERO ID:	597953			
Conditions of Use:	Use of Furniture and Furnishings			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.048 mg/m3 (note this values was not developed as part of this study but was obtained from an earlier (1998) study			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	German article	
	Metric 3: Applicability	Low	The data point is concentration of formaldehyde in cars. Possibly some applicability to occupational but seems more for consumer	
	Metric 4: Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after the PEL- published 2005 but the data were from 1998	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no information was provided- missing: sampling/analysis methods, number of samples, number of sites, worker activities, type of sampling, exposure duration and frequency, number of workers, and sampling locations	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed	
Overall Quality Determination		Low		

Study Citation:	Schwilk, E., Zhang, L., Smith, M.T., Smith, A.H., Steinmaus, C. (2010). Formaldehyde and leukemia: an updated meta-analysis and evaluation of bias. Journal of Occupational and Environmental Medicine 52(9):878-886.			
HERO ID:	655887			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	manufacture and use of formaldehyde products and embalming			
Exposure route:	inhalation			
Physical form:	vapor			
Number of workers:	>25,000 formaldehyde Industry and >13,000 funeral directors and embalmers			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Low	Data are aggregated for all industries with a focus on does response which is not in-scope or similar to an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years and prior to the PEL- Article published in 2010 monitoring data came for 1966
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type and exposure type not provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 5942366 Table: 1 of 1

Study Citation:	Seifert, B. (1989). Formaldehyde emission standards in the Federal Republic of Germany. :13-24.			
HERO ID:	5942366			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Preschool workers and children, and residents in homes with particleboard insulation. (1/12)			
Exposure route:	inhalation (1/12)			
Physical form:	gas (1/12)			
Area sampling data:	"Sampling program 1: 60+-43 ug/m3 Sampling program 2: 63+-68 ug/m3 Sampling program 3: 56+-28 ug/m3 (11/12)"			
Engineering control:	One effective control measure was the sealing of all uncoated particleboard edges in the rooms. (5/12)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	Low	Data are for ambient air, which is similar to the in-scope occupational scenario use of building/construction materials.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation, minimum, maximum) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at different locations around the country.
Overall Quality Determination		Medium		

Study Citation:	Seitz, T., Baron, S. (1990). Health hazard evaluation report No. HETA-87-349-2022, Rockcastle Manufacturing, Mount Vernon, Kentucky. :87-349.			
HERO ID:	626707			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Around 85% of the workforce operated sewing machines, the remaining individuals worked as press operators, oven operators. cut, spreaders, glue sprayers. bundlers. and maintenance workers.			
Exposure route:	inhalation			
Physical form:	Vapor			
Personal sampling data:	Formaldehyde air sampling results from the initial survey ranged from 0.14 ppm to 0.46 ppm in five personal breathing zone (PBZ) air samples. On the follow-up survey, formaldehyde exposureswere lower, with PBZ concentrations ranging from 0.19 ppm to 0.21 ppm.			
Area sampling data:	Formaldehyde air sampling results from the initial survey ranged from 0.32 ppm to 0.70 ppm in 13 area air samples obtainedthroughout the plant. On the follow-up survey, formaldehyde exposures were lower, ranging from 0.18 ppm to 0.22 ppm in area air samples obtained in production departments.			
Dermal exposure data:	nan			
Number of workers:	191			
Engineering control:	(1) Work with supplier to provide post-cure fabrics(2) installation of exhaust ventilation above the steampress tables, (3) installation of canopy hoods above the three fly press stations, (4) increasing the amount of outside air supplied to the plant by increasing the opening of the air supply louvers on the three air handling units, (5) installation of a ceiling exhaust system above the sewing area, with a 10,000 cubic feet per minute design specification, (6) installation of a receiving hood in the area wherespot cleaning of soiled garments is performed, and (7) replacing the practice of blowing lint from workstations with compressed air (and subsequent dry sweeping of the floors) withvacuuming, which was performed on breaks and at the end of theworkshift.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study Method 3500 / 2502
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (textile operation) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Study implemented in 1987- five years prior to the PEL (1992)
	Metric 5:	Sample Size	High	Results from each sampling event were provided (Table 1 and 2), and includes monitor- ing results using different methods.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, sample durations, and worker activities, but lacks additional metadata, such as exposure durations, and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study provides actual results of each sampling event and range values which could be used to approximate variability in the determinants of exposure. It was assumed that uncertainty was considered in the NIOSH methods.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 626707 Table: 1 of 1

...continued from previous page			
Study Citation:	Seitz, T., Baron, S. (1990). Health hazard evaluation report No. HETA-87-349-2022, Rockcastle Manufacturing, Mount Vernon, Kentucky. :87-349.		
HERO ID:	626707		
Conditions of Use:	Textile Finishing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Seitz, T., Kennedy, E., Gagnon, Y. (1990). Hazard Evaluation and Technical Assistance Branch HETA 90-021-L2055 Superior Manufacturing Cinnccinati, Ohio.			
HERO ID:	8157914			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Mill operators, cross cut saw operators, trothing operators. (2/10)			
Exposure route:	inhalation, dermal (4/10)			
Physical form:	vapor (2/10)			
Personal sampling data:	Personal samples for formaldehyde ranged from 0.09-0.15 ppm. (10/10)			
Area sampling data:	Area samples for formaldehyde ranged from 0.06-0.31 ppm. (10/10)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesive and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker activity provided, but missing number of workers, exposure duration, frequency, engineering controls, and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination		High		

Study Citation:	Sekizawa, J., Ohtawa, H., Yamamoto, H., Okada, Y., Nakano, T., Hirai, H., Yamamoto, S., Yasuno, K. (2007). Evaluation of human health risks from exposures to four air pollutants in the indoor and the outdoor environments in Tokushima, and communication of the outcomes to the local people. Journal of Risk Research 10(6):841-851.			
HERO ID:	3839231			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Table 3A (pg 7) has indoor sampling data (ranges with number of samples, mean +/- SD) for 2004 spring, 2004 summer, 2005 winter, and total). 3B (pg 7) has data for outdoor samples for 2004 spring and summer. Table 4 (pg 8) has comparison of outdoor sampling from table 3B with dispersion modeling data using PRTR release data, conducted by Japan’s National Institute of Technology and Evaluation (NITE). Tables also contain number of samples			
Comments:	Sampled inside and outside of several chemistry laboratories (pg 4). Brief active sampling, 24 hr passive sampling (pg 4). Analyzed via GC/MS (pg 4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemical, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, range, SD) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing exposure duration, exposure frequency, etc.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by comparing sampling data to modeling data. Variability addressed by sampling multiple sites, both indoor and outdoor.
Overall Quality Determination		Medium		

Study Citation:	Seow, W.J., Zhang, L., Vermeulen, R., Tang, X., Hu, W., Bassig, B.A., Ji, Z., Shiels, M.S., Kemp, T.J., Shen, M., Qiu, C., Reiss, B., Freeman, L.E., Blair, A., Kim, C., Guo, W., Wen, C., Li, L., Pinto, L.A., Huang, H., Smith, M.T., Hildesheim, A., Rothman, N., Lan, Q. (2015). Circulating immune/inflammation markers in Chinese workers occupationally exposed to formaldehyde. Carcinogenesis 36(8):852-857.			
HERO ID:	2993332			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	One of the factories produced formaldehyde melamine resins and the other factory used formaldehyde-melamine resins to manufacture plastic utensils. Fifty-one unexposed workers were selected as controls from three workplaces located in the same geographicregion as the two factories with formaldehyde exposure but did not have occupational exposures to formaldehyde or an			
Exposure route:	inhalation			
Personal sampling data:	The exposed group had a median formaldehyde exposure of 1.28 p.p.m. (range: 0.32–5.61) and the unexposed group had a median of 0.026 p.p.m. (range: 0.015–0.026).			
Exposure duration:	4 hours/day			
Exposure frequency:	3 weeks			
Number of workers:	43 workers among 2 factories			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the manufacture of resins, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data is less than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided but missing associated worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology and discussion on limitations of study. Variability is addressed by matching subjects with similar controls and sampling on multiple occasions.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 626717 Table: 1 of 1

Study Citation:	Shaham, J., Bomstein, Y., Melzer, A., Ribak, J. (1997). DNA-protein crosslinks and sister chromatid exchanges as biomarkers of exposure to formaldehyde. International Journal of Occupational and Environmental Health 3(2):95-104.			
HERO ID:	626717			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Study #1 (DNA-protein): 12 workers regularly exposed to formaldehyde [8 unexposed, 20 total]. Study #2 (Sister chromatid): 13 workers regularly exposed to formaldehyde [9 also included in DNA study, 20 unexposed, 33 total].			
Exposure route:	inhalation			
Personal sampling data:	3.1 to 2.8 ppm "when most of the work was in progress", and a mean value of 1.46 ppm at midday when most of the work had already been done.			
Area sampling data:	1.6 to 1.39 ppm (laminar flow conc. was 6.9 ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Published in 1997. The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., area, personal) and some metadata (e.g., when work in progress, laminar flow).
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The assessment does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Shaham, J., Gurvich, R., Kaufman, Z. (2002). Sister chromatid exchange in pathology staff occupationally exposed to formaldehyde. Mutation Research: Genetic Toxicology and Environmental Mutagenesis 514(1-2):115-123.			
HERO ID:	626721			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Pathology department workers			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.04-5.6 ppm - the study does not provide any additional details, instead the health impact component of the study considers exposure concentrations in bins Low 0.4 ppm mean (range 0.04-0.7 ppm); high 2.24 ppm mean (range 0.72-5.6 ppm).			
Exposure duration:	Average 15.4 years of exposure (1-39 years)			
Number of workers:	90			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Isreal - OECD member
	Metric 3:	Applicability	High	Data are for pathology labs, is in-scope occupational scenario
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2002.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean and range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata such as sampling location, employee activities, sampling and analytic methods, exposure frequency, number of samples.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by providing a range of values for the two exposure classifications, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5951448 Table: 1 of 1

Study Citation:	Shinohara, N., Okazaki, Y., Mizukoshi, A., Wakamatsu, S. (2019). Exposure to benzene, toluene, ethylbenzene, xylene, formaldehyde, and acetaldehyde in and around gas stations in Japan. Chemosphere 222:923-931.			
HERO ID:	5951448			
Conditions of Use:	Gas station use.			
EXTRACTION				
Parameter	Data			
Worker activity description:	Gas station employees			
Exposure route:	inhalation			
Physical form:	gas, vapor			
Personal sampling data:	the personal exposure, indoor, and ambient concentrations of formaldehyde were 5.08, 10.1, and 4.29 mg/m3, respectively, in spring and 11.6, 24.1, and 6.04 mg/m3, respectively, in winter. Exposures are depicted in Figure 1c. Concentrations were max in the spring at 10 ug/m^3 for indoor office, at the refueling station it was maxed at about 8 ug/m^3 with max background exposure at about 5 ug/m^3. For winter sampling, max indoor exposure was at about 30 ug/m^3, max refueling exposure at about 13 ug/m^3 and max background exposure at about 8 ug/m^3.			
Area sampling data:	formaldehyde concentrations indoors in spring (10.1 mg/m3) and winter (24.1 mg/m3)			
Comments:	Duration and frequency of exposure testing was every 2 hours but assumed exposure duration and frequency is constant or during refueling process.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for Japan, an OECD country.
	Metric 3:	Applicability	Medium	Data applicable to primarily ambient exposure at a gas station.
	Metric 4:	Temporal Representativeness	High	Data is under 10 years old (2019)
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes worker activity, physical form, exposure route, sampling data, duration and frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at different gas stations over different times of the year. Does not address uncertainty
Overall Quality Determination		Medium		

Study Citation:	Siew, S.S., Kauppinen, T., Kyyrönen, P., Heikkilä, P., Pukkala, E. (2012). Occupational exposure to wood dust and formaldehyde and risk of nasal, nasopharyngeal, and lung cancer among Finnish men. Cancer Management and Research 4:223-232.			
HERO ID:	1313381			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Exposure concentrations were derived from measurements, surveys and assessments from occupation health professionals			
Particle size characterization:	PM estimated concentrations were provided for 13 occupational groups			
Number of workers:	1.2 finish men born between 1906-1945			
Comments:	It is not clear where the measurements for 13 occupational groups are. Page 4/10 contains following six air measurements. Technical nursing assistants 0.35 ppm; cooks, furnace men 0.50 ppm; Chemical workers, nec 0.20 ppm; plastic product workers 0.10 ppm; plastic product workers, nec 0.10 ppm; paper product workers 0.20 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	it is unclear which estimates are based on sampling, survey or professional judgement	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Finland - and OECD member	
	Metric 3: Applicability	High	The data are for 13 different occupational groups included in the occupational scenarios within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The report was published in 2012 after the PEL (1992) and less than 10 years old.	
	Metric 5: Sample Size	Low	only mean exposure for each worker group was provided (note all values are multiples of 5	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No meta data were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1317069 Table: 1 of 1

Study Citation:	Simon, G.E. (1992). Epidemic multiple chemical sensitivity in an industrial setting. Toxicology and Industrial Health 8(4):41-46.			
HERO ID:	1317069			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	aerospace manufacturing firm-producing fire-retardant composite plastics			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	All measured levels of formaldehyde were less than 10% of Occupational Safety and Health Administration Permissible Exposure Limits (PEL).			
Particle size characterization:	All measured levels of total particulates were less than 10% of Occupational Safety and Health Administration Permissible Exposure Limits (PEL).			
Number of workers:	400 on site, & ~200 worked directly with the composite plastic material.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for aerospace manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were published in 1987, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	percent of PEL was provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 1392386 Table: 1 of 1

Study Citation:	Sinks, T. H., Hartle, R. W. (1988). Health Hazard Evaluation Report HETA 86-456-1877, South Texas Nuclear Project, Wadsworth, Texas, March 1988.			
HERO ID:	1392386			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Worker activity description:	Construction workers, particularly carpenters			
Exposure route:	dermal, inhalation			
Physical form:	gas			
Area sampling data:	Carpenter shop: No airborne formaldehyde was detected			
Dermal exposure data:	Dermal exposure data			
Personal protective equipment:	It was recommended that carpenters working on scaffolding crews and, those sawing treated lumber, should wear gloves and long-sleeve shirts whenever practical. Carpenters sawing wood should wear particulate masks to avoid inhalation exposure to wood dust. Personal hygiene measures, including washing of hands and arms at lunch and following work, should be made mandatory.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	Low	No values above limit of detection but number of samples taken is unknown.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include sample type and specific area with worker activities but no other metadata (duration or frequency).
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability in exposure estimates (e.g., different locations). Assume that uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		Medium		

Study Citation:	Skóra, J., Matusiak, K., Wojewódzki, P., Nowak, A., Sulyok, M., Ligocka, A., Okrasa, M., Hermann, J., Gutarowska, B. (2016). Evaluation of Microbio-logical and Chemical Contaminants in Poultry Farms. International Journal of Environmental Research and Public Health 13(2):192.			
HERO ID:	3172220			
Conditions of Use:	Non-TSCA			
EXTRACTION				
Parameter	Data			
Area sampling data:	Table 9 provides concentration (mg/m^3) of several volatile odorous compounds in the air: 0.07067, 0.07577; During production: 0.08544, 0.09168, 0.06900.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for Poland, an OECD country.
	Metric 3:	Applicability	Low	Data is for the poultry industry, which may be similar to an occupational scenario like agriculture, forestry, fishing, and hunting in the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data is from 2016, less than 10 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range of data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Slaughter, J.C., Koenig, J.Q., Reinhardt, T.E. (2004). Association between lung function and exposure to smoke among firefighters at prescribed burns. Journal of Occupational and Environmental Hygiene 1(1):45-49.			
HERO ID:	1313811			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	TWA concentrations 0.054 ppm mean SD 0.060 ppm (range 0-0.21 ppm) interquartile range 0.008 - 0.085 ppm			
Area sampling data:	Mop up 0.048-0.42 ppm			
Exposure duration:	Firefighters spend on average 5.4 ± 2.4 hours (70% of their time) exposed to some level of smoke between the time of their preshift and postshift lung function tests.			
Number of workers:	65			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Formaldehyde was measured by sorbent cartridge withHPLC analysis according to EPA Method TO-11.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data from US.
	Metric 3:	Applicability	High	The data are for firefighting which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report was published in 2004, after the most recent PEL (1992) and more than 10 and less than 20 years old.
	Metric 5:	Sample Size	Medium	The study provided mean value, SD and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		High		

Study Citation:	Smith, K.A., Williams, P.L., Middendorf, P.J., Zakraysek, N. (1984). Kidney dialysis: ambient formaldehyde levels. American Industrial Hygiene Association Journal 45(1):48-50.			
HERO ID:	5938060			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Cleaning/packing artificial kidneys [pumped from container into dialysis pump where it is mixed and then pumped through dialysate line]			
Personal sampling data:	Dialysis Machine Normal Operations: Range - 0.02-0.64 ppm, Mean - 0.11 ppmDialysis Machine Cleaning Cycle: Range - 0.10-0.65 ppm, Mean - 0.28 ppm Cleaning/packing artificial kidneys: Range - 0.02-0.75 pm, Mean - 0.21 ppm Drains: Range - 0.06-0.92 ppm, Mean - 0.27 ppmNurses Station: Range 0.02-0.37 ppm, Mean - 0.13 ppmUtility Room: 0.90 ppm Unoccupied Room (commonly used for dialysis): 0.08 ppm			
Area sampling data:	Dialysis Machine Normal Operations: Range - 0.02-0.64 ppm, Mean - 0.11 ppmDialysis Machine Cleaning Cycle: Range - 0.10-0.65 ppm, Mean - 0.28 ppm Cleaning/packing artificial kidneys: Range - 0.02-0.75 pm, Mean - 0.21 ppm Drains: Range - 0.06-0.92 ppm, Mean - 0.27 ppmNurses Station: Range 0.02-0.37 ppm, Mean - 0.13 ppmUtility Room: 0.90 ppm Unoccupied Room (commonly used for dialysis): 0.08 ppm			
Engineering control:	Local exhaust ventilation, drain systems.			
Comments:	Personal and Area samples not split out and included together in the same range.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data from the 1980s.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range and mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by collecting samples at various facilities and locations within each facility.
Overall Quality Determination			Medium	

Study Citation:	Smith, T.J., Davis, M.E., Hart, J.E., Blicharz, A., Laden, F., Committee, E.G. (2012). Potential air toxics hot spots in truck terminals and cabs. Research report (Health Effects Institute) (172):5-82.		
HERO ID:	1787892		
Conditions of Use:	Combustion Byproduct		
EXTRACTION			
Parameter	Data		
Number of sites:	phase 1: 15 truck terminals Phase 2: 6		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	Driver: 9.2 Ug/m3 SD 6.7ug/m3		
Area sampling data:	Upwind Yard n=137 mean=3.32 median=3.17 SD=1.91Downwind Yard n=110 mean=3.06 median=3.21 SD=1.68Dock n=65 mean=25.44 median=18.96 SD=19.03Shop n=17 mean=13.72 median= 5.05 SD=16.63		
Number of workers:	>100		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Initially aldehydes were collected using a derivatization with DNPH (Sep-Pak) but later a new method was used for sampling aldehydes developed using dansylhydrazine. The analytical method was developed by the Harvard School of Public Health.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The data were published in 2012, after the most recent PEL (1992) and less than 10 years old.
	Metric 5: Sample Size	Medium	Mean and SD values were provided for yard and driver exposure
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	The metadata include sample type, exposure type, but lacks sample durations, exposure durations, exposure frequency, worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The study provided SD data that can be used to evaluate variability. Detailed information about field and sampling blanks were provided that can be used to account for uncertainty.
Overall Quality Determination		High	

Study Citation:	Smith, T.J., Quinn, M.M., Marsh, G.M., Youk, A.O., Stone, R.A., Buchanich, J.M., Gula, M.J. (2001). Historical cohort study of US man-made vitreous fiber production workers: VII. Overview of the exposure assessment. Journal of Occupational and Environmental Medicine 43(9):809-823.			
HERO ID:	5949992			
Conditions of Use:	Incorporation into articles			
EXTRACTION				
Parameter	Data			
Worker activity description:	FA mixing for resin and spray stations			
Exposure route:	inhalation			
Physical form:	vapor, gas			
Personal sampling data:	Most of the exposure measurements were made in the Binder Room (average, 0.1 ppm; range, 0.02 to 0.16), where the phenol, formaldehyde, and urea were mixed to form liquid resin, and in the Forming Area (average, 0.16 ppm; range, 0.08 to 0.3 ppm), where the binder was sprayed onto the airborne fiber.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is applicable to use of FA resin in textile/wool/fiber products
	Metric 4:	Temporal Representativeness	Medium	Data is just under 20 years old (2001)
	Metric 5:	Sample Size	Medium	Range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes process description, description of sources of exposure, exposure route, physical form, sampling data, worker activity.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at multiple plants for sampling data. Does not address uncertainty.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1056805 Table: 1 of 1

Study Citation:	Sousa, F.W., Caracas, I.B., Nascimento, R.F., Cavalcante, R.M. (2011). Exposure and cancer risk assessment for formaldehyde and acetaldehyde in the hospitals, Fortaleza-Brazil. Building and Environment 46(11):2115-2120.			
HERO ID:	1056805			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Area sampling data:	Hospital A: 1.98-15.06 (ug/m^3); Hospital B: 17.79-24.87 (ug/m^3); Public hospitals in Brazil: 29-297 (ug/m^3); Hospitals in China: 5.3-11.4 (ug/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data from 2009.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability addressed by sampling from different hospitals and uncertainty is addressed in the sampling process.
Overall Quality Determination		Medium		

Study Citation:	Sousa, F.W., Cavalcante, R.M., Rocha, C.A., Nascimento, R.F., Ferreira, A.G. (2015). Carbonyl compounds from urban activities and their associated cancer risks: The influence of seasonality on air quality (Fortaleza-Ce, Brazil). Urban Climate 13:110-121.			
HERO ID:	6252277			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Gas station attendants (2/12)			
Exposure route:	inhalation (2/12)			
Area sampling data:	”This study: 14.11 ug/m3 in ambient air at the gas stations (5/12) Hangzhou, China: 22.2 ug/m3 Guangzhou, China: 1.1 ug/m3 Elizabeth/Houston, USA: 6.42 ug/m3 Niteroi, Brazil: 3.22 ug/m3 Rio Grande do Sul, Brazil: 18.2 ug/m3 Kolkata, India: 21.34 ug/m3 Beirut, Lebanon: 5.6 ug/m3 São Paulo, Brazil: 40.6 ug/m3 Salvador, Brazil: 98.4 ug/m3”			
Exposure duration:	8 hours/day (3/12)			
Exposure frequency:	6 days/week (3/12)			
Number of workers:	39 (4/12)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Brazil, a non-OECD country.
	Metric 3:	Applicability	Low	Data are for ambient air at gas stations, which is similar to the in-scope occupational scenario use of fuels and related products.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, sums, ratios) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling during multiple seasons.
Overall Quality Determination		Medium		

Study Citation:	Sparks, P.J., Ayars, G.H., Simon, G.E., Katon, W.J., Altman, L.C., Johnson, R.L. (1991). Depression and panic attacks related to phenol-formaldehyde composite material exposure in an aerospace manufacturing plant. Allergy Proceedings 12(6):389-393.			
HERO ID:	1316651			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers used fiberglass composite material impregnated with phenol-formaldehyde resin to fabricate aircraft interior parts in a process called "lay up". The material came in rolls with plastic backing film stored in a frozen state. The rolls were then thawed and put on a rack. The employee, called a plastic bench mechanic, would unroll the sheets, cut of appropriate lengths, peel of the plastic backing film and then form it into the shape desired by molding it over a tool or mandrel. Employees would use gloves and a small squeegee-type tool to press the material on the tool. "Liquid gloves," a hand barrier cream, was used on the gloves to prevent sticking. The part was then bagged, oven cured, and reworked to thecorrect specification by sanding, trimming, applying epoxy to holes, and prepping surfaces for painting and then packaged.			
Exposure route:	Inhalation			
Physical form:	vapor			
Area sampling data:	0.003-0.073 (ppm)			
Number of workers:	200 employees working in one building of a large aircraft manufacturing company.			
Personal protective equipment:	Use of gloves was mandatory although the use of lab coats, sleeves, and respirators was optional. The masks available were half-mask, combination organic vapor and acid gas respirators, but most workers used them infrequently.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1991)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range .
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data included worker activities, but excluded sample type and exposure type, sample durations, exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1314452 Table: 1 of 1

Study Citation:	Sparks, P.J., Simon, G.E., Katon, W.J., Altman, L.C., Ayars, G.H., Johnson, R.L. (1990). An outbreak of illness among aerospace workers. Western Journal of Medicine 153(1):28-33.			
HERO ID:	1314452			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers primarily used fiberglass impregnated with phenol-formaldehyde resin, although epoxy resins had also been used. The process, called "lay-up," involved hand molding and oven curing of the composite material. Some parts required reworking with saws and routers and filling in defects with epoxy or phenolic compounds. Small amounts of organic solvents were used for cleaning the parts and molds.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.003-0.073 ppm			
Number of workers:	200 employees working in one building of a large aircraft manufacturing company.			
Personal protective equipment:	Disposable plastic laboratory coats, sleeves, and gloves were available (but optional) until the spring of 1988 when the use of gloves became mandatory Half-mask respirators with organic vapor-acid gas cartridges were also made available at that time.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Used NIOSH methods
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for aerospace workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was derived from sampling implemented from 1987-88, before the most recent PEL (1992) update and are more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data included worker activities, but excluded sample type and exposure type, sample durations, exposure durations, and exposure frequency,
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Spitzer, H.L. (1997). An analysis of the health benefits associated with the use of MTBE reformulated gasoline and oxygenated fuels in reducing atmospheric concentrations of selected volatile organic compounds. Risk Analysis 17(6):683-691.			
HERO ID:	80077			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Service station data:15.4 ug/m3 mean (range of maximum values 4.9-44.2 ug/m3); inside vehicle 35.4 ug/m3; parking garages (41.8 ig/m3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	Could be of use to access exposure for service station attendants, parking garage employees, and cab drivers
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after the PEL- Monitoring data are greater than 20 years old -Published 1997
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Missing: sampling and analytic methods, number of samples, worker activities, exposure duration and frequency, number of workers
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty not addressed.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 6638 Table: 1 of 1

Study Citation:	Srivastava, A.K., Gupta, B.N., Bihari, V., Gaur, J.S., Mathur, N., Awasthi, V.K. (1992). Clinical studies of employees in a sheet-forming process at a paper mill. Veterinary and Human Toxicology 34(6):525-527.			
HERO ID:	6638			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.03 mg/m3 8 hour TWA concentration			
Number of workers:	22 exposed males			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	India - not and OECD country	
	Metric 3: Applicability	Medium	The data are for paper manufacture is an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities, but there may be significant difference between operations in India in 1992 and the US now.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is just a single air concentration, no statistics concerning the distribution was provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	It is assumed that the monitoring data were for area sampling, but no other metadata were provided such as sampling and analytic methods, sample durations, exposure durations, worker activities, and exposure frequency.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	Stantec ChemRisk, (2023). Submission by ACC Formaldehyde TSCA Risk Evaluation Consortium regarding analysis of industrial hygiene monitoring data for formaldehyde manufacturing and processing.			
HERO ID:	11204040			
Conditions of Use:	Domestic Manufacture Formaldehyde Production			
EXTRACTION				
Parameter	Data			
Worker activity description:	-Administrative - ONUs not directly associated with formaldehyde manufacturing or processing operations that work in building adjacent to or physically separated from manufacturing or processing operations.-Environmental, Health and Safety - work involves monitoring, analysis and surveying of employees or areas.- Quality Control/Quality Assurance - work involves sampling and analysis of raw materials, process streams and end products.- Logistics - work involves loading and unloading of railcars, trucks, totes, drums containing raw materials or finished products for distribution.-Maintenance - work involves fabricating, repairing and maintaining equipment.-Operations - work involves monitoring processes and auxiliary equipment from central control room or in operational areas; preparing equipment for maintenance and performing process changeout activities; unloading raw materials into reactor and unloading end products; and taking process samples. (pg. 10)			
Exposure route:	Inhalation			
Personal sampling data:	749 personal breathing zone samples included in data			
Exposure duration:	Full Shift, 8-hr TWA (pg. 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method (NIOSH 2016 or OSHA 52).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The data are from the 2012-2020 and represent current operations, equipment and activity.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include the most critical metadata, including sample types, exposure types, sample durations, exposure durations, and exposure frequency. Worker activities are not fully attributed to sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled sector. The uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination		High		

Study Citation:	Stantec ChemRisk, (2023). Submission by ACC Formaldehyde TSCA Risk Evaluation Consortium regarding analysis of industrial hygiene monitoring data for formaldehyde manufacturing and processing.			
HERO ID:	11204040			
Conditions of Use:	Domestic manufacture Formaldehyde Production and Resin Formulation			
EXTRACTION				
Parameter	Data			
Worker activity description:	-Administrative - ONUs not directly associated with formaldehyde manufacturing or processing operations that work in building adjacent to or physically separated from manufacturing or processing operations.-Environmental, Health and Safety - work involves monitoring, analysis and surveying of employees or areas.-Quality Control/Quality Assurance - work involves sampling and analysis of raw materials, process streams and end products.- Logistics - work involves loading and unloading of railcars, trucks, totes, drums containing raw materials or finished products for distribution.-Maintenance - work involves fabricating, repairing and maintaining equipment.-Operations - work involves monitoring processes and auxiliary equipment from central control room or in operational areas; preparing equipment for maintenance and performing process changeout activities; unloading raw materials into reactor and unloading end products; and taking process samples. (pg. 10)			
Personal sampling data:	Data includes 3226 breathing zone samples			
Exposure duration:	Full Shift, 8-hr TWA (pg. 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	Data are from 2012-2020 and represent the current industry operations, equipment and activities.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include the most critical metadata, including sample types, exposure types, sample durations, exposure durations, and exposure frequency. Worker activities are not fully attributed to sampling data.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.	
Overall Quality Determination		High		

Study Citation:	Stantec ChemRisk, (2023). Submission by ACC Formaldehyde TSCA Risk Evaluation Consortium regarding analysis of industrial hygiene monitoring data for formaldehyde manufacturing and processing.			
HERO ID:	11204040			
Conditions of Use:	Domestic Manufacturing Occupational Non-Users			
EXTRACTION				
Parameter	Data			
Worker activity description:	-Administrative - ONUs not directly associated with formaldehyde manufacturing or processing operations that work in building adjacent to or physically separated from manufacturing or processing operations.-Environmental, Health and Safety - work involves monitoring, analysis and surveying of employees or areas.-Quality Control/Quality Assurance - work involves sampling and analysis of raw materials, process streams and end products.- Logistics - work involves loading and unloading of railcars, trucks, totes, drums containing raw materials or finished products for distribution.-Maintenance - work involves fabricating, repairing and maintaining equipment.-Operations - work involves monitoring processes and auxiliary equipment from central control room or in operational areas; preparing equipment for maintenance and performing process changeout activities; unloading raw materials into reactor and unloading end products; and taking process samples. (pg. 10)			
Personal sampling data:	426 personal breathing zone samples included in data			
Exposure duration:	Full Shift, 8-hr TWA (pg. 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Study data are from 2012-2020 and represent current industry operations, equipment and activities.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include the most critical metadata, including sample types, exposure types, sample durations, exposure durations, and exposure frequency. Worker activities are not fully attributed to sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Stantec ChemRisk, (2023). Submission by ACC Formaldehyde TSCA Risk Evaluation Consortium regarding analysis of industrial hygiene monitoring data for formaldehyde manufacturing and processing.			
HERO ID:	11204040			
Conditions of Use:	Processing Incorporated into article			
EXTRACTION				
Parameter	Data			
Worker activity description:	-Administrative - ONUs not directly associated with formaldehyde manufacturing or processing operations that work in building adjacent to or physically separated from manufacturing or processing operations.-Environmental, Health and Safety - work involves monitoring, analysis and surveying of employees or areas.-Quality Control/Quality Assurance - work involves sampling and analysis of raw materials, process streams and end products.- Logistics - work involves loading and unloading of railcars, trucks, totes, drums containing raw materials or finished products for distribution.-Maintenance - work involves fabricating, repairing and maintaining equipment.-Operations - work involves monitoring processes and auxiliary equipment from central control room or in operational areas; preparing equipment for maintenance and performing process changeout activities; unloading raw materials into reactor and unloading end products; and taking process samples. (pg. 10)			
Personal sampling data:	139 personal breathing zone samples included in data			
Exposure duration:	Full Shift, 8-hr TWA (pg. 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data are from 2012-2020 and reflect current industry operations, equipment, and activities.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include the most critical metadata, including sample types, exposure types, sample durations, exposure durations, and exposure frequency. Worker activities are not fully attributed to sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Stantec ChemRisk, (2023). Submission by ACC Formaldehyde TSCA Risk Evaluation Consortium regarding analysis of industrial hygiene monitoring data for formaldehyde manufacturing and processing.			
HERO ID:	11204040			
Conditions of Use:	Processing as a Reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	-Administrative - ONUs not directly associated with formaldehyde manufacturing or processing operations that work in building adjacent to or physically separated from manufacturing or processing operations.-Environmental, Health and Safety - work involves monitoring, analysis and surveying of employees or areas.-Quality Control/Quality Assurance - work involves sampling and analysis of raw materials, process streams and end products.- Logistics - work involves loading and unloading of railcars, trucks, totes, drums containing raw materials or finished products for distribution.-Maintenance - work involves fabricating, repairing and maintaining equipment.-Operations - work involves monitoring processes and auxiliary equipment from central control room or in operational areas; preparing equipment for maintenance and performing process changeout activities; unloading raw materials into reactor and unloading end products; and taking process samples. (pg. 10)			
Personal sampling data:	51 personal breathing zone samples included in data			
Exposure duration:	Full Shift, 8-hr TWA (pg. 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	Data are from 2012-2020 and represent current industry operations, equipment, and activities.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include the most critical metadata, including sample types, exposure types, sample durations, exposure durations, and exposure frequency. Worker activities are not fully attributed to sampling data.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.	
Overall Quality Determination		High		

Study Citation:	Stantec ChemRisk, (2023). Submission by ACC Formaldehyde TSCA Risk Evaluation Consortium regarding analysis of industrial hygiene monitoring data for formaldehyde manufacturing and processing.			
HERO ID:	11204040			
Conditions of Use:	Incorporation into a formulation, mixture or reaction product			
EXTRACTION				
Parameter	Data			
Worker activity description:	-Administrative - ONUs not directly associated with formaldehyde manufacturing or processing operations that work in building adjacent to or physically separated from manufacturing or processing operations.-Environmental, Health and Safety - work involves monitoring, analysis and surveying of employees or areas.-Quality Control/Quality Assurance - work involves sampling and analysis of raw materials, process streams and end products.- Logistics - work involves loading and unloading of railcars, trucks, totes, drums containing raw materials or finished products for distribution.-Maintenance - work involves fabricating, repairing and maintaining equipment.-Operations - work involves monitoring processes and auxiliary equipment from central control room or in operational areas; preparing equipment for maintenance and performing process changeout activities; unloading raw materials into reactor and unloading end products; and taking process samples. (pg. 10)			
Personal sampling data:	56 personal breathing zone samples included in data			
Exposure duration:	Full Shift, 8-hr TWA (pg. 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	Data are from 2012-2020 and reflect current industry operations, equipment, and activities.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include the most critical metadata, including sample types, exposure types, sample durations, exposure durations, and exposure frequency. Worker activities are not fully attributed to sampling data.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.	
Overall Quality Determination		High		

Study Citation:	Stantec ChemRisk, (2023). Submission by ACC Formaldehyde TSCA Risk Evaluation Consortium regarding analysis of industrial hygiene monitoring data for formaldehyde manufacturing and processing.			
HERO ID:	11204040			
Conditions of Use:	Processing Occupational Non-Users			
EXTRACTION				
Parameter	Data			
Worker activity description:	-Administrative - ONUs not directly associated with formaldehyde manufacturing or processing operations that work in building adjacent to or physically separated from manufacturing or processing operations.-Environmental, Health and Safety - work involves monitoring, analysis and surveying of employees or areas.-Quality Control/Quality Assurance - work involves sampling and analysis of raw materials, process streams and end products.- Logistics - work involves loading and unloading of railcars, trucks, totes, drums containing raw materials or finished products for distribution.-Maintenance - work involves fabricating, repairing and maintaining equipment.-Operations - work involves monitoring processes and auxiliary equipment from central control room or in operational areas; preparing equipment for maintenance and performing process changeout activities; unloading raw materials into reactor and unloading end products; and taking process samples. (pg. 10)			
Personal sampling data:	41 personal breathing zone samples included in data			
Exposure duration:	Full Shift, 8-hr TWA (pg. 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data are from 2012-2020 and reflect the current industry operations, equipment and activities.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include the most critical metadata, including sample types, exposure types, sample durations, exposure durations, and exposure frequency. Worker activities are not fully attributed to sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Stayner, L.T., Elliott, L., Blade, L., Keenlyside, R., Halperin, W. (1988). A retrospective cohort mortality study of workers exposed to formaldehyde in the garment industry. American Journal of Industrial Medicine 13(6):667-681.			
HERO ID:	32315			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.9-2.7 ppm formaldehyde air levels			
Comments:	Secondary source, primary source is Blejer HP, Miller BH (1966): Occupational health report of formaldehyde concentrations and effects on workers at Bayly Manufacturing Company, Visalia, California, California Department of Public Health, Bureau of Occupational Health, Los Angeles, California, Study No. S-1806.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States, specifically California
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Published in 1988
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics range provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., area sampling) but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty for the extracted data.
Overall Quality Determination		Low		

Study Citation:	Stayner, L.T., Elliott, L., Blade, L., Keenlyside, R., Halperin, W. (1988). A retrospective cohort mortality study of workers exposed to formaldehyde in the garment industry. American Journal of Industrial Medicine 13(6):667-681.		
HERO ID:	32315		
Conditions of Use:	Use of fabric, textile and leather products		
EXTRACTION			
Parameter	Data		
Worker activity description:	Garment facility produce shirts from fabrics which are treated with formaldehyde resins in order to impart crease resistance and other desirable properties. The fabrics emit unreacted formaldehyde gas;cutting, collar, parts, assembly and packaging		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	0.15 ppm geometric mean (Range 0.14-0.17 ppm) across three sites; values for departments at each plant are in Table II		
Number of workers:	1.6 million american workers exposed in workplace; 11030 reported for 3 garment facility		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved NIOSH method (Method 2016 Cartridge sampler, HPLB UV detection)
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States, specifically GA and PA
	Metric 3: Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - Published in 1988
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics - geometric mean and range provided
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, but lacks additional meta-data e.g., exposure duration and frequency
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	uncertainty included in the methodology and variability provided in the range from sampling at different facilities
Overall Quality Determination		High	

Study Citation:	Steinsvag, K., Bratveit, M., Moen, B.E. (2007). Exposure to carcinogens for defined job categories in Norway’s offshore petroleum industry, 1970 to 2005. Occupational and Environmental Medicine 64(4):250-258.			
HERO ID:	524541			
Conditions of Use:	Processing aids, specific to petroleum production in: oil and gas drilling, extraction, and support activities and all other basic inorganic chemical manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	biocide unit; maintaining chemcial stores, opening pumps, calibrating injection pumptps, filling biocide tanks from transportation tanks, injedting biocide into water injection system.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Personal: 0.13 mg/m3 mean (0.09 SD) 0.10 mg/m3 geometric mean (3.8 GSD) range 0.06-0.29 mg/m3;			
Area sampling data:	Area: 0.21 mg/m3 mean (0.15 SD) 0.25 mg/m3 geometric mean (0.15 GSD) range 0.05-0.53 mg/m3;			
Comments:	See Table 2 for monitoring data			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it was noted that GMD system dosimeter and HPLC were used
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Norway - OECD member
	Metric 3:	Applicability	High	Data are for an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Published in 2007 data covered the period from 1970-2005
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics -mean, SD, range, geometric mean , geometric SD and sample size provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Missing: sampling and analytic methods, number of sites, exposure duration and frequency, number of workers, and sampling locations
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Range, arithmetic and geometric standard deviation provided to assess variance but nothing provided for uncertainty
Overall Quality Determination			Medium	

Study Citation:	Stephenson, R. L., Aw, T. C. (1986). Health Hazard Evaluation Report HETA-1984-0132-1703 Purex Industrial Division, Marion, Ohio.			
HERO ID:	8251533			
Conditions of Use:	Processing-Reactant-All other chemical product and preparation manufacturing			
EXTRACTION				
Parameter	Data			
Area sampling data:	Five formaldehyde air samples were collected: four in the Purex Industrial Packaging Department (three on the Pail Line and one on the Laub line); and, one in the Compound Room - Purex Industrial Liquid (LOD 0.002 mg/sample). No formaldehyde was detected.			
Exposure duration:	The majority of the work is accomplished on one shift, 0730-1600.			
Number of workers:	The total plant workforce (80 employees), consists.of 50 production workers, 25 administrative and clerical staff and 5 maintenance employees.			
Personal protective equipment:	...some of the workers wore disposable ornon-disposable half-face piece respirators with dust/mist filters,organic vapor, acid gas or combination organic vapor-acid gas chemical cartridges or cartridges for specific contaminants; for example ammonia, methyl amine or formaldehyde. More recently, however, (in September 1985), plant management provided several workers in the Compound Room with positive pressure hood-type supplied-air respirators.			
Engineering control:	Extensive changes were made in the ventilation system for the Compound Room in 1984 when local exhaust ventilation equipment was installed on most of the processing equipment. In January 1986, engineering control equipment was installed in the Compound Room to further enclose and automate the ammonia handling procedures and production operations utilizing liquid ammonia.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty
Overall Quality Determination			High	

Study Citation:	Stephenson, R. L., Murphy, D. C., Habes, D. J. (1985). Health hazard evaluation report: HETA-81-369-1591 and HETA-81-466-1591 - Electric Machinery McGraw Edison Company. Minneapolis, Minnesota.			
HERO ID:	1320981			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Worker activity description:	Coil winding Coil forming Hand tapingArmature windingPole winding VPI			
Exposure route:	Inhalation			
Physical form:	vapor			
Personal sampling data:	Two personal samples collected during soldering operations in thearmature winding area revealed formaldehyde levels of 7.8 ug/m3 (0.006 ppm) and 53.5 ug/m3 (0.04 ppm)			
Dermal exposure data:	nan			
Exposure duration:	8 hours per day			
Exposure frequency:	5 days per week			
Number of workers:	550 employees, 165 admin and clerical, 350 production workers and 35 maintenance staff.			
Personal protective equipment:	Recommended: Personal protective equipment including long sleeved shirts, coveralls or aprons, and gloves should be provided_ for and used by those employees exposed to epoxy resins. The gloves used should be tear-resistant, disposable, impervious to the epoxy resin materials, and of sufficient length.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method P&CAM 125
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (Electric motor manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1983 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Medium	Results from two sampling events was provided - no other statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data includes most critical metadata, such as sample type, exposure type, exposure durations, exposure frequency, and worker activities, but lacks sample durations.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Results from two sampling events was provided - which has limited value in assessing variability. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 626857 Table: 1 of 1

Study Citation: Stewart, P. A., Blair, A., Cubit, D. A., Bales, R. E., Kaplan, S. A., Ward, J., Gaffey, W., O’Berg, M. T., Walrath, J. (1986). Estimating historical exposures to formaldehyde in a retrospective mortality study. Applied Industrial Hygiene 1(1):34-41.
HERO ID: 626857
Conditions of Use: Processing as a reactant

EXTRACTION

Parameter	Data
Exposure route:	inhalation
Area sampling data:	only one example was provided: Sifter 0.38 -1.15 ppm; Batchman 0.35-1.0 Supplemental data shows concentrations that reflect changes in the plant.
Number of workers:	30000

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH P&CAM 125 method was used at 3 of the 10 plants for which sampling was implemented
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	Low	mostly a methodolgy data presented was only as example of data compiled, still the example is similar to the the in-scope occupational scenario for use of formaldehyde resins.
	Metric 4: Temporal Representativeness	Low	Monitoring data are greater than 20 years old and prior to the PEL - Article published in 1986
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Sample type and exposure type not provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability over time presented for example but uncertainty are not addressed.

Overall Quality Determination **Uninformative**

Study Citation:	Stewart, P.A., Blair, A. (1994). Women in the formaldehyde industry: Their exposures and their jobs. Journal of Occupational Medicine 36(8):918-923.			
HERO ID:	6110873			
Conditions of Use:	Manufacturing and Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Formaldehyde producing and formaldehyde using plants			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	8-hr TWA (pg 1-2): Table 1 presents mean and SD in ppm, split out for men and women, for first job, last job, highest exposed job, and peak exposures for the 10 plants (pg 3); similar data in Table 2 (pg 4) but split out for first job (1940-45), job held on 12/31/1965, and job held 12/31/1979; cumulative data in Table 3 (pg 4)			
Number of workers:	26,561 workers employed at 10 FA-producing or FA-using plants; 3,130 being women (pg 1)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for multiple in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean and SD) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by evaluating multiple sites over multiple time periods, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1313829 Table: 1 of 1

Study Citation:	Stone, R. A., Youk, A. O., Marsh, G. M., Buchanich, J. M., Smith, T. J. (2004). Historical cohort study of U.S. man-made vitreous fiber production workers IX: summary of 1992 mortality follow up and analysis of respiratory system cancer among female workers. Journal of Occupational and Environmental Medicine 46(1):55-67.			
HERO ID:	1313829			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.03-0.1 ppm			
Number of workers:	32,110			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for fiberglass manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 2004 but is based on data collected from 1946-1992 prior to the 1992 PEL and over 20 years old. Actual sampling was performed form 1970-1990.
	Metric 5:	Sample Size	Medium	range data were provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Sugata, Y., Miyaso, H., Odaka, Y., Komiyama, M., Sakamoto, N., Mori, C., Matsuno, Y. (2016). Levels of formaldehyde vapor released from embalmed cadavers in each dissection stage. Environmental Science and Pollution Research 23(16):16176-16182.		
HERO ID:	4455765		
Conditions of Use:	Lab chemical (mortuary science)		
EXTRACTION			
Parameter	Data		
Worker activity description:	6 cadavers (pg 2); Short term (30 min sampling, pg 2); Sampling conducted above thoracoabdominal region of each dissected cadaver (pg 1). Analyzed via HPLC (pg 3)		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	Original data: 0.1, 0.63, 0.87, 0.77, 0.62 ppm (pg 4; in order of dissection steps)		
Engineering control:	the room was ventilated for 60 min to allow the FA level to returnto background		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (assumed average) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency, number of workers.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling multiple cadavers , but uncertainty is not addressed.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1319726 Table: 1 of 1

Study Citation:	Sundell, J. (1994). On the association between building ventilation characteristics, some indoor environmental exposures, some allergic manifestations and subjective symptom reports. Indoor Air 4(S2):7-49.			
HERO ID:	1319726			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office workers (2/42)			
Exposure route:	inhalation (2/42)			
Area sampling data:	In a study of office locations, concentrations were 11-59 ug/m3. (24/42)			
Number of workers:	5986 workers in the study (2/42)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	Low	Data are for ambient air in an office/building, which is similar to the in-scope occupational scenario use of furniture products.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by analyzing and comparing the results from 8 studies.
Overall Quality Determination		Medium		

Study Citation:	Sundell, J., Andersson, B., Andersson, K., Lindvall, T. (1993). Volatile organic compounds in ventilating air in buildings at different sampling points in the buildings and their relationship with the prevalence of occupant symptoms. Indoor Air 3(2):82-93.		
HERO ID:	21346		
Conditions of Use:	Office Environment		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	31 Ug/m3 mean (min 11 Max 59 ug/m3) geometric mean 26 ug/m3; rooms with low SBS: 29 ug/m3 mean 24 ug/m3 geometric mean; high SBS: 33 ug/m3 mean 27 ug/m3 geometric mean. The document also includes adjusted values to account for outdoor temperature. also provided are adjusted values for different flooring materials, air recirculation cleaning, temperature and humidity		
Number of workers:	nearly 6000 from 210 office buildings		
Comments:	29 (14 buildings classified as high Sick Building Syndrome (SBS) and 15 classified as low SBS		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling and analysis methods were not provided but it was documented that Formaldehyde was collected by diffuse samplers in two parallel sampling trains and analyzed by liquid chromatography (HPLC)
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden - OECD member
	Metric 3: Applicability	High	The data are for an office exposure, an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1993, after the most recent PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized, though uncertainty not documented
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	data were provided for sampling type, building ventilation rates, year of remodeling, use of plastic floors, frequency of cleaning, air temperature, and humidity. But, other key metadata were noted provided such as sampling and analytic methods, number of sites, sample durations, exposure durations, worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The monitoring data included range information for high SBS and Low SBS scenarios which could be used to evaluate variability. There was no discussion about uncertainty in the exposure estimates.
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 21346 Table: 1 of 1

...continued from previous page

Study Citation:	Sundell, J., Andersson, B., Andersson, K., Lindvall, T. (1993). Volatile organic compounds in ventilating air in buildings at different sampling points in the buildings and their relationship with the prevalence of occupant symptoms. Indoor Air 3(2):82-93.		
HERO ID:	21346		
Conditions of Use:	Office Environment		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 32713 Table: 1 of 1

Study Citation:	Suruda, A., Schulte, P., Boeniger, M., Hayes, R.B., Livingston, G.K., Steenland, K., Stewart, P., Herrick, R., Douthit, D., Fingerhut, M.A. (1993). Cytogenetic effects of formaldehyde exposure in students of mortuary science. Cancer Epidemiology Biomarkers and Prevention 2(5):453-460.			
HERO ID:	32713			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Worker activity description:	embalming			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Average 1.4 ppm during embalming (range 0.15-4.3 ppm) 8 hr TWA 0.33 ppm the study further disaggregated exposure into: normal bodies, 0.9 ppm mean (range 0.2-2.1 ppm); bodies for anatomical donation 1.3 ppm mean (range 0.5-4.3 ppm); autopsied bodies 1.5 ppm mean (range 0.4-3.8 ppm); other cases 0.2 ppm mean (range 0.15-0.9 ppm); outside funeral homes 1.06 ppm mean (range 0.58-3.32 ppm)			
Number of workers:	29 students			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology based on NIOSH 2502 method. Additionally, NIOSH staff were present during the first 2 weeks of the course to provide training.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1993, soon after the posting of the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability thgou the provision of data ranges, while uncertainty was address in the sampling and analytical method.
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 18763 Table: 1 of 1

Study Citation:	Suskov, I. I., Sazonova, L. A. (1982). Cytogenetic effects of epoxy, phenolformaldehyde and polyvinylchloride resins in man. Mutation Research 104(1-3):137-140.			
HERO ID:	18763			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalatin			
Physical form:	Vapor			
Area sampling data:	0.5 mg/m3			
Exposure duration:	4-30 years			
Number of workers:	52			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Unknown but believe it is likely Russia
	Metric 3:	Applicability	Low	older article in a location that does not have the same worker safety standards
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL and is older than 20 years - article published in 1981 but no sense how old the data are
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics - just a single concentration value was provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	nothing provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	no discussion of uncertainty
Overall Quality Determination		Uninformative		

Study Citation:	Sussell, A. (1995). Health hazard evaluation report No. HETA-91-0239-2509, Medite Of New Mexico, Las Vegas, New Mexico. :91-0239.			
HERO ID:	1316591			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	job titles mentioned were press operator, former operator, sander operator, utilityman, and (production) laborer. Report does not clarify which positions are the most risk via formaldehyde dust exposure.			
Exposure route:	inhalation			
Physical form:	dust			
Area sampling data:	Formaldehyde in Dust (6/2/93)NIOSH 5700 [mg/m3] Blender room: 0.61, 0.55; Form Line: 0.33, 0.26 Form Station Control room: 0.016, 0.020; Inline Saw: 0.007, 0.019; Outside (at EOM sign): 0.0005, 0.003Ella et al. [mg/m3] Blender room: 0.094, 0.064; Form Line: 0.050, 0.039 Form Station Control room: 0.003, 0.003; Inline Saw: 0.002, 0.001; Outside (at EOM sign): 0.0003, 0.0003			
Exposure duration:	three 8-hour shifts per day			
Exposure frequency:	operating 7 days per week			
Number of workers:	133-135 hourly and 20 administrative employees			
Personal protective equipment:	Workers were provided NIOSH-approved full-facepiece air-purifying respirators with formaldehyde/organic vapor cartridges and dust/mist filters for certain jobs associated with high formaldehyde exposures, such as press maintenance.			
Engineering control:	The former, form line, form line saw, press, cooling wheel, in-line saw, and sander were provided with local exhaust ventilation to remove airborne wood dust and formaldehyde vapors. The warehouse was provided with general dilution ventilation.Additional openings were installed in outside walls to provide for passive movement ofmake-up air.Larger exhaust fans were installed on the board cooler to drop temperatures faster andproduce more air movement in the plant.The molar ratio of formaldehyde to urea was reduced in the urea-formaldehyde resins used for binding both the “face” and “core” areas of the fiberboard.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	As this is an NIOSH study NIOSH methods 3500 and 5700 was used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (composite wood product manufacturing) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Study implemented from 1991 and 1993, around the period that the PEL was implemented and study results are more than 20 years old.
	Metric 5:	Sample Size	Medium	Appears to have taken 1 sample in 1991 and 2 samples in 1992, but only provides the mean for the 1992 sample. Uncertain statistics with low sample size.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, and sample durations, but lacks additional metadata, such as exposure duration, exposure frequency, and/or worker activities (beyond job title).
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1316591 Table: 1 of 2

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Study Citation:		Sussell, A. (1995). Health hazard evaluation report No. HETA-91-0239-2509, Medite Of New Mexico, Las Vegas, New Mexico. :91-0239.		
HERO ID:		1316591		
Conditions of Use:		Compressed Wood Product Manufacturing		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	There is discussion of variance(different locations and two visits). As this is a NIOSH study and it is assumed that NIOSH methods were used, it is also assumed that uncertainty was considered as part of the sampling and analytic methodology.
Overall Quality Determination			High	

Study Citation:	Sussell, A. (1995). Health hazard evaluation report No. HETA-91-0239-2509, Medite Of New Mexico, Las Vegas, New Mexico. :91-0239.			
HERO ID:	1316591			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	the jobs with the highest formaldehyde vapor exposures were press operator, former operator, sander operator, utilityman,and (production) laborer.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	0.23-0.48 mg/m3 (1991) Table 1Sander 0.45 mg/m3Press 0.23 mg/m3Utility 0.31 mg/m3laborer 0.48mg/m3* Sampling results using 3M diffusional monitors side by side reported for the above workers (0.42-0.45 mg/m3)0.122-0.346 mg/m3 (1993) Table 4Sander 0.346 mg/m3Press 0.122 mg/m3Utility 0.26 mg/m3Laborer 0.255 mg/m3 (average of 2 workers)			
Area sampling data:	0.38 mg/m3 (first visit) 0.25 mg/m3 (second visit)Range 0.15-0.53 mg/m3 (method 3500) and 0.007-0.61 mg/m3 (method 5700) (1993) Table 2Table 1 (1991)Form Line: 0.47 mg/m3; Blender Room: 0.56 mg/m3; Form Station Control Room: 0.35 mg/m3; In-line Saw: 0.54 mg/m3; Outdoors at Employee of the month side: 0.05 mg/m3Table 2 (1993)Form Line (2): 0.53 mg/m3, 0.32 mg/m3; Blender Room(2): 0.29 mg/m3, 0.21 mg/m3; Form Station Control Room: 0.20 mg/m3, 0.15 mg/m3; In-line Saw: 0.38 mg/m3, 0.37 mg/m3; Outdoors at Employee of the month side: 0.13 mg/m3, 0.07 mg/m3			
Exposure duration:	three 8-hour shifts per day			
Exposure frequency:	operating 7 days per week			
Number of workers:	133-135 hourly and 20 administrative employees			
Personal protective equipment:	Workers were provided NIOSH-approved full-facepiece air-purifying respirators with formaldehyde/organic vapor cartridges and dust/mist filters for certain jobs associated with high formaldehyde exposures, such as press maintenance.			
Engineering control:	The former, form line, form line saw, press, cooling wheel, in-line saw, and sander were provided with local exhaust ventilation to remove airborne wood dust and formaldehyde vapors. The warehouse was provided with general dilution ventilation.Additional openings were installed in outside walls to provide for passive movement ofmake-up air.Larger exhaust fans were installed on the board cooler to drop temperatures faster andproduce more air movement in the plant.The molar ratio of formaldehyde to urea was reduced in the urea-formaldehyde resins used for binding both the “face” and “core” areas of the fiberboard.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	As this is an NIOSH study NIOSH methods 3500 and 5700 was used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (composite wood product manufacturing) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Study implemented from 1991 and 1993, around the period that the PEL was implemented and study results are more than 20 years old.
	Metric 5:	Sample Size	Medium	Appears to have taken 1 sample in 1991 and 2 samples in 1992, but only provides the mean for the 1992 sample. Uncertain statistics with low sample size.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, and sample durations, but lacks additional metadata, such as exposure duration, exposure frequency, and/or worker activities (beyond job title).
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 1316591 Table: 2 of 2

...continued from previous page

Study Citation:		Sussell, A. (1995). Health hazard evaluation report No. HETA-91-0239-2509, Medite Of New Mexico, Las Vegas, New Mexico. :91-0239.		
HERO ID:		1316591		
Conditions of Use:		Compressed Wood Product Manufacturing		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	There is discussion of variance in different locations and time. As this is a NIOSH study and it is assumed that NIOSH methods were used, it is also assumed that uncertainty was considered as part of the sampling and analytic methodology.
Overall Quality Determination			High	

Study Citation:	Sussell, A. L. (1990). Heta 89-335-2041 May 1990 Sheffield Lake Service Department Sheffield Lake, Ohio.			
HERO ID:	8156936			
Conditions of Use:	Fuels and related products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Administrative employees, diesel truck maintenance and service workers. (2/13)			
Exposure route:	inhalation (2/13) from diesel exhaust or off-gas from office furniture/building materials			
Physical form:	gas (4/13)			
Area sampling data:	Area samples for formaldehyde were 0.003 mg/m3 outdoors, 0.026 mg/m3 in the office area, 0.023 mg/m3 in the parking bays, and 0.024 mg/m3 in the maintenance shop. (9/13)			
Exposure duration:	6-7 hours (2/13)			
Number of workers:	11 employees (2/13)			
Engineering control:	Ventilation consists of a wall fan on the south wall and two overhead ceiling vents which must be opened manually. (2/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method (NIOSH 3500).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for commercial use of fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sampling data, exposure type, and worker information provided, but mission exposure frequency and PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling inside and outside the shop.
Overall Quality Determination			High	

Study Citation:	Suuronen, K., Henriks-Eckerman, M.L., Riala, R., Tuomi, T. (2008). Respiratory exposure to components of water-miscible metalworking fluids. Annals of Occupational Hygiene 52(7):607-614.			
HERO ID:	632121			
Conditions of Use:	Use of Metalworking fluid			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	From Table 2: 0.040 mg/m3 mean (0.011-0.150 mg/m3)			
Exposure duration:	sampling duration 2 hrs			
Comments:	Exposure measurements were carried out in 10 metal workshops in southern Finland during the year 2004. The companies were selected from a pool of 60 metal workshops where machining was one of the main activities.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods. (Sampling methods used described in Table 1)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD member
	Metric 3:	Applicability	High	Data are for metal workshops which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2008.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (me and range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing details about sampling location and exposure frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by range, but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Suzuki, R.A., Irokawa, T., Ogawa, H., Ohkouchi, S., Tabata, M., Togashi, S., Nakamura, T., Ohisa, N., Nikkuni, E., Miura, E., Yoshida, K., Inomata, H., Kurosawa, H. (2017). Fractional exhaled nitric oxide (FeNO) and spirometry as indicators of inhalation exposure to chemical agents in pathology workers. Journal of Occupational and Environmental Medicine 59(5):467-473.			
HERO ID:	3847911			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Physicians and laboratory technicians who worked in the pathology departments of six general hospitals and always handled several chemical substances, including FA, through their work.			
Exposure route:	Inhalation			
Personal sampling data:	Median: 0.024, interquartile range: 0.012 - 0.054, min: 0.004, max: 0.079 (all values TWA 8-hr, ppm)			
Exposure duration:	8 hour/day			
Exposure frequency:	5 days/week			
Number of workers:	33 subjects (pathology technicians) and 30 controls (workers without handling any chemicals in the same hospitals) participated in this study.			
Comments:	All participants worked for 8 hours a day, for 5 days a week.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3:	Applicability	High	Data are for pathology workers, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (total sample number, Median, min, max, IQR).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination			High	

Study Citation:	Svendsen, K., Jensen, H.N., Sivertsen, I., Sjaastad, A.K. (2002). Exposure to cooking fumes in restaurant kitchens in Norway. Annals of Occupational Hygiene 46(4):395-400.			
HERO ID:	4679415			
Conditions of Use:	Use/exposure in restaurant kitchens as cooking fumes			
EXTRACTION				
Parameter	Data			
Worker activity description:	Kitchen employees in Hotel Kitchens, Hamburger Chains, Restaurants with Grills, Local Restaurants.			
Exposure route:	inhalation			
Physical form:	vapor/gas			
Personal sampling data:	Table 1 provides the results of sampling (ug/m^3): hotel kitchen: mean - 11, SD - 8, Min - 4, Max - 24, GM - 8; Hamburger chain: Mean - 7, SD - 0, Min - 7, Max - 7, GM - 7; Restaurants with grill: mean - 15, SD - 11, Min - 2, Max - 60, GM - 12; Small local restaurants: mean - 14, SD - 6, Min - 7, Max - 26, GM - 13; Total: mean - 14, SD - 9, Min - 2, Max - 60, GM - 11			
Engineering control:	Deep fryer, cooking tops, frying cabinets all were equipped with ventilation hoods.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Medium	Range of data with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Provides worker activity, exposure route, physical form, some engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by looking at multiple different type of kitchens from hotel kitchens to fast food places. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Sylvain, D. (1999). Health hazard evaluation report: HETA 98-0194-2721, U.S. Fish and Wildlife Service, Nashua, New Hampshire.			
HERO ID:	6558295			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers at Nashua National Fish Hatchery (NFH) in Nashua, New Hampshire, specifically employee exposure to formaldehyde during the treatment of sea-run Atlantic Salmon.			
Exposure route:	Inhalation			
Personal sampling data:	Formaldehyde concentration in personal breathing zone (PBZ) sample was 1.1 ppm. PBZ sampling indicates that worker exposure to formaldehyde exceeded the REL (ceiling limit) and TLV while filling of the sprayer and applying formalin to a broodstock tank. The PEL was not exceeded.			
Area sampling data:	Formaldehyde concentrations in area samples: (1) at perimeter of tank during spraying – 0.59 ppm; (2) at perimeter of tank during aeration – 0.23 during the first 31 minutes of aeration (following spraying) and 0.03 ppm during the final 35-minute sampling period.			
Personal protective equipment:	Personal protective equipment (PPE) worn during treatment consisted of a full-face respirator, respirator equipped with formaldehyde cartridges, neoprene apron, and rubber gloves. The effectiveness of the PPE ensemble was limited by: (1) the use of neoprene, which can be permeated by methanol, and (2) uncertainty regarding the type of rubber comprising the gloves.			
Engineering control:	The routine exposure to airborne formaldehyde due to formalin spraying could be eliminated by applying the formalin beneath the surface of the water in the broodstock tanks, possibly using the aeration system to mix the formalin into the water.			
Comments:	NIOSH has established the REL for formaldehyde at the lowest concentrations that can be reliably quantified: 0.016 ppm for up to a 10-hour TWA exposure, and 0.1 ppm as a 15-minute ceiling concentration. ACGIH has set the TLV for formaldehyde at 0.3 ppm. The OSHA general industry formaldehyde standard (29 CFR 1910.1048), sets the PEL for airborne exposure to formaldehyde at 0.75 ppm as an 8-hour TWA and 2 ppm as a 15-minute STEL.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data is more than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Sylvain, D. C. (1996). Health Hazard Evaluation Report HETA 96-0120-2608, Acton Post Office, Acton, Massachusetts, October 1996.
HERO ID:	1316934
Conditions of Use:	Use of Cleaning and Furniture Care Products

EXTRACTION	
Parameter	Data
Worker activity description:	Mail is manually sorted in “cases,” which are two or three sided metal units with vertically divided shelves. The cases measure approximately 5½ feet wide, 5½ deep, and 6 feet in height. Newsprint and other bulk mail is kept on the workroom floor until it is sorted and delivered. The amount of mail that moves through the post office was reported to vary throughout the week, with lightest volumes on Wednesday, and heaviest on Friday. Postal staff reported that newsprint comprises the largest part of the mail stream. Of the approximately 60 clerks and carriers who are employed at the post office, 15 to 20 remain in the building throughout the day. Carriers typically remain in the building for several hours in the morning while preparing mail for delivery
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	The results of personal breathing zone (PBZ) air sampling revealed formaldehyde concentrations below 0.02 parts per million (ppm).Administrative clerk <0.02 ppmBulk mail clerk <0.01 ppmClerk <0.02 ppmWindow distribution <0.01 ppm
Area sampling data:	Area sampling, using a more sensitive sampling and analytical method, indicated formaldehyde concentrations of approximately 0.01 ppm in all area samples. Carrier supervisor office 0.01 ppmWorkroom 0.082 ppmAdministrative office 0.011 ppmCustomer window 0.0087 ppm
Exposure duration:	up to 10 hours per day
Exposure frequency:	40 hours per week.
Number of workers:	60
Engineering control:	Replace the floor wax with a product that does not have formaldehyde.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study using Method 3500 and 2541
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (government office work) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	sampling initiated in 1995, after the release of the PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	actual results from each sampling event was provided, which can be used to generate statistics , no discussion of uncertainty.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include the critical metadata, such as sample type and exposure type, sample durations, exposure durations, exposure frequency, and worker activities.

Domain 4: Variability and Uncertainty

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Formaldehyde

Occupational Exposure

HERO ID: 1316934 Table: 1 of 1

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Study Citation:		Sylvain, D. C. (1996). Health Hazard Evaluation Report HETA 96-0120-2608, Acton Post Office, Acton, Massachusetts, October 1996.		
HERO ID:		1316934		
Conditions of Use:		Use of Cleaning and Furniture Care Products		
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 7:	Metadata Completeness	High	variability was not discussed but results from each sampling event were provided allowing for assessment of variability between locations and jobs. As NIOSH Methods were used it is assumed that uncertainty is considered in the method.
Overall Quality Determination			High	

Study Citation:	Takahashi, M., Abe, M., Yamagishi, T., Nakatani, K., Okade, T., Ogawa, T., Konishi, H., Kiryu-Seo, S., Kiyama, H., Nakajima, Y. (2010). Local ventilation system successfully reduced formaldehyde exposure during gross anatomy dissection classes. Anatomical Science International 85(4):251-252.			
HERO ID:	2582385			
Conditions of Use:	Laboratory use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Dissection			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	The mean FA concentration of the room (“A” measurement) and the estimated maximum exposure to FA (“B” measurement) during dissection classes were 0.520 and 0.480 ppm.			
Engineering control:	Use of ventilated tables: 0.035 ppm average for room and 0.054 ppm peak during dissection - the system consists of a simple plenum-chambered dissection table and a transparent vinyl duct which connects the table to the pre-existing general ventilation duct via a flow control valve in the ceiling. However, the formaldehyde concentration exceeded 0.08 ppm during the dissections of specific areas of the room, so it may be necessary to consider additional strategies for formaldehyde reduction, such as downward flow of air supply above the table and the utilization of personal protective equipment by students with hypersensitivity to formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified, but it was noted that HPLC analysis performed by Panasonic Health Organization Science Center of Industrial Hygiene, Osaka, Japan. Also used used a photoelectronic method (FP-30, Rikenkeiki, Tokyo, Japan).
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Japan - an OECD member
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	The data are more than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided results for each sampling event that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Study Citation:	Takigawa, T., Horike, T., Ohashi, Y., Kataoka, H., Wang, D.H., Kira, S. (2004). Were volatile organic compounds the inducing factors for subjective symptoms of employees working in newly constructed hospitals?. Environmental Toxicology 19(4):280-290.			
HERO ID:	1313804			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	doctor, nurse, co-medical, clerk			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Indoor formaldehyde was detected in all rooms investigated; crude- 20 ug/m3 median (range 6–32 ug/m3) and adjusted 33 ug/m3 adjusted median (range 4 –59 ug/m3). The ambient air outside the hospitals was 7 ug/m3 median (range 4 –13 ug/m3) .			
Number of workers:	312			
Comments:	It is unclear what the source of the formaldehyde is, could be disinfectant or off gasing from construction or furniture			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology was not specified, but it was noted that formaldehyde was collected using 2,4-dinitrophenylhydrazine (DNPH)-coated silica cartridges (SepPak DNPH-Silica cartridge, Waters, Milford, MA, USA), kept cool in an insulated container and sent to our laboratory. The cartridgeswere eluted with 3 mL of acetonitrile before analysis with ahigh-performance liquid chromatograph (Hewlett PackardSeries 1100, Hewlett Packard, Palo Alto, CA, USA)equipped with a photodiode array detector (Hewlett Packard, USA). Analytical column (Hypersil ODS Agilent Technologies, Palo Alto, CA, USA) was used. The mobile phase was acetonitrile and distilled water. The column was thermostated at 40°C. The detection wavelength was 360 nm. The temperature and relative humidity (RH) of the air were also recorded during sampling with an Assmanpsychrometer. Formaldehyde concentrations were adjustedfor the values of 20°C and 50% RH according to MHLWrecommendations.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Japan - and OECD member
	Metric 3:	Applicability	High	The data are for hospital exposure which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The study was published in 2004, after the most recent PEL (1992) and more than 10 and less than 20 years old.
	Metric 5:	Sample Size	Medium	crude and adjusted (temp & Humidity) median values are provided for all rooms tested and outside concentrations. Also range data provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were provided.
Domain 4: Variability and Uncertainty				
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Formaldehyde

Occupational Exposure

HERO ID: 1313804 Table: 1 of 1

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Study Citation:	Takigawa, T., Horike, T., Ohashi, Y., Kataoka, H., Wang, D.H., Kira, S. (2004). Were volatile organic compounds the inducing factors for subjective symptoms of employees working in newly constructed hospitals?. Environmental Toxicology 19(4):280-290.		
HERO ID:	1313804		
Conditions of Use:	Office Environment		
Domain		EVALUATION	
Metric		Rating	Comments
Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium	

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Formaldehyde oxidation			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1.2 mg/m3 mean (range 0.01-2.1 mg/m3)			
Comments:	Not the primary source			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for a formaldehyde oxidation plant which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (1988-97) more than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by an average value, number of samples and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., area) but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provide range that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination		Low		

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1.07 mg/m3 (range 0.5-3.5 mg/m3)			
Comments:	Not the primary source of the data.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for formaldehyde production which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (2001) after the PEL (1992) , but more than 10 and less than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by an average value and and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., area) but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination			Low	

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Formaldehyde workshop: mean values vary by primary source from 0.029, 0.985, 2.53+/- 2.17 (range 0-8.03 mg/m3)			
Comments:	Not primary source.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for formaldehyde workshops which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (1994-96) after the PEL (1992), but more than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by an average value, and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range data (and SD for Shanghai) for five different locations that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination		Low		

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	processing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Wood blocking: mean values vary by site: Shanghai 1.13+/-0.59 mg/m3 mean (range 0.35-2.60 mg/m3); Kunshan 0.18 mg/m3 mean			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for wood blocking which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (2002-2005) more than 10 but less than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by an average value, and range (for Shanghai).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range (for Shanghai) and includes data from two different locations, that can be used to assess variability. Uncertainty is not discussed.
Overall Quality Determination		Medium		

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Vinylon production: 2.5 mg/m3 mean (range 0.95-5.72 mg/m3); Hexamine workshop: 0.787 mg/m3 mean ; Polyacetal workshop: 1.023 mg/m3 mean			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for a processing as a reactant which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (1990) prior to the most recent PEL establishment or update (1992), more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by an average value, and range for certain cases.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., area) but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provide range and different reaction products that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination		Low		

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Distribution in Commerce			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1.3 mg/m3 mean (range 0.02-1.8 mg/m3)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for a formaldehyde storage which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (1988-97) more than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by an average value, number of samples and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., area) but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provide range that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination			Low	

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Cork Compression			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	3.01 mg/m3 (range 0.33-46.14 mg/m3) [Combined average calculated from subsets of means with corresponding sample sizes given in the original paper.]			
Comments:	Not the primary source of the data- review paper.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for a cork compression which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (1985) prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by an average value, and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Lacking critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination			Low	

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Wood Processing: mean values vary by source: 0.87+/- 0.5; 0.92+/-0.4; 3.07+/-5.83 mg/m3 (range 0.7 - 19.2 mg/m3)			
Comments:	Not primary source.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for wood processing which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (1990-98) more than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by an average value, and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range and margin of error data for three different locations, that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 626839 Table: 9 of 18

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	1.92+/-0.8 mg/m3 mean (range 0.4-4.3 mg/m3)			
Comments:	Not the primary source for the data.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for incorporation into formulation (paint production) which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (2000) after the PEL (1992) and around 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by range values.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range data that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination		Low		

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Textile resin collar: mean values vary by season- summer: range 0.22-0.62 mg/m3; winter: range 1.39-5.59 mg/m3			
Comments:	Not the primary source for the data			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for incorporation into textile product (resin collar) which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (1989) prior to the PEL (1992), and more than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by range values.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range data for two different seasons that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination		Low		

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Life cycle description:	incorporation into article: insulation material			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	mean values vary by season- summer: range 0.15-0.39 mg/m3; winter: range 0.64-0.93 mg/m3			
Comments:	Not the primary source for the data.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for insulation material manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (1989) prior to the PEL (1992), and more than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by range values.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range data for two different seasons that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination			Low	

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Non-TSCA			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	varies by site and sampling location: Qingyuan (Hood) range 0.6-23.0 mg/m3; Quigyuan (room) range 0.05-0.36 mg/m3; Wuhan (room) range 0.44-6.84 mg/m3			
Comments:	Not the primary source for the data.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	Uninformative	The data are for food germination which EPA expect is a use of formaldehyde that is non-TSCA, therefore not within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (2000-2005) prior to the PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by an average and range values.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range data that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination		Uninformative		

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	mean values vary by year of testing 2003: 0.42 mg/m3 mean (range 0.11-0.86 mg/m3); 2005: 0.41 mg/m3 mean (range 0.14-3.20 mg/m3)			
Comments:	Not the primary source for the data.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for producing density fiberboard production which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (2003-2005) after the PEL (1992), but more than 10 and less than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by an average value, and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range data for two different time periods that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination		Medium		

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	student, professors			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	varies by location and site: Teacher office: Lanzhou 0.386 mg/m3 mean; Dalian 0.20+/-0.088 mg/m3 mean; Urumuqi 0.040+/-0.020 mg/m3 mean; Corridors: Dalian 0.315+/-0.117 mg/m3 mean; Urumuqi 0.056 +/-0.040 mg/m3 mean; Specimen work shops 1.100 mg/m3; Anatomy classrooms 2.514 mg/m3; Specimen rooms 12.783 mg/m3			
Comments:	Not primary source for data.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	China - not an OECD member	
	Metric 3: Applicability	High	The data are for a medical college which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (1998-2006) after the PEL (1992) and more than 10 but less than 20 years old.	
	Metric 5: Sample Size	High	The distribution of samples is characterized by an average and sometimes SD.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	No metadata provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The monitoring study provides SD values that can be used to assess variability, but uncertainty is not discussed.	
Overall Quality Determination		Medium		

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	varies by site: Pathology rooms- Shanghai 1.60+/-1.1 mg/m3 mean (range 0.18-5.84 mg/m3); Chaoyang, Beijing 0.086–0.088 mg/m3; Xuanwu, Beijing 0.610–0.630 mg/m3; Xicheng, Beijing 1.300–1.500 mg/m3; Chongwen, Beijing 1.900–2.000 mg/m3; Bengpu 0.184–0.931 mg/m3 (Includes diagnostic rooms, stock rooms, and offices.)			
Comments:	Not primary source for data.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	High	The data are for a hospital pathology room which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (2003-2005) after the PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by an average with margins of error (for Shanghai) and range values.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range values that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination		Low		

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.256 mg/m3 new office building (city specific averages, SD and Range values are provided (Range 0-3390 ug/m3) for the period from 1996 to 2005 for 351 sites measured.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	Medium	The data are for an occupational scenario but it is assumed to be within the scope of the risk evaluation, as source of formaldehyde exposure is not explained.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (2003-2008) after the most recent PEL establishment or update (1992), more than 10 but less than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by an average value, SD,and range.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provide range and SD that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination		Low		

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Wuhan data- After opening the cadaver container for 20 minutes without turning on the circulation system.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	varies by site: Lanzhou 4.134 mg/m3 mean; Dalian 1.074+/-0.454 mg/m3 mean; Wuhan 8.349+/-2.644 mg/m3 mean (range 5.869-11.13 mg/m3); Luzhou range 12.95-20.94 mg/m3; Urumuqi 0.326 +/-0.508 mg/m3 mean (range 0.037-3.98 mg/m3)			
Comments:	Not primary source for data			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (1998-2006) after the PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	High	Distribution of samples is characterized by an average and range values.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range data or SD that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 626839 Table: 18 of 18

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.			
HERO ID:	626839			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	hemodialysis labs- 0.184 mg/m3 mean (range 0.06-3.44 mg/m3).			
Comments:	Combined average calculated from subsets of means with corresponding sample sizes given in the original paper. Not primary source for data.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China - not an OECD member
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (1997) after the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by an average with margins of error (for Shanghai) and range values.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides range values that can be used to assess variability, but uncertainty is not discussed.
Overall Quality Determination			Low	

Study Citation:	Tanveer, H., Rastogi, S. K., Mathur, N., Gupta, B. N. (1995). Respiratory responses of paper mill workers occupationally exposed to formaldehyde. Indian Journal of Industrial Medicine 41(1):2-8.				
HERO ID:	1322589				
Conditions of Use:	Paper Manufacturing				
EXTRACTION					
Parameter	Data				
Worker activity description:	Sheet forming process in paper manufacturing				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	probably area sampling 0.03 mg/m3 8 hr TWA				
Number of workers:	49				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	India - not an OECD member	
	Metric 3:	Applicability	High	The data are for paper mill workers which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	The study was published in 1985, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5:	Sample Size	Medium	8 hr TWA was provided	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data included exposure type, and duration (years), and worker activities; but lacks additional metadata, such as sample type and duration, and exposure frequency.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination			Low		

Formaldehyde

Occupational Exposure

HERO ID: 8684532 Table: 1 of 1

Study Citation:	Tapp, L., Ewers, L., Durgam, S. (2008). Evaluation of contact dermatitis among machinists at an automotive parts manufacturer.			
HERO ID:	8684532			
Conditions of Use:	Processing aids, not otherwise listed			
EXTRACTION				
Parameter	Data			
Exposure route:	dermal (17/40), inhalation (18/40)			
Physical form:	liquid (14/40)			
Exposure duration:	8 hours (9/40)			
Number of workers:	Over 200 employees at the time of the evaluation. (9/40)			
Personal protective equipment:	Gloves, long sleeves, barrier creams. (18/40)			
Comments:	It does not appear that any monitoring data (PBZ, Area, wipes, etc) was collected, only the actual working fluid compositions were analyzed.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for the use of metalworking fluids, which is similar to the in-scope occupational scenario of functional fluids and processing aids.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Exposure type, duration, and PPE provided, but mission exposure frequency, worker information, and personal/area sampling.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability is not addressed.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 626831 Table: 1 of 1

Study Citation:	Taskinen, H.K., Kyyronen, P., Sallmen, M., Virtanen, S.V., Liukkonen, T.A., Huida, O., Lindbohm, M.L., Anttila, A. (1999). Reduced fertility among female wood workers exposed to formaldehyde. American Journal of Industrial Medicine 36(1):206-212.			
HERO ID:	626831			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Furnishing/ wood processing industry: plywood, fiberboard, carpentry, and furniture industry			
Exposure route:	Inhalation			
Physical form:	vapor			
Area sampling data:	0.01-1.0 ppm - the study does not provide any additional details, instead the health impact component of the study considers exposure concentrations in bins Low 0.07 ppm mean (range 0.01-0.3 ppm); medium 0.14 ppm mean (range 0.05-0.40); high 0.33 ppm mean (range 0.15-1.0 ppm).			
Number of workers:	602 women out of 5,187			
Personal protective equipment:	Recommend using gloves			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden/Finland - OECD member
	Metric 3:	Applicability	High	Data are for wood products are an in-scope occupational scenario
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after PEL - Article published in 1999
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics mean and range within each exposure bin, but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type not provided nor were other metadata such as number of sites, sampling location, number of samples, employee activities, sampling and analytic methods, exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by providing by providing range for each exposure bin, but uncertainty is not addressed.
Overall Quality Determination		Low		

Study Citation:	Teixeira, J.V., Miranda, S., Monteiro, R.A., Lopes, F.V., Madureira, J., Silva, G.V., Pestana, N., Pinto, E., Vilar, V.J., Boaventura, R.A. (2013). Assessment of indoor airborne contamination in a wastewater treatment plant. Environmental Monitoring and Assessment 185(1):59-72.		
HERO ID:	1938014		
Conditions of Use:	Disposal		
EXTRACTION			
Parameter	Data		
Life cycle description:	Wastewater treatment plant		
Number of sites:	1		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	Range ND-<0.01 ppm for 8 different sampling sites and three different sampling events (per site) - total 24 records		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified, but it was noted that formaldehyde was determined using a portable detector (RKI Instruments FP-30) with an accuracy of ±10%.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Portugal - an OECD member
	Metric 3: Applicability	High	The data are for wastewater treatment plant workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The study was published in 2012 based on sampling implemented from September 2010 to February 2011, after the most recent PEL (1992) and less than 10 years old.
	Metric 5: Sample Size	High	results for three testing events that occurred at 8 different sampling sites.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Metadata included sample type sample duration and exposure type, but lacks additional metadata, such as exposure duration, exposure frequency, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided actual results for 8 different locations for 3 different sampling days that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		High	

Study Citation:	Tharr, D. G., Singal, M. (1985). Health hazard evaluation report: HETA-83-376-1556 - Portsmouth Naval Shipyard, Portsmouth, New Hampshire.			
HERO ID:	1599536			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	submarine overhaul at Portsmouth Naval Shipyard, Portsmouth, New Hampshire			
Area sampling data:	Detected formaldehyde concentrations was between 0.21 ppm to 0.23 ppm.			
Exposure duration:	most workers may be exposed up to 10 hours per day			
Exposure frequency:	40 hours per week			
Number of workers:	nine workers			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is approved by NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data is more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Thetkathuek, A., Yingratanasuk, T., Ekburanawat, W. (2016). Respiratory Symptoms due to Occupational Exposure to Formaldehyde and MDF Dust in a MDF Furniture Factory in Eastern Thailand. 2016:3705824.			
HERO ID:	4454841			
Conditions of Use:	Medium-density fiberboard (MDF) furniture manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	The MDF furniture making process included tasks such as cutting, sawing, drilling holes, polishing, and gluing. Workers are at-risk of exposure to MDF dust and formaldehyde released from the work process and the storage of raw materials and the finished products. In the furniture production process there are 10 working departments which cover similar exposure groups (SEG), namely, office, combination, edging, fitting, clearing, drilling, laminating, wrapping, packing, and line.			
Personal sampling data:	See Table 2. Mean and Range as follows. Office: 1.52 ppm (0-4.21 ppm), Combination: 0.90 ppm (0-5.37 ppm), Edging: 0.68 ppm (0-4.51 ppm), Fitting: 2.36 pm (0-5.97 ppm), Clearing: 8.32 ppm (0.43-20.85 ppm), Drilling: 0.57 ppm (0-1.70 ppm), Laminating: 4.55 ppm (0.39-11.96 ppm), Wrapping: 1.41 ppm (0-4.12 ppm), Packing: 1.89 ppm (0-6.57 ppm), Line: 4.46 ppm (0-14.0 ppm), Total: 2.62 ppm (0-20.85 ppm).			
Area sampling data:	A study conducted by Vaizo’glu et al. [21] indicated that the concentration of formaldehyde at 100 furniture factories in Japan was 0.6 ppm (SD 0.3).			
Exposure duration:	8 hours			
Number of workers:	The total number of employees at this factory was 535			
Personal protective equipment:	Table 1 indicates the number and percent of employees that use PPE in the form of masks (62% use PPE).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S., or the country of origin is not specified.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data are expected to be representative of current operations, equipment, and activities. The monitoring data were collected after the most recent permissible exposure limit (PEL) establishment or update or are generally, no more than 10 years old, whichever is shorter. If no PEL is established, the data are no more than 10 years old. Metadata on the operations, equipment, and worker activities associated with the data show that the data should be representative of current operations, equipment, and activities.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Mean, Median, Range, and SD included.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as exposure frequency.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 4454841 Table: 1 of 1

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Study Citation:	Thetkathuek, A., Yingratanasuk, T., Ekburanawat, W. (2016). Respiratory Symptoms due to Occupational Exposure to Formaldehyde and MDF Dust in a MDF Furniture Factory in Eastern Thailand. 2016:3705824.		
HERO ID:	4454841		
Conditions of Use:	Medium-density fiberboard (MDF) furniture manufacturing		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Medium	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. Uncertainty is not addressed.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 1970347 Table: 1 of 1

Study Citation:	Thorne, P.S., Dekoster, J.A., Subramanian, P. (1996). Environmental assessment of aerosols, bioaerosols, and airborne endotoxins in a machining plant. American Industrial Hygiene Association Journal 57(12):1163-1167.			
HERO ID:	1970347			
Conditions of Use:	Use of Metalworking fluid			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Personal sampling data:	Airborne concentrations of formaldehyde ranged from below detection to 0.62 mg/m3. All machining sites had higher concentrations than the mean value in assembly (0.012 mg/m3).			
Area sampling data:	Concentration of aerosol averaged 1,24 mg/m3 on the older engine line and 0.74 mg/m3 on the new line.			
Number of workers:	900 production workers and 300 in the skilled trades			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	Low	no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Thorud, S., Gjolstad, M., Ellingsen, D. G., Molander, P. (2005). Air formaldehyde and solvent concentrations during surface coating with acid-curing lacquers and paints in the woodworking and furniture industry. Journal of Environmental Monitoring 7(6):586-591.			
HERO ID:	1457796			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Curtain painting, Automatic spray-painting, Manual spray-painting, Manual painting, Dip painting, Assistant, manual spray-painting, Conveyor work (feeding/receiving), Grinding, Other work tasks.-Norwegian furniture and woodworking factories			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Curtain painting 0.51 ppm geometric mean 2.53 GSD (range 0.08–1.48 ppm) 95% CI 0.35–0.75 ppm; Automatic spray-painting 0.11 ppm geometric mean 1.48 GSD (range 0.04–0.24 ppm) 95% CI 0.10–0.12 ppm; Manual spray-painting 0.15 ppm geometric mean 2.29 GSD (range 0.01–1.14 ppm) 95% CI 0.14–0.17 ppm; Manual painting 0.07 ppm geometric mean 1.32 GSD (range 0.05–0.16 ppm) 95% CI 0.06–0.09 ppm; Dip painting 0.16 ppm geometric mean 1.39 GSD (range 0.10–0.27 ppm) 95% CI 0.12–0.21 ppm; Assistant, manual spray-painting 0.16 ppm geometric mean 1.88 GSD (range 0.07–0.81 ppm) 95% CI 0.12–0.22 ppm; Conveyor work (feeding/receiving) 0.09 ppm geometric mean 1.43 GSD (range 0.07–0.24 ppm) 95% CI 0.07–0.12 ppm; Grinding 0.17 ppm geometric mean 2.36 GSD (range 0.04–1.00 ppm) 95% CI 0.14–0.19 ppm; Other work tasks 0.11 ppm geometric mean 2.14 GSD (range 0.02–0.48 ppm) 95% CI 0.08–0.13 ppm; All work tasks 0.15 ppm geometric mean 2.26 GSD (range 0.01–1.48 ppm) 95% CI 0.14–0.16 ppm.			
Exposure frequency:	3 year period in the late 1990			
Number of workers:	235			
Personal protective equipment:	During painting operations the workers used personal protective equipment of different kinds, i.e. charcoal filter masks, battery-driven air-purifying masks with charcoal filters or masks with supplies of pressurized air. Regarding formaldehyde, the results were somewhat contradictory. At one factory with moderate formaldehyde concentrations (0.17–0.18 ppm) the breakthrough was 100% or even higher using filters with long user time (430 h). In another factory with rather high formaldehyde concentrations (0.61–1.54 ppm) the AM breakthrough was only 5.7% (SD 6%, n ¼ 5), but also in this factory there was a tendency to higher breakthrough with longer user time. The breakthrough increased from 3.3% (1 h use) to 16% (11 h use). By changing to new filters the breakthrough was again reduced to 3%.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified but it was noted that sampling was performed using Sep-Pak DNPH-Silica sampling cartridges. The Sep-Pak DNPH-Silica cartridges contain silica gel coated with 2,4-dinitrophenylhydrazine. The Sep-Pak DNPH-Silica cartridges were slowly eluted with acetonitrile and analyzed by liquid chromatography (LC) in isocratic mode.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Norway - an OECD member
	Metric 3:	Applicability	High	The data are for woodworkers exposed to acid-cured lacquers and paints which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report was published in 2005, but data used in the report was from a 3 year period in the late 1990s, after the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Geometric mean and geometric standard deviation values, range data and 95% confidence interval was provided
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Formaldehyde

Occupational Exposure

HERO ID: 1457796 Table: 1 of 1

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Study Citation:	Thorud, S., Gjolstad, M., Ellingsen, D. G., Molander, P. (2005). Air formaldehyde and solvent concentrations during surface coating with acid-curing lacquers and paints in the woodworking and furniture industry. Journal of Environmental Monitoring 7(6):586-591.			
HERO ID:	1457796			
Conditions of Use:	Use of Paints/Coatings			
		EVALUATION		
Domain		Metric	Rating	Comments
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Monitoring data include critical metadata, such as sample type, exposure type, sample durations, and worker activities, but lacks additional metadata, such as exposure durations, and exposure frequency.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The study provided geometric standard deviation values, range data and 95% confidence interval that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Study Citation:	Thrasher, J.D., Broughton, A., Madison, R. (1990). Immune activation and autoantibodies in humans with long-term inhalation exposure to formaldehyde. Archives of Environmental Health 45(4):217-223.			
HERO ID:	626818			
Conditions of Use:	Consumer Use- Residential Home			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Mobile home concentrations 0.05-0.5 ppm; mobile home /particle board 0.14-0.81 ppm;			
Exposure duration:	13 hours/ week for the controls			
Exposure frequency:	28 weeks of exposure for controls			
Number of workers:	19 patients for mobile homes and 21 patients for mobile homes/particle board, 28 controls			
Comments:	Exposure duration and frequency mentioned for the other groups			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling/analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Us
	Metric 3:	Applicability	High	Data are for off gasing in a mobile home or from particle board are in-scope occupational scenario
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old and prior to the PEL - Article published in 1990
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics Range, but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type not provided nor were other metadata such as sampling location, number of samples, employee activities, sampling, and analytic methods, exposure frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by providing by providing values for different operations and an overall range, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Thredgold, L., Gaskin, S., Heath, L., Pisaniello, D., Logan, M., Baxter, C. (2019). Understanding skin absorption of common aldehyde vapours from exposure during hazardous material incidents.
HERO ID:	5024659
Conditions of Use:	disposal

EXTRACTION	
Parameter	Data
Worker activity description:	Solid paraformaldehyde (97%, BDH Chemicals, Australia) was used to produce dynamic formaldehyde atmospheres. Concentration: 1000 ppm/1227 mg/m ³ (pg 3)
Exposure route:	dermal
Physical form:	vapor
Dermal exposure data:	Dermal exposure data
Exposure duration:	30 min exposure: 3.45+/- 2.58 µg/cm ² penetration Absorption: 294 +/- 146 µg/cm ² after 10 minutes up to 834 +/- 595 µg/cm ² at 30 minAbsorption after ventilation: 473 +/- 319 µg/cm ² at 20 min to 458 +/- 167 µg/cm ² at 30 min Denim: 0.252 +/- 0.0421 µg/cm ² penetration and 18.5+/-4.92 µg/cm ² absorption after 30 min (pg 5)Predicted flux: 1.5 µg/cm ² /h (pg 7)Comparison with inhalation exposure: assuming 30 min exposure, 0.625m ³ /30 min inhalation rate (10m ³ /8 hr), and worst-case inhalation absorption rate (100%), along with 18,500 cm ² for body surface area, the ratio of dermal uptake to inhaled uptake is 64 mg / 766 mg (pg 8)HPLC-UV detection according to a modified HSE method (MDHS102: Aldehydes in Air) (pg 3-4)
Personal protective equipment:	Denim w/ 0.772+/-0.011 mm thickness (pg 3). APF of 10 for penetration and >40 APF for absorption (pg 5)
Engineering control:	Not really a control, but tested samples immediately after 30 minute exposure vs 30 min exposure + 30 minute "ventilation" (samples open to atmosphere). Supposed to mimic HAZMAT incident conditions (waiting for decontamination procedures) (pg 3). % reduction can be calculated

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for disposal, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data are no more than 10 years old (not related to PEL, dermal exposure).
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, SD) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as number of workers, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling with and without ventilation, but uncertainty is not addressed.

Overall Quality Determination

Medium

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Study Citation:	Thredgold, L., Gaskin, S., Heath, L., Pisaniello, D., Logan, M., Baxter, C. (2019). Understanding skin absorption of common aldehyde vapours from exposure during hazardous material incidents.		
HERO ID:	5024659		
Conditions of Use:	disposal		
		EVALUATION	
Domain	Metric	Rating	Comments

Study Citation:	Tian, S., Ecoff, S., Sebroski, J., Miller, J., Rickenbacker, H., Bilec, M. (2018). An indoor air quality evaluation in a residential retrofit project using spray polyurethane foam. Journal of Occupational and Environmental Hygiene 15(5):363-375.			
HERO ID:	4641626			
Conditions of Use:	Building/construction materials (spray polyurethane foam)			
EXTRACTION				
Parameter	Data			
Worker activity description:	application of spray polyurethane foam			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	12.8 $\mu\text{g}/\text{m}^3$ on first floor, $<3.1 \mu\text{g}/\text{m}^3$ second floor and attic 1 week prior to SPF application. Post application concentrations only showed graphically (Figure 7a) (pg 8)			
Comments:	Sampling location: 3 bedrooms, center of attic (pg 4). sampled 4 hr, 8 hr, 12 hr, 24 hr, 2 days, 3 days, 2 weeks, 4 weeks, 7 weeks, and 3 months after SPF application (Table 2; pg 7). Analyze via HPLC using methodology based on ASTM D5197-09e1 (pg 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved ASTM method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is described graphically.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as number of work-ers.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling in multiple rooms after different lengths of time.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 4679476 Table: 1 of 1

Study Citation:	Tikuisis, T., Phibbs, M.R., Sonnenberg, K.L. (1995). Quantitation of employee exposure to emission products generated by commercial-scale processing of polyethylene. American Industrial Hygiene Association Journal 56(8):809-814.			
HERO ID:	4679476			
Conditions of Use:	Processing of polyethylene			
EXTRACTION				
Parameter	Data			
Worker activity description:	Extrusion coating, blown film, rotational molding, blow molding, pipe extrusion.			
Exposure route:	Inhalation			
Physical form:	vapor/gas			
Personal sampling data:	Exposure limit of 0.3 ppm with personal samples measured at: <0.2, <0.1, and <0.08			
Area sampling data:	Exposure limit of 0.3 ppm with area samples: <0.1, <0.09.			
Engineering control:	Ventilation system provides 3 air changes per hour.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved method. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	Data is applicable to exposure/use of FA in processing of polyethylene
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range of data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes worker activity, physical form, exposure route, personal and area sampling data, and engineering controls about ventilation data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Tikuisis, T., Taylor, G., Sonnenberg, K., Cavanagh, J. (2010). Quantification of Emission Compounds Generated During Commercial-Scale Processing of Advanced Sclairtech TM Polyethylene. Journal of Plastic Film and Sheeting 26(2):167-191.			
HERO ID:	932312			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	varies by resin <0.04 (Table A1 page 17/35)			
Area sampling data:	film 0.016 ppm (page 3/25)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling method EPA TO-11A (DNPH filter) Analytical method HPLC (UV)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - OECD member
	Metric 3:	Applicability	High	The data are for polyethylene product manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 2010 (sampling date was not provided), after the most recent PEL (1992) and approximately 10 years old.
	Metric 5:	Sample Size	Low	The distribution of samples is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	No metadata were3 provided such as exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability, though uncertainty may have been including the the sampling and analytical methods..
Overall Quality Determination		Medium		

Study Citation:	Titenko-Holland, N., Levine, A. J., Smith, M. T., Quintana, P. J., Boeniger, M., Hayes, R., Suruda, A., Schulte, P. (1996). Quantification of epithelial cell micronuclei by fluorescence in situ hybridization (FISH) in mortuary science students exposed to formaldehyde. Mutation Research 371(3-4):237-248.			
HERO ID:	626815			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Personal sampling data:	See table 1			
Number of workers:	35			
Comments:	Study was conducted on Mortuary Science students during a 90 day embalming course			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	TOMA, (1981). Occupational health evaluation of the Raleigh, NC, plant of Koppers Company, Inc. final report.			
HERO ID:	1787225			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	glue mixer, glue crew, glue foreman			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	0.02-0.29 mg/m3 additional test results are provided individual sampling events for two different days.			
Particle size characterization:	0.2-3 mg/m3 total wood dust; 0.05-0.2 mg/m3 Respirable wood dust - additional data is provided for individual pieces of equipment.			
Number of workers:	120			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH method 5-327	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The data are for wood working which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The data were published in 1981 using data from 1981, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	High	specific test results are provided for glue mixer, glue crew, glue foreman for two different sampling days additionally range data are provided.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include metadata, such as sample type, exposure type, and sample durations, but lacks data, such as exposure durations, exposure frequency, and/or worker activities.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The study provided range of data that can be used to evaluate variability. Uncertainty likely addressed in the NIOSH method used.	
Overall Quality Determination		High		

Study Citation:	TOMA, (1981). 1979 cross sectional health study of workers at Magnolia, Arkansas plant of Koppers Company, Inc (addendum) with attachments.			
HERO ID:	5904074			
Conditions of Use:	FA used in wood manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Gluer, finisher, lumber handler, load out, pattern loft, maintenance, supervisor, office, truck driver			
Exposure route:	inhalation			
Physical form:	vapor, gas			
Area sampling data:	0.7 - 1.5 ppm			
Number of workers:	101			
Personal protective equipment:	Uniforms with long sleeves and gloves			
Engineering control:	Showers are available for employees if needed along with proper ventilation			
Comments:	Primarily for other chemicals but FA exposure is briefly mentioned			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	TSCA submission to EPA so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is applicable to use of FA in wood manufacturing
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes exposure type, physical form, worker activities, some PPE and engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address uncertainty or variability.
Overall Quality Determination		Medium		

Study Citation:	Tong, X., Shen, W., Chen, X., Corriou, J.P. (2018). Qualitative and quantitative analysis of gaseous pollutants for cleaner production in pulp and paper mills. Journal of Cleaner Production 198:1066-1075.			
HERO ID:	5956412			
Conditions of Use:	Processing: Paper manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Figure 5 (pg 4) presents concentration in mg/m3. The averageHCHO value of each mill is Mill A: 0.128, Mill B: 0.275, Mill C: 0.230, Mill D: 0.100, Mill E: 0.103. 3.1.2 discusses data and provides comparison to standards (Chinese standards, NIOSH). Table 1 presents comparisons to standards (pg 5)			
Comments:	Chinese national standards (GBZ, 2004; GB/T, 1995), and the detailed sampling and determination methods refer to those of our reported works (Tong et al., 2016) (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country
	Metric 3:	Applicability	High	Data are for paper manufacturing, an in-scope occupational scenario
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (graphically, comparison to standards) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing other metadata such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple mills, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Traviss, N., Thelen, B.A., Ingalls, J.K., Treadwell, M.D. (2010). Biodiesel versus diesel: a pilot study comparing exhaust exposures for employees at a rural municipal facility. Journal of the Air and Waste Management Association 60(9):1026-1033.			
HERO ID:	1940647			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Area sampling data:	Formaldehyde emission concentration at a municipal facility for diesel operated heavy equipment ranged between approximately 0.65 to 2.5 ug/m3. Formaldehyde emission concentration at a municipal facility for biodiesel operated heavy equipment ranged between approximately 0.3 to 1.2 ug/m3. In both cases, the maximum was observed near the small front loader.			
Exposure duration:	Preparation and calibration of the equipment is a precision-based process that was used as an instructional activity for the students, resulting in a reduced (6 vs. 8 hr) sampling period. Despite this shorter sampling time, exposures were still measured over most of the work shift.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	method well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data less than 10 years old
	Metric 5:	Sample Size	Low	no statistics presented
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no available metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	study does not present any discussion on uncertainty
Overall Quality Determination		Medium		

Study Citation:	Triebig, G., Schaller, K.H., Beyer, B., Müller, J., Valentin, H. (1989). Formaldehyde exposure at various workplaces. Science of the Total Environment 79(2):191-195.			
HERO ID:	1793050			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers at various workplaces, such as anatomic theatres, pathological laboratories and chipboard manufacturers.			
Personal sampling data:	At anatomical theatre using passive sampling, median concentration – 1.4 mg/m3 and ranged between 0.9 and 2.2 mg/m3. At pathological laboratories using passive sampling, median concentration – 0.6 mg/m3 and ranged between <0.01 and 1.6 mg/m3. At clipboard production using passive sampling, median concentration – 1.9 mg/m3 and ranged between <0.01 and 10.9 mg/m3. At clipboard production using active sampling, median concentration – 0.3 mg/m3 and ranged between 0.02 and 0.8 mg/m3.			
Area sampling data:	At anatomical theatre using active sampling, median concentration – 0.6 mg/m3 and ranged between 0.4 and 0.7 mg/m3. At pathological laboratories using passive sampling, median concentration – 0.2 mg/m3 and ranged between <0.01 and 0.4 mg/m3. At pathological laboratories using active sampling, median concentration – 1.6 mg/m3 and ranged between 0.2 and 13.3 mg/m3. At clipboard production using active sampling, median concentration – 0.4 mg/m3 and ranged between <0.01 and 0.8 mg/m3. At bedrooms in hospital using active sampling, median concentration – 0.06 mg/m3 and ranged between <0.01 and 0.9 mg/m3. At medical school room using active sampling, median concentration – 0.03 mg/m3 and ranged between 0.02 and 0.09 mg/m3.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	limited discussion on uncertainty
Overall Quality Determination		Medium		

Study Citation:	Tuomi, T., Engstrom, B., Niemela, R., Svinhufvud, J., Reijula, K. (2000). Emission of ozone and organic volatiles from a selection of laser printers and photocopiers. Applied Occupational and Environmental Hygiene 15(8):629-634.			
HERO ID:	12084			
Conditions of Use:	Use of Ink, Toner, and Colorant Products			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	vapor			
Area sampling data:	Table 1 provides exposure concentrations from 0-22 ug/m3 (printers on line but not printing); 0-46 ug/m3 (printing); and a photocopier 18 ug/m3 on line and not operating; 5 ug/m3 operating. Also provided emission rates 0 -3700 ug/h (printing).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it is noted that samples collected in stainless steel tubes packed with 150 mg Tenax TA mesh; analysis performed using HP 5890 GCMS
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - OECD country
	Metric 3:	Applicability	High	Data are for photocopying and printing which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old - though the article is published in 2000, the equipment being tested is from 1988-1990
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics - average concentration and emission rates provided, nothing additional to characterize the data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	details were provided about how the samples were handled and analysis performed
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	variability between printers and photocopier provided but not uncertainty
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1316622 Table: 1 of 1

Study Citation:	Turner, L.K., Warren, K.R., Baker, L.R., Laing, S.J. (1984). Formaldehyde concentrations in workrooms resulting from off-gassing from sandpaper. American Industrial Hygiene Association Journal 45(7):499-500.			
HERO ID:	1316622			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Sailors working in a compartment in Navy ship. The compartment’s volume is approximately 115 m3 (4050ft3). There is no mechanical ventilation to this compartment and it has a single opening for access. It contained approximately 2000 sheets of sandpaper.			
Exposure route:	Inhalation			
Physical form:	Solid (component in glue)			
Personal sampling data:	3.16-3.69 ppm (385 min sample) (samples taken after compartment was ventilated with portable ventilation unit (see area sample data for information about this ventilation.)			
Area sampling data:	Initial: 6 and 7 ppm. A portable ventilation unit was set up to exhaust the contaminated air from the compartment at a rate of 0.35 m3 / sec (750 CFM) for 24 hr. After this, the concentration was 4.5 ppm (379 min. sample)			
Exposure duration:	7 to 8 hours per day			
Exposure frequency:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved OSHA/NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plasticizer, additive and impurity in adhesives, sealants and lubricants, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1984)
	Metric 5:	Sample Size	Medium	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	most meta data given.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling personal breathing zone and area concentrations but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	TVA, (1991). Formaldehyde in urea product and urea production – status report with cover letter dated 02/01/91 and attachments.			
HERO ID:	5899360			
Conditions of Use:	Processing into a formulation- Fertilizer (Urea)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Occupational exposure during the urea fertilizer manufacturing occurs chiefly during maintenance and repair operations.			
Area sampling data:	Several workplace and storage area were checked for formaldehyde level, and results ranged from 0.51 parts per million under the evaporator close to the point where formaldehyde is added to 0.03 parts per million in the fume from the product melt. Formaldehyde levels 3 inches away and downwind from a vent on an outside formaldehyde storage tank were 13.69 and 42.16 parts per million in two samples collected on two different days. Available data on formaldehyde levels in and around the urea production process frequently are below or near the limits of detection. Average formaldehyde levels varied from not detectable (< 0.005 parts per million (ppm)) to one ppm. The highest exposure levels for formaldehyde were measured around pumps. The formaldehyde concentrations around urea concentrations and solidification processes (prilling or granulations) typically were 0.05 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	well described sampling and analytical methods
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data more than 20 years old
	Metric 5:	Sample Size	High	Discrete sampling value is provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. Congress, (1982). Federal response to health risks of formaldehyde in home insulation, mobile homes, and other consumer products: Hearings before a subcommittee of the Committee on Government Operations, House of Representatives, Ninety-seventh Congress, second session.			
HERO ID:	6018048			
Conditions of Use:	Mobile homes			
EXTRACTION				
Parameter	Data			
Personal sampling data:	0.403 ppm in dining room (p. 141)			
Area sampling data:	0.81 ppm 2 years after installing particleboard; 0.03 ppm after removal of particleboard; 0.23 ppm in Feb 1979, 1.2 ppm in June 1979, 3 ppm in August 1979, 1.8 ppm June 1980 (p. 62); 0.78 ppm maximum in home (p. 137); 0.12 ppm, 0.26 ppm, 0.54 ppm (living room), 0.42 ppm (master), 0.38 ppm (children’s bedroom), 0.05 outside, 0.38 (kitchen), 0.55 ppm (master) (p. 144-145); p. 220 contains a figure of formaldehyde concentrations in wall cavities; 0.25 ppm in living room and 0.21 ppm in bedroom (p. 265); 0.12 ppm, 0.5 ppm, 0.6 ppm (p. 267-268); 0.54 ppm (p. 271); 4.0 ppm in master and 0.8 ppm in living room (p. 272)			
Comments:	Source is a collection of statements and articles about formaldehyde in mobile homes. The source is generally limited to exposures to occupants / residents of mobile homes (not to workers).			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Low	The data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, such as a consumer DIY scenario that is similar to a worker scenario.
	Metric 4:	Temporal Representativeness	Low	1982 report
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	U.S. EPA, (2023). Summarized data of the Building Assessment Survey and Evaluation (BASE) Study.			
HERO ID:	11328021			
Conditions of Use:	Building and construction materials			
EXTRACTION				
Parameter	Data			
Area sampling data:	SUMMA® canister and multisorbent tube sampling methods were used. Analyte concentration indoors: 5th percentile - 4.4 ug/m3, 50th percentile - 15 ug/m3, 95th percentile - 32 ug/m3. Analyte Concentration Indoors Arithmetic Mean - 16 ug/m3. (pg 6 of 10)			
Comments:	Frequency of detection indoors - 100% in 100 buildings sampled			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling method well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario (indoor air-office workers)within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	the data is no more than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by some statistics but full distribution is not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, butlacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study addresses variability in the determinants of exposure but limited discussion on uncertainty.
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (1988). Preliminary results summary: Indoor air monitoring phase II and data for warehouse and navy yard and evaluation of selected heating, ventilation and air conditioning system with attachments.			
HERO ID:	1481714			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Seems like it is area sampling- results provided for individual rooms for three different sampling days: 5/24/88 - <4.1-429.0 ppb; 5/25/88 - <4.1 - 284.0 ppb; 6/3/88- <2.4 - 9.0 ppb. Warehouse (5/6/88 & 4/29/88) 9.9 ppb mean; Navy Yard 26.0 ppb mean			
Comments:	Subject to other regulations			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH 3500 methods SODIUM BISULFITE SOLUTION
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Uninformative	The data are for office/warehouse exposure which is subject to other regulations
	Metric 4:	Temporal Representativeness	Low	The data were published in 1988, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Mean values provided for navy yard & warehouse; data for individual offices provided for EPA HQ
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, sample type and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	As data for individual offices at HQ are provided for different days, it is possible to evaluation variability. Uncertainty addressed in the the NIOSH methodology.
Overall Quality Determination		Uninformative		

Study Citation:	U.S. EPA, (2008). Interim acute exposure guideline levels (AEGLs) for formaldehyde (CAS reg. no. 50-00-0).			
HERO ID:	5113354			
Conditions of Use:	Incorporation into an Article- Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	resin manufacturing and paper plant, paper conditioning installation, paper mill and plastic molding industries, particle board and molded plastics plant, anatomy laboratory, formaldehyde manufacturing.			
Exposure route:	inhalation			
Area sampling data:	resin manufacturing and paper plant: 16-30 ppm; paper conditioning installation: 0.9 - 1.6 ppm; 1.9 million workers in the apparel, furniture, paper mill and plastic molding industries were exposed to between 0.1 and 0.5 ppm, about 123,000 were exposed to between 0.5-0.75 ppm and 84,000 were exposed to 0.75-1.0 ppm.			
Number of workers:	OSHA estimates in the late 1980 over 2 million workers were exposed to formaldehyde. Most of the workers were in the garment industry. About 1.9 million workers in the apparel, furniture, paper mill and plastic molding industries.			
Comments:	Not primary source for the monitoring data, references NIOSH NIOSH. 1976. Criteria for a Recommended Standard: Occupational Exposure to Formaldehyde. Cincinnati, OH: Department of Health , Education and Welfare, National Institute for Occupational Safety and Health. DHEW Publication No. 77-126.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Primary source for the data is NIOSH and OSHA therefore assumed to be an approved OSHA/NIOSH method but report does not specify the report.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to an occupational scenario within scope.
	Metric 4:	Temporal Representativeness	Low	Data is from source more than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes number of workers exposed, personal and area sampling, exposure route, physical form and worker activity.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at multiple sampling areas. Does not address uncertainty.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2008). Interim acute exposure guideline levels (AEGLs) for formaldehyde (CAS reg. no. 50-00-0).
HERO ID:	5113354
Conditions of Use:	Incorporation into Article & Commercial Use- textiles, apparel, and leather

EXTRACTION	
Parameter	Data
Worker activity description:	Handling flame-proof fabrics, dress shop, clothing store, textile garment factory, garment industry - apparel
Exposure route:	inhalation
Personal sampling data:	1.9 million workers in the apparel, furniture, paper mill and plastic molding industries were exposed to between 0.1 and 0.5 ppm, about 123,000 were exposed to between 0.5-0.75 ppm and 84,000 were exposed to 0.75-1.0 ppm.
Area sampling data:	handling flame proof fabrics: 1-11 ppm; dress shop: 0.13-0.45 ppm; clothing store: 0.9-3.3 ppm; textile garment factory: 0.9-2.7 ppm;
Number of workers:	OSHA estimates in the late 1980 over 2 million workers were exposed to formaldehyde. Most of the workers were in the garment industry. About 1.9 million workers in the apparel, furniture, paper mill and plastic molding industries.
Comments:	Not primary source for the monitoring data, references NIOSH NIOSH. 1976. Criteria for a Recommended Standard: Occupational Exposure to Formaldehyde. Cincinnati, OH: Department of Health , Education and Welfare, National Institute for Occupational Safety and Health. DHEW Publication No. 77-126.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Primary source for the data is NIOSH and OSHA therefore assumed to be an approved OSHA/NIOSH method but report does not specify methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to an occupational scenario within scope.
	Metric 4:	Temporal Representativeness	Low	Data is from source more than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes number of workers exposed, personal and area sampling, exposure route, physical form and worker activity.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at multiple sampling areas. Does not address uncertainty.

Overall Quality Determination	Medium

Study Citation:	U.S. EPA, (2008). Interim acute exposure guideline levels (AEGLs) for formaldehyde (CAS reg. no. 50-00-0).			
HERO ID:	5113354			
Conditions of Use:	Manufacturing and Processing as a reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	formaldehyde manufacturing.			
Exposure route:	inhalation			
Physical form:	colorless flammable gas			
Personal sampling data:	EPA survey found occupational exposures from 0.1-0.9 ppm with ranges up to 2.2 ppm. Highest in direct manufacture of formaldehyde. Mean concentrations in FA and resin manufacturing plants, plywood mills, particle-board mills, furniture factories, textile mills and garment factories, foundries, mortuaries, building sites, etc., ranged from 0.1 to 38 ppm (range, <0.01 to 61 ppm).			
Comments:	Not primary source of data, cites U.S. EPA (1982)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Primary source for the data is NIOSH and OSHA therefore assumed to be an approved OSHA/NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to an occupational scenario within scope.
	Metric 4:	Temporal Representativeness	Low	Data is from source more than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes number of workers exposed, personal and area sampling, exposure route, physical form and worker activity.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at multiple sampling areas. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2008). Interim acute exposure guideline levels (AEGLs) for formaldehyde (CAS reg. no. 50-00-0).			
HERO ID:	5113354			
Conditions of Use:	Incorporation into Article- Wood Product Manufacturing, Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	wood processing plant, two laminating plants using phenol resorcinol glue (which emits formaldehyde), furniture, and plastic molding industries, particle board and molded plastics plant.			
Exposure route:	inhalation			
Area sampling data:	Control study had exposed workers in particle board and molded plastics plant with FA conc. from 0.17 to 2.93 ppm (mean 0.63 ppm). wood processing plant: 2.1-8.9 ppm, ranging up to 31 ppm; two laminating plants using phenol-resorcinol glue: 0.04-10.9 ppm. 1.9 million workers in the apparel, furniture, paper mill and plastic molding industries were exposed to between 0.1 and 0.5 ppm, about 123,000 were exposed to between 0.5-0.75 ppm and 84,000 were exposed to 0.75-1.0 ppm. EPA survey found occupational exposures from 0.1-0.9 ppm with ranges up to 2.2 ppm. Highest in direct manufacture of formaldehyde. Mean concentrations in FA and resin manufacturing plants, plywood mills, particle-board mills, furniture factories, textile mills and garment factories, foundries, mortuaries, building sites, etc., ranged from 0.1 to 38 ppm (range, <0.01 to 61 ppm).			
Number of workers:	OSHA estimates in the late 1980 over 2 million workers were exposed to formaldehyde. Most of the workers were in the garment industry. About 1.9 million workers in the apparel, furniture, paper mill and plastic molding industries.			
Comments:	Not primary source for monitoring data.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Primary source for the data is NIOSH and OSHA therefore assumed to be an approved OSHA/NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to an occupational scenario within scope.
	Metric 4:	Temporal Representativeness	Low	Data is from source more than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes number of workers exposed, personal and area sampling, exposure route, physical form and worker activity.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at multiple sampling areas. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2008). Interim acute exposure guideline levels (AEGLs) for formaldehyde (CAS reg. no. 50-00-0).			
HERO ID:	5113354			
Conditions of Use:	Incorporation into Article- Wood Product Manufacturing, Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	exposed workers were employed in a particle board and molded plastics plant			
Exposure route:	inhalation			
Area sampling data:	0.17 to 2.93 ppm (mean 0.69 ppm). Combination of personal and area sampling was taken; no distinction made in report			
Number of workers:	OSHA estimates in the late 1980 over 2 million workers were exposed to formaldehyde. Most of the workers were in the garment industry. About 1.9 million workers in the apparel, furniture, paper mill and plastic molding industries.			
Comments:	Not primary source for monitoring data. Cites Horvath et al. (1988).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	The report states monitoring data was collected using passive and active sampling procedures and NIOSH 77-157A.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to an occupational scenario within scope.
	Metric 4:	Temporal Representativeness	Low	Data is from source more than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes number of workers exposed, personal and area sampling, exposure route, physical form and worker activity.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at multiple sampling areas. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2008). Interim acute exposure guideline levels (AEGLs) for formaldehyde (CAS reg. no. 50-00-0).			
HERO ID:	5113354			
Conditions of Use:	Chemical substances in products not described by other codes- Laboratory Chemicals (Embalming, Anatomy Lab)			
EXTRACTION				
Parameter	Data			
Worker activity description:	funeral home (use of formaldehyde and paraformaldehyde in embalming process), anatomy laboratory			
Exposure route:	inhalation			
Area sampling data:	funeral home: average of 0.25 - 1.39 ppm with range up to 5.26 ppm;			
Comments:	Not primary source for the monitoring data, references NIOSH NIOSH. 1976. Criteria for a Recommended Standard: Occupational Exposure to Formaldehyde. Cincinnati, OH: Department of Health , Education and Welfare, National Institute for Occupational Safety and Health. DHEW Publication No. 77-126.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Primary source for the data is NIOSH therefore assumed to be an approved OSHA/NIOSH method but the methodology is not specified in report.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data is from source more than 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes number of workers exposed, personal and area sampling, exposure route, physical form and worker activity.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at multiple sampling areas. Does not address uncertainty.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (1985). Preliminary assessment of health risks to garment workers and certain home residents from exposure to formaldehyde (draft).			
HERO ID:	5901066			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	garment workers			
Exposure route:	inhalation			
Personal sampling data:	The principal source of HCHO in the garment manufacturing workplace, is the release of HCHO from fabric treated with resins that impart durable or permanent-press properties. HCHO levels in apparel manufacturing facilities were generally below 3 ppm prior to 1980. OSHA had established a 3 ppm TWA in 1967. The ACGIH level is 1 ppm TWA. In recent years, however, HCHO levels observed were generally below 1 ppm. The surveys were done at two large manufacturing sites producing men’s dress shirts. HCHO exposure levels were determined for 54 of 72 job titles in two different plants. All levels of exposure were less than 0.51 ppm TWA. Also, the combined range of data was very narrow (0.01-0.39 ppm) for 5 of the 6 departments in the two plants. The range of mean concentrations of all departments (0.13-0.20 ppm) is also very narrow and compares well within the overall combined mean exposure level of 0.17 ppm. In addition, the average exposure levels used in EPA’s section 4(f) determination (EPA, 1984b), were 0.23 ppm (area) and 0.64 ppm (personal) (Versar, 1982).			
Area sampling data:	The principal source of HCHO in the garment manufacturing workplace, is the release of HCHO from fabric treated with resins that impart durable or permanent-press properties. HCHO levels in apparel manufacturing facilities were generally below 3 ppm prior to 1980. OSHA had established a 3 ppm TWA in 1967. The ACGIH level is 1 ppm TWA. In recent years, however, HCHO levels observed were generally below 1 ppm. The surveys were done at two large manufacturing sites producing men’s dress shirts. HCHO exposure levels were determined for 54 of 72 job titles in two different plants. All levels of exposure were less than 0.51 ppm TWA. Also, the combined range of data was very narrow (0.01-0.39 ppm) for 5 of the 6 departments in the two plants. The range of mean concentrations of all departments (0.13-0.20 ppm) is also very narrow and compares well within the overall combined mean exposure level of 0.17 ppm. In addition, the average exposure levels used in EPA’s section 4(f) determination (EPA, 1984b), were 0.23 ppm (area) and 0.64 ppm (personal) (Versar, 1982).			
Exposure duration:	2-6 hr/day			
Exposure frequency:	2-5 days/weeks			
Number of workers:	The number of potentially exposed garment workers is estimated to be 777,000 (Versar, 1982) out of 1,100,000 workers employed in the U.S. apparel industry (Ward, 1984).			
Comments:	Workers in the garment industry were assumed to be exposed 5 days per week for 40 years			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	used an approved method
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 5901066 Table: 1 of 1

...continued from previous page

Study Citation:		U.S. EPA, (1985). Preliminary assessment of health risks to garment workers and certain home residents from exposure to formaldehyde (draft).			
HERO ID:		5901066			
Conditions of Use:		commercial use			
		EVALUATION			
Domain		Metric	Rating	Comments	
	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty	
Overall Quality Determination			Medium		

Study Citation:	U.S. EPA, (1984). Occupational exposures to formaldehyde from Schweer G to Hefter R of Existing Chem Assessment Div with enclosures (3).			
HERO ID:	5908882			
Conditions of Use:	Multiple COUs - Resins, plastics, moldings, textile, particleboard, castings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Manufacture of plastic products, of metal molds and castings, particleboard, textiles, of FA, resins			
Exposure route:	inhalation			
Physical form:	vapor, gas			
Personal sampling data:	Plastic products - .01; metal molds and castings - 0.33 ppm, and 1.22ppm;particle board - 0.39 ppm, 0.20 ppm;textiles - 0.70 ppm, 0.22 to 0.39 ppm; manufacture of FA - 0.46 ppm, 0.5 ppm, 0.02 to 0.8 ppm, 0.23 ppm, 0.71 ppm, 0.39 ppm; FA resins - 1.4 ppm, 0.3 ppm, 0.2 ppm, 0.8 ppm, 0.01 to 0.2 ppm, 1.44 ppm			
Area sampling data:	Plastic products - <0.01 to 4.0 ppm; Metal molds and castings - 1.55 ppm; Particleboard - 1.15 ppm, 0.30 ppm, 1.28 ppm; Textiles - 0.42 ppm, 0.27 to 0.56 ppm; Manufacture of FA - 0.41 ppm;FA resins - 0.24 ppm			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Report conducted by the EPA so high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to multiple COUs.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Contains worker activity/industry, exposure route, physical form, personal/area samples.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at multiple COUs and multiple samples. Does not address uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 3575 Table: 1 of 1

Study Citation:	Uba, G., Pachorek, D., Bernstein, J., Garabrant, D.H., Balmes, J.R., Wright, W.E., Amar, R.B. (1989). Prospective study of respiratory effects of formalde- hyde among healthy and asthmatic medical students. American Journal of Industrial Medicine 15(1):91-101.			
HERO ID:	3575			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Personal sampling data:	0.05 (below limit of detection) to 0.93 ppm (time-weighted avg); monthly ranges presented. 0.1 - 5.0 ppm with a mean of 1.9 ppm (peak exposures)			
Number of workers:	103 medical students			
Comments:	'The time-weighted average exposure to formaldehyde vapor was measured during gross anatomy laboratory by using personal sampling devices (impingers) located in the breathing zones of the medical students... portable infrared spectrophotometer (Miran 1 B, Foxboro Instruments). Samples were analyzed by using chromotropic acid as a spectrophotometric reagent (NIOSH method 3500).			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is an approved [NIOSH/OSHA] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States (i.e., University of Southern California School of Medicine).
	Metric 3:	Applicability	Medium	Data are for medical students, this may be used as surrogates for the medical occupation.
	Metric 4:	Temporal Representativeness	Low	Data collected before the most recent PEL (1992). Published in 1989. Sample collection before then.
	Metric 5:	Sample Size	Medium	Data characterized by median and range, but full statistical distribution not provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other metadata. Metadata included is more relevant to health outcomes (e.g., asthmatic, male/female).
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability.
Overall Quality Determination		Medium		

Study Citation:	Ulfvarson, U., Alexandersson, R. (1990). Reduction in adverse effect on pulmonary function after exposure to filtered diesel exhaust. American Journal of Industrial Medicine 17(3):341-347.			
HERO ID:	4948589			
Conditions of Use:	Distribution in Commerce (roll-on-roll-off ships to trucks)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Diesel exhaust from trucks (pg 1)			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	62 samples: 0.27+/-0.05 ppm (Table 1, pg 3)			
Number of workers:	24 subjects exposed without filter, 18 with, 6 on both occasions (pg 3)			
Engineering control:	Exhaust filters - 99.97% degree of retention of dioctylphthalate mist with particle size 0.3 μm (pg. 2)			
Comments:	Analyzed via HPLC (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data are for distribution in commerce, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard error) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure duration and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling workers exposed to both filtered and unfiltered diesel exhaust, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Ulfvarson, U., Alexandersson, R., Aringer, L., Svensson, E., Hedenstierna, G., Hogstedt, C., Holmberg, B., Rosen, G., Sorsa, M. (1987). Effects of exposure to vehicle exhaust on health. Scandinavian Journal of Work, Environment and Health 13(6):505-512.			
HERO ID:	35819			
Conditions of Use:	Commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workplaces investigated were bus garage, car ferry, and roll-on roll-off ships. Staff from the bus garage included marshaler (2 workers), cleaner (1 worker), foreman (2 workers), and mechanic (12 workers). Staff from car ferry included upper deck crew who directed vehicles to and from their parking places on the car deck, and staff who assisted in the unloading of vehicles from the deck after the ferry had docked. Staff from the roll-on roll-off ships included the lower deck crews.			
Exposure route:	Inhalation			
Personal sampling data:	Formaldehyde concentrations (mg/m3) obtained with a personal sampling technique were: bus garage – 0.04–0.8; car ferry (2 hr run) - 0.03-0.31; car ferry (20 min run) - 0.1-0.3; roll-on-roll-off ship - <= 0.03 (1st phase) and 0.1-0.5 (2nd phase).			
Area sampling data:	no area samples were collected for formaldehyde			
Number of workers:	Number of workers participating were: bus garage – 17, car ferries – 25, roll-on-roll-off ships – 23 (during 1st phase) and 24 (during 2nd phase), with 10 persons taking part on both occasions.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	Data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data greater than 20 years old
	Metric 5:	Sample Size	Low	Characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	No discussion on uncertainties
Overall Quality Determination		Medium		

Study Citation:	Ulfvarson, U., Alexandersson, R., Aringer, L., Svensson, E., Hedenstierna, G., Hogstedt, C., Holmberg, B., Rosen, G., Sorsa, M. (1987). Effects of exposure to vehicle exhaust on health. Scandinavian Journal of Work, Environment and Health 13(6):505-512.			
HERO ID:	5137939			
Conditions of Use:	Commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workplaces investigated were bus garage, car ferry, and roll-on roll-off ships. Staff from the bus garage included marshaler (2 workers), cleaner (1 worker), foreman (2 workers), and mechanic (12 workers). Staff from car ferry included upper deck crew who directed vehicles to and from their parking places on the car deck, and staff who assisted in the unloading of vehicles from the deck after the ferry had docked. Staff from the roll-on roll-off ships included the lower deck crews.			
Exposure route:	Inhalation			
Personal sampling data:	Formaldehyde concentrations (mg/m3) obtained with a personal sampling technique were: bus garage – 0.04–0.8; car ferry (2 hr run) - 0.03-0.31; car ferry (20 min run) - 0.1-0.3; roll-on-roll-off ship - <= 0.03 (1st phase) and 0.1-0.5 (2nd phase).			
Area sampling data:	no area samples were collected for formaldehyde			
Number of workers:	Number of workers participating were: bus garage – 17, car ferries – 25, roll-on-roll-off ships – 23 (during 1st phase) and 24 (during 2nd phase), with 10 persons taking part on both occasions.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	Data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data greater than 20 years old
	Metric 5:	Sample Size	Low	Characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	No discussion on uncertainties
Overall Quality Determination		Medium		

Study Citation:	University of Birmingham,, UK, (1984). Letter from the University of Birmingham to US EPA regarding information on the exposure of pathologist to formaldehyde with attachments.			
HERO ID:	5901023			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Tissue trimming, disposal & making up dilute formalin solution in anatomy laboratory			
Personal sampling data:	<1 to 6 (mg/m^3)			
Number of workers:	2,720			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data from U.K.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Report from 1986.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Formaldehyde

Occupational Exposure

HERO ID: 5895420 Table: 1 of 1

Study Citation:	University of Pittsburgh, (1992). Supplemental information: The wallingford cohort study - Mortality patterns among chemical plant workers exposed to formaldehyde and other substances (final report) w-attach and ltr.
HERO ID:	5895420
Conditions of Use:	Plastic (thermoset) Manufacturing

EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Personal sampling data:	0-2 ppm

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Uninformative	Does not appear to be sampling data, rather assigned exposure levels for epidemiology study.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for plastics manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by considering exposures across multiple years for multiple job types, but uncertainty is not addressed.

Overall Quality Determination **Uninformative**

Study Citation:	USTMA, (2020). Comment submitted by U.S. Tire Manufacturers Association (USTMA), dated 06/08/2020.				
HERO ID:	8802196				
Conditions of Use:	Incorporation into Article- Tire Manufacturing				
EXTRACTION					
Parameter		Data			
Worker activity description:		Workers involve with mixing, milling, curing, block cutting, and machine operation (e.g. cutters, conveyers, andchippers)			
Exposure route:		Inhalation			
Physical form:		vapor			
Personal sampling data:		the median (50th percentile) air concentration in these tire manufacturing areas was 0.02 ppm and the 95th percentile was 0.15 ppm.Raw data available on pdf pg. 18-84			
Area sampling data:		The air concentrations in these areas ranged from <0.01 to 0.04 ppm.Raw data available on pdf pg. 18-84			
Number of workers:		250,000 workers (pdf pg. 1)			
Personal protective equipment:		For example, the standard PPE requirements in main operational areas of the factory (i.e., raw materials weighing and transfer, rubber mixing, milling, calendaring, extrusion, and curing)include safety glasses, steel toe shoes, work gloves and in some areas hearing protection. (pdf pg. 9)			
Engineering control:		Engineering controls may include local exhaust ventilation for various operations including mixers (which are also generally enclosed with dedicated exhaust), mills, grinding or machining, and curing ovens. Examples of other engineering controls may include use of pre-melt bags for adding minor ingredients to the mixer or mills, various floor sweeper/cleaners to ensure particulate does not accumulate on working surfaces, and isolation of noisy equipment to minimize sound levels in the factory. (pdf pg. 9)			
EVALUATION					
Domain		Metric	Rating	Comments	
Domain 1: Reliability		Metric 1:	Sampling and Analytical Methodology	Medium	Majority of the sampling/analytical methods cited are OSHA, NIOSH, or EPA. A few sampling data note 'modified', which is uncertain if equivalent to NIOSH methods.
Domain 2: Representativeness		Metric 2:	Geographic Scope	High	The data are from the United States
		Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
		Metric 4:	Temporal Representativeness	Medium	Data were collected after the most recent PEL establishment, but range from very recent to more than 20 years.
		Metric 5:	Sample Size	High	Full distribution of samples are provided in the appendix.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but additional metadata lacks details such as explanation of job tasks, frequency of tasks, durations, and additional environmental details(i.e., unable to determine which set of data belong to the same or different site).
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	Medium	Uncertainty is not addressed and not enough details on sampling/analytical method to determine uncertainty. The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled sector.
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Formaldehyde

Occupational Exposure

HERO ID: 8802196 Table: 1 of 1

...continued from previous page			
Study Citation:	USTMA, (2020). Comment submitted by U.S. Tire Manufacturers Association (USTMA), dated 06/08/2020.		
HERO ID:	8802196		
Conditions of Use:	Incorporation into Article- Tire Manufacturing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 1482054 Table: 1 of 1

Study Citation:	Vainiotalo, S., Matveinen, K. (1993). Cooking fumes as a hygienic problem in the food and catering industries. American Industrial Hygiene Association Journal 54(7):376-382.
HERO ID:	1482054
Conditions of Use:	Combustion Byproduct

EXTRACTION

Parameter	Data
Worker activity description:	Preparation and packaging of food products
Exposure route:	Inhalation
Area sampling data:	0.02-0.75 (mg/m^3)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling and analytical method is well described and it is not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Finland is an OECD country
	Metric 3: Applicability	Uninformative	Data are for byproduct creation during cooking, a scenario that is out of scope.
	Metric 4: Temporal Representativeness	Low	Article was published in 1993, so data is more than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Article indicates a range of sample durations and a range of exposure durations for area monitoring samples.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The article provides a discussion for variability between sites and within sites, but does not address uncertainty.

Overall Quality Determination Uninformative

Formaldehyde

Occupational Exposure

HERO ID: 6011894 Table: 1 of 1

Study Citation:	Vainiotalo, S., Pfaffli, P. (1989). Measurement of depolymerization products in the polyacetal polyamide and polymethylmethacrylate processing industry. American Industrial Hygiene Association Journal 50(8):396-399.			
HERO ID:	6011894			
Conditions of Use:	Processing: Plastic material manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Injection molding, extrusion, thermoforming			
Exposure route:	inhalation			
Physical form:	gas, vapor			
Area sampling data:	concentrations ranged from 0.06 to 0.23 mg/m^3; injection molding sampling (mg/m^3): 0.06 +/- 0.01; 0.09 +/- 0.02; 0.23 +/- 0.02; 0.06 +/- 0;			
Engineering control:	Standard exhaust ventilation systems are used to reduce airborne concentrations.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for Finland, an OECD country.
	Metric 3:	Applicability	High	Data is applicable to processing of plastics.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1989)
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Contains worker activity, exposure route, physical form, engineering control, and area sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Vaizoğlu, S. A., Aycan, S., Akin, L., Koçdor, P., Pamukçu, G., Muhsinoğlu, O., Ozer, F., Evci, E. D., Güler, C. (2005). Determination of formaldehyde levels in 100 furniture workshops in Ankara. Tohoku Journal of Experimental Medicine 207(2):157-163.			
HERO ID:	1986814			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in furniture-manufacturing workshops - workers using glue, fiberoard, medium-density fiber board, and other wood products			
Exposure route:	Inhalation			
Area sampling data:	Indoor formaldehyde levels ranged from 0.02 ppm to 2.22 ppm with a mean of 0.6 +/- 0.3 ppm. Outdoor formaldehyde levels ranged from 0 ppm to 0.08 ppm with a mean of 0.03 +/- 0.03 ppm. Formaldehyde levels were higher in workplaces located at basement than in workplaces located at or above ground level. The levels were higher in workplaces where only sawdust was used for heating than in workplaces where wood, coal, and sawdust are used.			
Number of workers:	229 workers in 100 workplaces			
Engineering control:	No additional ventilation other than fans and natural ventilation (windows and doors).			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	data between 10 and 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	uncertainty has not been discussed
Overall Quality Determination		High		

Study Citation:	Vangronsveld, E., Berckmans, S., Verbinen, K., Leeuw, C.V., Bormans, C. (2010). Isocyanate and total inhalable particulate air measurements in the European wood panel industry. International Journal of Hygiene and Environmental Health 213(6):475-488.			
HERO ID:	1075984			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Press operator assistant; QC operator; QC technician; Press operator; Bander operator; Giben+Bander operator; Tongue and groove operator; Cleaner			
Personal sampling data:	Press operator assistant: 0.047 (mg/m^3); QC operator: 0.051 (mg/m^3); QC technician: 0.046 (mg/m^3); Press operator: 0.016 (mg/m^3); Bander operator: 0.0381 (mg/m^3); Giben+Bander operator: 0.0157 (mg/m^3); Togue and groove operator: 0.0082 (mg/m^3); Cleaner: 0.0257 (mg/m^3)			
Area sampling data:	Press begin: 0.3672 (mg/m^3); Press end: 0.5985 (mg/m^3); Boardcoolers: 0.0478 (mg/m^3); Saw area: 0.0407 (mg/m^3); Bottom former bin: 0.0736 (mg/m^3); top former bin: 0.0615 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved OSHA/NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Belgium, an OECD country.
	Metric 3:	Applicability	High	Data are for building/construction materials (wood and wood-engineered products), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE, exposure duration, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling multiple job types and areas of the site.
Overall Quality Determination			High	

Study Citation:	Vargova, M., Janota, S., Karelova, J., Barancokova, M., Sulcova, M. (1993). The evaluation of possible health risk associated with occupational exposure to formaldehyde. Proceedings of the International Conference on Monitoring of Toxic Chemicals and Biomarkers :447-454.		
HERO ID:	5954678		
Conditions of Use:	Processing: Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	Workers occupationally exposed to formaldehyde in the process of the manufacture of woodsplinter materials.		
Exposure route:	Inhalation		
Personal sampling data:	0.55 - 10.36 mg/m3		
Number of workers:	25 workers		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S. (Slovakia), and locality-specific factors (e.g., potential differences in regulatory occupational exposure limits, industry/ process technologies) may impact exposures relative to the U.S.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low	

Study Citation:	Vargová, M., Janota, S., Karelová, J., Barancokova, M., Sulcova, M. (1992). Analysis of the health risk of occupational exposure to formaldehyde using biological markers. Analusis 20(8):451-454.		
HERO ID:	626741		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	The process is the manufacture of wood splinter materials and the sampling locations/worker activities are given in Table 1.		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	0.55-10.36 mg/m3 collection of boards 1.19 mg/m3; 1 meter from site 0.97 mg/m3; Conveyor to press 0.827 mg/m3; new press control panel 0.913 .g/m3; Trimming shorter sie boards 1.654 mg/m3; Trimming longer side of boards 2.39 mg.m3; Slot milling 1.95 mg/m3; intake of new press- manual painf of boards 1.203 mg/m3’ preparation of mixture 10.39 mg/m3; old press 0.55 mg/m3		
Exposure duration:	20% 5 years, 20% 6-10 years, 16% 11-15 years, 44% 16 years or more.		
Number of workers:	20		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not specified though it was noted that Spectophotometry was used.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Czechoslovakia- OECD member
	Metric 3: Applicability	High	Data are for manufacture of pressed wood products in-scope occupational scenario
	Metric 4: Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after PEL - Article published in 1992
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Sample type not provided nor were other metadata such as sampling location, number of samples, employee activities, sampling and analytic methods, exposure frequency
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by providing by providing values for different operations and an overall range, but uncertainty is not addressed.
Overall Quality Determination		Low	

Study Citation:	Venable, H. L., Esswein, E. J. (1993). Health hazard evaluation report No. HETA-91-392-2291, Iron Workers Union, Local 372, Cincinnati, Ohio. :91-392.		
HERO ID:	1357393		
Conditions of Use:	Use of Paints/Coatings		
EXTRACTION			
Parameter	Data		
Worker activity description:	rod cutting with gasoline powered cut-off saw fitted with a cutting wheel or with an oxy-acetylene cutting torch and painting uncoated steel with a "patch" kit consisting of a two-part epoxy resin paint. (Page 3 of 15)		
Exposure route:	inhalation and dermal (page 2 of 13)		
Physical form:	vapor/fumes or liquid (Page 4 of 15)		
Area sampling data:	A trace level of formaldehyde was detected on the sampling tube. The presence of trace levels of formaldehyde was also detected by thermal desorption. Formaldehyde levels were below the limits of detection of the direct reading Interscan monitor or the Draeger detector tubes. (Page 8 of 15)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	From the US
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	From 1991
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site or sector. The monitoring study addresses uncertainty in the exposure estimates or uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination		High	

Study Citation:	Vicente, E.D., Ribeiro, J.P., Custodio, D., Alves, C.A. (2017). Assessment of the indoor air quality in copy centres at Aveiro, Portugal. Air Quality, Atmosphere and Health 10(2):117-127.
HERO ID:	3870802
Conditions of Use:	Electrical and electronic products

EXTRACTION	
Parameter	Data
Worker activity description:	Workers at commercial copy centers. (1/11)
Exposure route:	inhalation (1/11)
Area sampling data:	Hourly average formaldehyde concentrations of 0.04 ± 0.01 and 0.03 ± 0.01 mg/m ³ for copy centers A and B, respectively. (5/11)
Exposure duration:	10 hours/day at Center A, 3 hours/day at Center B (2/11)
Engineering control:	"Among the measures recommended to protect the health of those who work in copying facilities, we may refer to (i) choose low emission equipment (e.g. dry-process photocopiers, instead of wet-process ones) and which do not run so hot; (ii) ensure that photocopiers are equipped with ozone filters and replace these latter regularly; (iii) perform photocopiers maintenance on a regular basis; (iv) photocopiers should be placed such that exhaust affect as little as possible personnel or workstations; (v) maintain the room well ventilated; and (vi) avoid spillage when refilling the toner in dry machines." (11/11)

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Portugal, an OECD country.
	Metric 3:	Applicability	High	Data are for workers who commercially use ink and toner products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (averages, graph) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provides only limited discussion of the variability in the determinants of exposure for the sampled site or sector. The monitoring study provides only limited discussion of the uncertainty in the exposure estimates. Variability addressed by sampling at two copy centers, both indoors and outdoors.

Overall Quality Determination

High

Study Citation:	Viegas, S., Ladeira, C., Gomes, M., Nunes, C., Brito, M., Prista, J. (2013). Exposure and genotoxicity assessment methodologies - the case of formaldehyde occupational exposure. Current Analytical Chemistry 9(3):476-484.			
HERO ID:	2454064			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers involved in anatomy and pathology laboratories (pathologists, technicians and technical assistant) in Portuguese hospitals and workers in formaldehyde and formaldehyde-based resins production factory (production of resins, impregnation and quality control).			
Exposure route:	inhalation			
Physical form:	vapor/gas			
Personal sampling data:	Mean formaldehyde concentrations in 10 laboratories studied range between 0.28 and 3.24 ppm, while in the factory, the mean values ranged between 0.08 and 0.21 ppm. In laboratories, the concentrations were between 0.18 ppm and 5.02 ppm, while in the factory, the concentrations were between 0.0 and 1.04 ppm. Results in laboratories indicate “macroscopic examination” as the task involving the highest exposure. In the case of the factory, the task that included collecting a sample from the reactor was manual. The proximity of the reactor and the fact that it was opened might have promoted exposure.			
Area sampling data:	no data available			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	presented the most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
Overall Quality Determination		High		

Study Citation:	Viegas, S., Ladeira, C., Nunes, C., Malta-Vacas, J., Gomes, M., Brito, M., Mendonca, P., Prista, J. (2010). Genotoxic effects in occupational exposure to formaldehyde: A study in anatomy and pathology laboratories and formaldehyde-resins production. Journal of Occupational Medicine and Toxicology 5(1):25.			
HERO ID:	1239492			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.05-0.51 (ppm); ceiling: 0.02-5.02 (ppm)			
Exposure duration:	7 hours (data given as 8 hour TWA)			
Number of workers:	50			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method. (NIOSH 2541)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Portugal, an OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data is slightly more than 10 years old (article published in 2010)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1239492 Table: 2 of 2

Study Citation:	Viegas, S., Ladeira, C., Nunes, C., Malta-Vacas, J., Gomes, M., Brito, M., Mendonca, P., Prista, J. (2010). Genotoxic effects in occupational exposure to formaldehyde: A study in anatomy and pathology laboratories and formaldehyde-resins production. Journal of Occupational Medicine and Toxicology 5(1):25.			
HERO ID:	1239492			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.2-0.22 (ppm); ceiling: 0.003-1.04 (ppm)			
Exposure duration:	7 hours (data is given in 8 hour TWA)			
Number of workers:	30			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method. (NIOSH 2541)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Portugal, an OECD country.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are slightly more than 10 years old (Article published in 2010)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering controls, PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Viegas, S., Prista, J. (2010). Aspects to consider for selection of chemical risk assessment methodology: The case of formaldehyde occupational exposure. WIT Transactions on Ecology and the Environment 132:23-32.			
HERO ID:	5953568			
Conditions of Use:	lab chemical (anatomy/pathology labs)			
EXTRACTION				
Parameter	Data			
Number of sites:	10 labs studied			
Worker activity description:	Exposure groups: assistants, pathologists, technicians			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Table 4 (pg 5-6) present the 8-hr TWA concentrations in ppm; ceiling values not provided			
Comments:	Number of samples: 1 per exposure group per site (30 total)Method: NIOSH 2541; Photo Ionisation Detection (PID) equipment (with 11.7 eV lamp) (pg 3-4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is equivalent to an approved OSHA/NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Portugal, an OECD country.
	Metric 3:	Applicability	High	Data are for lab chemical, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by grouping exposures among different groups of employees in a laboratory. Uncertainty is not addressed.
Overall Quality Determination		High		

Study Citation:	Viegas, S., Prista, J., Gomes, M. (2009). Exposure assessment: the influence of environmental monitoring methodology. 14:353-359.			
HERO ID:	5953558			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Macroscopy as highest exposure task; worker categories as assistant, pathologist, or technician in hospital anatomy and pathology labs			
Exposure route:	Inhalation			
Personal sampling data:	TWA measurements ranged from non-detect to 0.51 ppm; ceiling measurements ranged between 0.28 ppm to 5.02 ppm			
Exposure duration:	Typical working day is 6 to 8 hours			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Portugal, an OECD country.
	Metric 3:	Applicability	High	Data are for use in embalming, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing worker activity for each ceiling exposure and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by measuring various hospitals/labs and worker categories.
Overall Quality Determination			High	

Study Citation:	Vimercati, L., Carrus, A., Martino, T., Galise, I., Minunni, V., Caputo, F., Dell’erba, A., Assennato, G. (2010). Formaldehyde exposure and irritative effects on medical examiners, pathologic anatomy post-graduate students and technicians. Iranian Journal of Public Health 39(4):26-34.			
HERO ID:	1578665			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Students practicing forensic medicine			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Autopsy room: Medical examiner 0.12 mg/m3 mean, 0.08 mg/m3 median, SD 0.08 (range 0.05-0.26mg/m3); Student: 0.12 mg/m3 mean, 0.09 mg/m3 median, SD 0.08 (range 0.04-0.25 mg/m3); Average: 0.12 mg/m3 mean, 0.09 mg/m3 median, SD 0.08 (range 0.04-0.26 mg/m3); Pathology anatomy lab: Technician 0.10 mg/m3 mean, 0.10 mg/m3 median, SD 0.05 (range 0.06-0.19 mg/m3); Student: 0.25 mg/m3 mean, 0.23 mg/m3 median, SD 0.12 (range 0.11-0.49 mg/m3); Average: 0.19 mg/m3 mean, 0.17 mg/m3 median, SD 0.12 (range 0.06-0.49 mg/m3)			
Area sampling data:	Autopsy room: 0.10 mg/m3 mean, 0.08 mg/m3 median, SD 0.07 (range 0.04-0.24 mg/m3); Pathology anatomy lab - Lab #1: 0.24 mg/m3 mean, 0.24 mg/m3 median, SD 0.08 (range 0.11-0.34 mg/m3); Lab #2: 0.12 mg/m3 mean, 0.13 mg/m3 median, SD 0.05 (range 0.06-0.17 mg/m3); Lab #3: 0.06 mg/m3 mean, 0.05 mg/m3 median, SD 0.02 (range 0.04-0.08 mg/m3)			
Number of workers:	16			
Personal protective equipment:	Recommended provision to technicians of appropriate masks for the protection of airways (filtering masks with carbon filters)			
Engineering control:	Recommended: 1) installation of dedicated chemical cloaks with aspiration from the bottom and suited filters; 2) Installation of a suitable system of forced ventilation that guarantees the correct exchange of the air in the laboratories.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not specified; though it was noted that air sampling was performed using diffusive samplers which collect airborne carbonyl compounds as 2, 4-dinitrophenylhydrazine (DNPH) derivatives. Sampling, storage and analysis were performed according to manufacture instructions. Analysis was performed by HPLC with ultraviolet absorbance detection.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Italy - an OECD member
	Metric 3:	Applicability	High	The data are for exposure in an anatomy lab which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The study was based on data from 2006, after the most recent PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized with mean, median, standard deviation, and range data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, exposure type, and sample durations, but lacks additional metadata, such as exposure duration, exposure frequency, and worker activities.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 1578665 Table: 1 of 1

...continued from previous page

Study Citation:	Vimercati, L., Carrus, A., Martino, T., Galise, I., Minunni, V., Caputo, F., Dell’erba, A., Assennato, G. (2010). Formaldehyde exposure and irritative effects on medical examiners, pathologic anatomy post-graduate students and technicians. Iranian Journal of Public Health 39(4):26-34.		
HERO ID:	1578665		
Conditions of Use:	Laboratory Use		
Domain	Metric	EVALUATION Rating	Comments
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided standard deviation and range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1513823 Table: 1 of 2

Study Citation:	Vinzents, P., Laursen, B. (1993). A national cross-sectional study of the working environment in the Danish wood and furniture industry: Air pollution and noise. Annals of Occupational Hygiene 37(1):25-34.			
HERO ID:	1513823			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Painting during furniture manufacture			
Exposure route:	Inhalation			
Physical form:	Liquid			
Personal sampling data:	0.20 (mg/m^3) - Geometric Means			
Number of workers:	43			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from Denmark, an OECD country.
	Metric 3:	Applicability	High	Data are for plasticizer, paint additive and coating additive, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1992)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing PPE and engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at multiple facilities.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1513823 Table: 2 of 2

Study Citation:	Vinzents, P., Laursen, B. (1993). A national cross-sectional study of the working environment in the Danish wood and furniture industry: Air pollution and noise. Annals of Occupational Hygiene 37(1):25-34.			
HERO ID:	1513823			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Gluing during furniture manufacture			
Exposure route:	Inhalation			
Physical form:	Liquid			
Personal sampling data:	0.15 (mg/m^3) GM			
Number of workers:	68			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from Denmark, an OECD country.
	Metric 3:	Applicability	High	Data are for furniture and furnishings not covered elsewhere, an in scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1992)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing PPE and engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at multiple facilities.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 2453786 Table: 1 of 1

Study Citation:	Virtamo, M., Tossavainen, A. (1976). Gases formed from furan binding agents. Scandinavian Journal of Work, Environment and Health 2(Suppl 1):50-53.			
HERO ID:	2453786			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers in foundries (coremakers and those present in the core-making vicinity)			
Exposure route:	inhalation			
Physical form:	vapor/gas			
Area sampling data:	The mean formaldehyde concentration was 2.7 cm3/m3. 38% of the measurements exceeded the formaldehyde TLV (2 cm3/m3). The highest formaldehyde concentrations (5-16 cm3/m3) appeared when large core boxes were being filled.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Vohra, M.S. (2011). Personal formaldehyde exposure level in the gross anatomy dissecting room at College of Medicine King Saud University Riyadh. International Journal of Occupational Medicine and Environmental Health 24(1):108-113.			
HERO ID:	2575943			
Conditions of Use:	Laboratory use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Instructors and students in gross anatomy laboratory			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	The average personal exposure level for the students was 0.75 (range 0.62 – 0.89), 1.20 (range 0.98 – 1.42), and 1.10 (0.88 – 1.31) ppm and 1.27 (range 0.82 – 1.72), 1.44 (range 1.18 – 1.70) and 1.33 (0.94 – 1.72) ppm for instructors during the 4th, 10th and 14th week, respectively. These levels were relatively higher than the World Health Organization guideline. These levels were always higher than the average indoor concentrations throughout the laboratory sessions and the difference in formaldehyde personal exposure levels between instructors and students might reflect both the time spent in a particular area in the dissection room and the region of the cadaver they dissect.			
Area sampling data:	The average concentration of FA in dissection room was 0.68, 0.85, and 0.73 ppm in the 4th, 10th and 14th weeks, respectively. During the 4th week, the concentrations varied between 0.53 and 0.80 ppm for different locations of the dissection room. During the 10th week, the concentrations varied between 0.64 and 1.29 ppm for different locations of the dissection room. During the 14th week, the concentrations varied between 0.65 and 0.92 ppm for different locations of the dissection room. In general, formaldehyde levels near the dissecting table were higher than in the areas away from it.			
Exposure duration:	Personal sampling and area sampling collected for 2 to 3 hours during the dissection class.			
Number of workers:	Ten instructors and 20 students			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	Data less than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	No discussion on uncertainty but data from different sample areas included for variability.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 2575943 Table: 1 of 1

...continued from previous page			
Study Citation:	Vohra, M.S. (2011). Personal formaldehyde exposure level in the gross anatomy dissecting room at College of Medicine King Saud University Riyadh. International Journal of Occupational Medicine and Environmental Health 24(1):108-113.		
HERO ID:	2575943		
Conditions of Use:	Laboratory use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Voorhees, J.M., Barnes, M.E. (2016). Airborne formaldehyde levels during simulated formalin egg treatments in vertical-flow tray incubators at a production fish hatchery. Journal of Agricultural Safety and Health 22(3):199-207.			
HERO ID:	5944108			
Conditions of Use:	Use in Fish Hatcheries (Agriculture, forestry, fishing, and hunting)			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation, dermal			
Physical form:	gas, vapor, liquid			
Area sampling data:	Mean max FA levels after formalin treatments of 1, 3, or 5 incupation stacks with teh external door open or closed: 0.4 ppm (1 stack) both open and closed; 3 stacks: open - 0.9 ppm; closed - 1.2 ppm; 5 stacks: open - 1.2 ppm, closed - 2 ppm.			
Personal protective equipment:	Respirators			
Engineering control:	Exhaust Fans			
Comments:	Source is a study on Formalin use in Egg Treatment for production of Fish Hatchery			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data. References EPA, OSHA, NIOSH, and other reputable sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	Data is under 10 years old (2016)
	Metric 5:	Sample Size	Low	Provides only maximum mean exposure levels.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes exposure route, physical form, and area sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Does not address uncertainty but variability addressed in terms of door open or closed.
Overall Quality Determination		Medium		

Study Citation:	Vyas, A., Pickering, C.A., Oldham, L.A., Francis, H.C., Fletcher, A.M., Merrett, T., Niven, R.M. (2000). Survey of symptoms, respiratory function, and immunology and their relation to glutaraldehyde and other occupational exposures among endoscopy nursing staff. Occupational and Environmental Medicine 57(11):752-759.			
HERO ID:	1313998			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Endoscopy nursing staff			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	mean 0.01 (mg/m^3) range (<0.001–0.38)			
Number of workers:	30			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from the United Kingdom, an OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old. (2000)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering control, PPE.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Wal, V.d., J. F. (1982). Formaldehyde measurements in Dutch houses, schools and offices in the years 1977-1980. Atmospheric Environment 16(10):2471-2478.			
HERO ID:	26999			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	data from individual homes (range 30-1800 ug/m3), offices (30-2300 ug/m3) and schools (range 50-1500 ug/m3) were provided			
Engineering control:	sealed with paint, ventilation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	sampling and analytic methods not provide, but the article did document that that air was led through an absorber with distilled water for 30-60 minutes, followed by the addition of Pararosaniline, mercuric chloride and sodium sulfite. Analysis was performed using a spectrophotometer.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Netherlands - OECD member
	Metric 3:	Applicability	High	The data are, use in composite wood products, which is an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1982, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	testing values were provided for each site
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study provided data for individual test sites which could be used to assess variability. But the study did not provide any discussion of uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Wallingford, K. M., Elliot, L. J., McAuley, D. B. (1988). Health Hazard Evaluation Report HETA 82-354-1897, Kemper-Tappan, Richmond, Indiana, May 1988.			
HERO ID:	8139239			
Conditions of Use:	Adhesive and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Millroom operators (band sawing, drilling, sanding), assembly workers, salvage room workers, finishing (sealing), and final assembly. (23/30)			
Exposure route:	inhalation (8/30)			
Physical form:	gas (8/30), vapor (10/30)			
Personal sampling data:	TWA exposure levels ranged from non-detectable to 0.56 ppm. By department area, the primary assembly and finishing areas had the highest exposure levels ranging from 0.11 ppm to 0.22 ppm (mean=0.15, N=4) and 0.10 to 0.56 ppm (mean=0.25, N=5) respectively. (11/30)			
Area sampling data:	Area samples ranged from 0.07 ppm in the particle board storage area to greater than 2.14 ppm at the drying oven exit in case finishing. (10/30) During the 1983 survey, the GA formaldehyde concentrations ranged from 0.05 ppm at the Giben Saw #2 to 0.25 ppm at the Giben Saw #1 and also at the case finishing area.			
Number of workers:	At the time of these evaluations, there were approximately 270 production employees operating on a single work shift. (5/30)			
Engineering control:	Local exhaust ventilation was utilized at the majority of powered woodworking machinery, spray booths, and drying ovens used in the production operations at the Kemper plant. (6/30)			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method (NIOSH Method 2501 & 3500).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesives and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling multiple locations and different job operations.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 3072990 Table: 1 of 1

Study Citation:	Wan, H., Wang, X.M., Barry, A., Shen, J. (2014). Recycling wood composite panels: Characterizing recycled materials. BioResources 9(4):7554-7565.			
HERO ID:	3072990			
Conditions of Use:	Recycling			
EXTRACTION				
Parameter	Data			
Area sampling data:	Free fromaldehyde emission of recycled MDF furnishes was 1 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method (NIOSH 3500).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is from US and Canada.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	no more than 10 years old
	Metric 5:	Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, but lacks additional meta-data
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Wang, H., Li, H., Lv, M., Zhou, D., Bai, L., Du, L., Xue, X., Lin, P., Qiu, S. (2015). Associations between occupation exposure to Formaldehyde and semen quality, a primary study. Scientific Reports 5:15874.			
HERO ID:	3421098			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers are from wood processing industry producing plywood			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	FA concentrations in 76 referents ranged from 0.0 to 0.02 mg/m3. These values can be neglected because they were far lower than FA occupation exposure limit. Moreover, the concentrations of FA measured in air ranged from 0.22 to 2.91 mg/m3 in all 114 workers			
Number of workers:	114			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is for China, a non-OECD country.
	Metric 3:	Applicability	High	Data is applicable to processing use of formaldehyde in wood processing
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2016)
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes number of workers, worker activity, exposure route, physical form
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1070240 Table: 1 of 1

Study Citation:	Wang, H.X., Zhou, D.X., Zheng, L.R., Zhang, J., Huo, Y.W., Tian, H., Han, S.P., Zhang, J., Zhao, W.B. (2012). Effects of paternal occupation exposure to formaldehyde on reproductive outcomes. Journal of Occupational and Environmental Medicine 54(5):518-524.			
HERO ID:	1070240			
Conditions of Use:	Commercial use, Industrial Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in wood processing industry			
Exposure route:	Inhalation			
Area sampling data:	In China, the current occupational exposure limit for FA is 0.5 mg/m3; however, studies have shown that the levels of FA in some occupational environments were far higher than this limit, with a few extreme instances where FA concentrations measured between 5.84 and 20.94 mg/m3. For this paper, the daily mean exposure was calculated as follows: daily exposure index = concentration of FA (mean value of three measurements, in mg/m3) x the proportion of the exposed work time during a workday x 100 (100 = whole day). Actual value of FA exposure not indicated in the paper.			
Number of workers:	302 workers exposed to FA and 305 non-exposed workers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from a non-OECD country.
	Metric 3:	Applicability	High	Data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Data is more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Wang, K., Wang, T.W., Xu, J., Zhu, Y., Jian, L., Au, W., Xia, Z.L. (2019). Determination of benchmark dose based on adduct and micronucleus formations in formaldehyde-exposed workers. International Journal of Hygiene and Environmental Health 222(5):738-743.			
HERO ID:	6083963			
Conditions of Use:	Processing: Chemical Factory			
EXTRACTION				
Parameter	Data			
Worker activity description:	Chemical factory: production examination, glue spraying, coating, workplace inspection, logistics workshop			
Exposure route:	Inhalation			
Area sampling data:	Range and geometric means for each worker area are: Production Examination: 0.01-0.15 mg/m3, Mean: 0.06Glue Spraying: 0.2-0.49 mg/m3, Mean: 0.25Coat- ing: 0.067-0.15 mg/m3, Mean: 0.1Workplace Inspection: 0.05-0.2 mg/m3, Mean: 0.09Logistics Workshop: 0.0-0.01 mg/m3, Mean: 0.01			
Number of workers:	In this study, 100 formaldehyde-exposed workers were selected and matched with 100 controls.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Monitoring data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range and geometric mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, and/or exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Wang, Y., Tsai, C.H., Lin, C.H., Chen, S.H. (2014). Measurement of Air Quality during a Decorating Engineering. Aerosol and Air Quality Research 14(7):2029-2039.			
HERO ID:	3001485			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Worker activity description:	Table 1 provides specific activities of workers: dismantling old decorating, water and electrical pipe engineering, tiling engineering, window installation, pre-system furniture installation, flooring engineering, post-system furniture installation, finishing engineering			
Area sampling data:	Formaldehyde sampling data provided on Table 1 (ppm): dismantling old decorating - 0.11 +/- 0.08; water and electrical pipe engineering - 0.13 +/- 0.02; tiling engineering - 0.51 +/- 0.16; window installation - 0.16 +/- 0.06; pre-system furniture installation - 0.24 +/- 0.20; flooring engineering - 0.08 +/- 0.02; post-system furniture installation - 0.69 +/- 0.43; finishing engineering - 0.55 +/- 0.32. The individual HCHO concentration ranged from 0.05 to 1.3 ppm during the decorating engineering. The averaged HCHO concentration for various engineering was between 0.08 and 0.69 ppm (Table 1), happening in the flooring engineering and post-system furniture installation, respectively. Figure 3 provides graphical data of the table.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source is peer reviewed so analytics and methodology are likely high quality.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is for Taiwan, a non-OECD country.
	Metric 3:	Applicability	Low	Similar to an occupational scenario of construction.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2014)
	Metric 5:	Sample Size	Medium	Range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Contains worker activity only.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by showing different worker activities and their respective exposure levels. Does not address uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1314025 Table: 1 of 1

Study Citation:	Wantke, F., Focke, M., Hemmer, W., Bracun, R., Wolf-Abdolvahab, S., Götz, M., Jarisch, R., Götz, M., Tschabitscher, M., Gann, M., Tappler, P. (2000). Exposure to formaldehyde and phenol during an anatomy dissecting course: Sensitizing potency of formaldehyde in medical students. Allergy 55(1):84-87.			
HERO ID:	1314025			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	students in a dissecting course			
Exposure route:	Inhalation			
Physical form:	gas			
Area sampling data:	mean: 0.265 ± 0.07 mg/m3; range: 0.133 - 0.410 mg/m3)			
Exposure duration:	43 days			
Number of workers:	27			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Method not specified but a reference containing information about method is cited.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from the Austria, an OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old. (2000)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing engineering control, PPE, exposure duration, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability not addressed.
Overall Quality Determination		Medium		

Study Citation:	Wantke, F., Focke, M., Hemmer, W., Tschabitscher, M., Gann, M., Tappler, P., Götz, M., Jarisch, R. (1996). Formaldehyde and phenol exposure during an anatomy dissection course: A possible source of IgE-mediated sensitization. Allergy 51(11):837-841.			
HERO ID:	626700			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Mean: 0.124 ppm, with a minimum of 0.059 ppm and a maximum of 0.219 ppm			
Exposure duration:	3 hr daily (51 hours)			
Exposure frequency:	4 weeks			
Number of workers:	45			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country. other than the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data from the 1990s.
	Metric 5:	Sample Size	Medium	Information includes mean, min, max, and standard deviation.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Washko, R., Burkhart, J., Piacitelli, C. (1998). Health hazard evaluation report 96–0093–2685, Microfibres Inc. Pawtucket, Rhode Island, April 1998.			
HERO ID:	8024157			
Conditions of Use:	Incorporation into an article - Finishing agents in textiles			
EXTRACTION				
Parameter	Data			
Worker activity description:	This plant dyes, finishes, and cuts nylon (and some polyester)continuous fiber to produce flock and also applies the nylon flock to a backing fabric to produce flock–coatedupholstery fabric, some of which is screen printed, embossed, or otherwise finished.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Two of the highest formaldehyde concentrations, 0.44 ppm and 0.21 ppm, were measured at Range 1 and Range 2, respectively. Also, a concentration of 0.25 ppm was measured at the RPC 1–2 area, where no products containing formaldehyde are used. All other samples were below the minimum quantifiable concentration.Compounding Area (0.07 ppm) RPC 1–2 Area 0.25 ppmRPC 3–7 Area NDBasement Screening ND Range 1 Pre-Coat (0.05 ppm)Range 2 Pre-Coat (0.04 ppm)Range 1 Flocking (0.08 ppm) Range 2 Flocking (0.06 ppm) Range 1 ScotchGard® 0.44 ppmRange 2 ScotchGard 0.21 ppmEmbossing Area (0.07 ppm)Printing Range Area (0.05 ppm)Values in parenthesis are considered trace amounts, above Minimum Quantifiable Concentration 0.13 ppm			
Exposure duration:	Table 11 provides survey on hrs/day			
Exposure frequency:	more than 5 days per week 16-112 hours per week			
Number of workers:	170			
Personal protective equipment:	The company’s respirator program wasfound to be inadequate, and the only respirators in use were single–use dust masks.			
Engineering control:	The general and local ventilation exhaust systems were inadequate at a number of locations, and many process cyclones used to transfer flock exhausted directly into the workplace air without filtration.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study - Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (textile) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1996 - after the PEL (1992) but more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, exposure durations, and exposure frequency, but lacks additional metadata, such as sample durations, and worker activities.
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 8024157 Table: 1 of 1

...continued from previous page

Study Citation:		Washko, R., Burkhart, J., Piacitelli, C. (1998). Health hazard evaluation report 96–0093–2685, Microfibres Inc. Pawtucket, Rhode Island, April 1998.		
HERO ID:		8024157		
Conditions of Use:		Incorporation into an article - Finishing agents in textiles		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1316827 Table: 1 of 1

Study Citation:	Weaver, V. M. (1997). Chemical hazards in health care workers. Occupational Medicine: State of the Art Reviews 12(4):655-667.			
HERO ID:	1316827			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	vapor			
Personal sampling data:	mean of 0.45 ppm (range 0.01-7 ppm)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD member
	Metric 3:	Applicability	High	The data are for histology workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were from 1995 study, after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Mean and range data were provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, exposure frequency, and/orworker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Medium		

Study Citation:	Wentrup, G. J., Brenk, F. R., Wenzel, M., Striefler, B. (1987). Field measurements of formaldehyde for workplace monitoring, using various active and passive methods for personal and area sampling. :328-332.
HERO ID:	4120003
Conditions of Use:	Furniture, textile and chipboard manufacturing

EXTRACTION	
Parameter	Data
Worker activity description:	Board store employees, board saw operators, veneering station operator, veneering press operator, thermoplastic edge gluing equipment operator, inspecting and rolling machine operators, continuous press operators, discontinuous press operators, sanding belt operators
Exposure route:	inhalation
Physical form:	vapor/gas
Personal sampling data:	Tables 1, 2 and 3 provide data for furniture, textile, and chipboard industries, respectively. All units are mg/m ³ : There are 2 different personal sampling methodologies: DNPH and silicage type B. DNPH values are: Table 1: board saw - 0.15; veneering station - 0.26, 0.24; thermoplastic edge glueing equipment: 0.11, 0.10, 0.09, 0.16; Output interim for parts requiring assembly - 0.27; Table 2: tenter frame input - 0.10; tenter frame output - 0.09; inspecting and rolling machine- 0.09; underground store centre gangway - 0.07; Table 3 - continuous press - 0.68; sanding belt - 0.08, 0.19; Cutting-to-size - 0.04, 0.05; board inspection - 0.19. Silicage type B: Table 1 Board store- 0.06, Board saw- 0.05, veneering station – 0.09, Table 2 : tenter frame input - 0.03; tenter frame output - 0.03, 0.03, 0.03, 0.01 tenter frame input- 0.02, 0.04, 0.03; inspecting machine- 0.01, inspecting and rolling machine- 0.05; underground store centre gangway - 0.08, 0.01; Table 3 - continuous press - 0.32; discontinuous press 1.04, 0.30, sanding belt - 0.05; panel saw – 0.05, 0.04;; board inspection - 0.03, 0.04.
Area sampling data:	Table 1: board store - 0.10 and 0.02; Board saw - 0.13 and 0.02; Veneering station - 0.26 and 0.06; veneering press - 0.20 and 0.09 and 0.04; Veneering press output - 0.22, 0.06, Thermoplastic edge glueing equipment (dual) - 0.09, 0.18, and 0.03; Thermoplastic edge glueing equipment (single) output - 0.15 and 0.02; Interim store for parts requiring assembly - 0.15 and 0.01; Table 2: tenter frame input - 0.06, 0.07, 0.03 and 0.02; tenter frame output - 0.06 and 0.03; tenter frame input - 0.06, 0.04 and 0.01; tenter frame output - 0.05 and 0.03; tenter frame input - 0.23 and 0.07; tenter frame output – 0.32, 0.02 inspecting machine - 0.08 and 0.06, 0.03; inspecting and rolling machine - 0.09 and 0.06, 0.03; underground store centre gangway - 0.12 and 0.18, 0.07; underground store side passage- 0.16, above-ground store centre gangway - 0.20 and 0.02; Table 3: continuous press - 1.22, 1.10, and 1.33, 0.39; Discontinuous press - 3.2; Sanding belt - 0.10; Cutting to size - 0.07 and 0.02; Board inspection - 0.09;

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Unclear if source is peer reviewed but likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for UK, an OECD country
	Metric 3:	Applicability	High	Data is applicable to manufacture of furniture, textile and chipboards.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	High	Individual samples and their sampling times are provided and the characteristics of them are stated in the tables.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Provides worker activity/sampling location, exposure route, physical form, personal and area sampling data but lacks additional metadata on the process/site

Domain 4: Variability and Uncertainty

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Formaldehyde

Occupational Exposure

HERO ID: 4120003 Table: 1 of 1

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Study Citation:	Wentrup, G. J., Brenk, F. R., Wenzel, M., Striefler, B. (1987). Field measurements of formaldehyde for workplace monitoring, using various active and passive methods for personal and area sampling. :328-332.		
HERO ID:	4120003		
Conditions of Use:	Furniture, textile and chipboard manufacturing		
		EVALUATION	
Domain	Metric	Rating	Comments
	Metric 7: Metadata Completeness	Medium	Addresses variability by looking at different manufacturing sites. Does not address uncertainty.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1989125 Table: 1 of 1

Study Citation:	Westberg, H. B., Seldén, A. I., Bellander, T. (2001). Exposure to chemical agents in Swedish aluminum foundries and aluminum remelting plants—a comprehensive survey. Applied Occupational and Environmental Hygiene 16(1):66-77.			
HERO ID:	1989125			
Conditions of Use:	Use of metal products			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers in aluminum foundries			
Personal sampling data:	Formaldehyde concentrations (mg/m3) for different job titles in aluminum sand foundries: molding - <0.008-0.15; core making - 0.031–0.14; Pouring - 0.025–0.11; shake-out - < 0.025–0.035. Formaldehyde concentrations (mg/m3) for different job titles in aluminum static die-casting: core making - < 0.028–0.053; static die-casting - < 0.026–0.044; core knock-out - < 0.0256.			
Area sampling data:	Formaldehyde concentrations (mg/m3) in air in aluminum foundries: geometric mean - 0.028+/- 1.7 and range - 0.008 - 0.15			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	it was published in 2001 and data is more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainty
Overall Quality Determination		Medium		

Study Citation:	Westberg, H., Löfstedt, H., Seldén, A., Lilja, B.G., Nayström, P. (2005). Exposure to low molecular weight isocyanates and formaldehyde in foundries using hot box core binders. Annals of Occupational Hygiene 49(8):719-725.			
HERO ID:	5943728			
Conditions of Use:	Binder in Metal Manufacturing (Foundries)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in Swedish foundries using Hot Box binders			
Exposure route:	Inhalation			
Physical form:	gas			
Personal sampling data:	Personal sampling results for formaldehyde in grey iron foundry: GM - 260 +/- 2.1 ug/m3, AM – 343+/-339 ug/m3, Range - 100–1600 ug/m3. Personal sampling results for formaldehyde in brass foundries: GM - 71 +/- 2.5 ug/m3, AM – 105+/-9.6 ug/m3, Range - 14–440 ug/m3. Personal sampling results for formaldehyde for core makers: GM - 136 +/- 2 ug/m3, AM – 169+/-110 ug/m3, Range - 50–440 ug/m3. Personal sampling results for formaldehyde for die-caster: GM - 63 +/- 2.1 ug/m3, AM – 80+/-58 ug/m3, Range - 21–220 ug/m3. Personal sampling results for formaldehyde for others: GM - 32 +/- 2.2 ug/m3, AM – 46+/-50 ug/m3, Range - 14–170 ug/m3. The formaldehyde levels ranged from 14 to 1600 mg/m3, but the ACGIH-TLV (600 mg/m3) was exceeded in only 3% of the samples.			
Area sampling data:	Air concentrations (ug/m3) for formaldehyde (total): GM - 120 +/- 2.8, AM – 190+/-250, Range - 14–1600. Air concentrations (ug/m3) for formaldehyde for core-maker: GM - 200 +/- 2.1, AM – 280+/-290, Range - 50–1600. Air concentrations (ug/m3) for formaldehyde for die-caster: GM - 63 +/- 2.1, AM – 80+/-58, Range - 21–220. Air concentrations (ug/m3) for formaldehyde for others: GM - 32 +/- 2.2, AM – 46+/-50, Range - 14–170. The air concentrations of formaldehyde were higher for core-makers (GM = 200 mg/m3) than for die-casters (GM = 63 mg/m3). The formaldehyde concentrations were higher for the core-makers, although still below the ACGIH-TLV for most of the exposed workers.			
Exposure duration:	Measurements are given as 8-hr time-weighted averages.			
Number of workers:	64 (15 die-casters, 39 core-makers and 10 other workers in the foundry); In the brass foundries, all coremakers, die-casters and fettlers were included (in total 40 workers) and in the grey iron foundry 24 coremakers			
Comments:	Swedish occupational exposure limit is 600 mg/m3;			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	methodology well described, but information not clear if it is equivalent to NIOSH or OSHA method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country. other than the U.S.
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	data are more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
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Formaldehyde

Occupational Exposure

HERO ID: 5943728 Table: 1 of 1

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Study Citation:	Westberg, H., Löfstedt, H., Seldén, A., Lilja, B.G., Nayström, P. (2005). Exposure to low molecular weight isocyanates and formaldehyde in foundries using hot box core binders. Annals of Occupational Hygiene 49(8):719-725.		
HERO ID:	5943728		
Conditions of Use:	Binder in Metal Manufacturing (Foundries)		
Domain		Metric	
		EVALUATION	
		Rating	
		Comments	
Overall Quality Determination		High	

Study Citation:	White, G. L., Keogh, J. P. (1978). Hazard Evaluation and Technical Assistance Report No. TA-78-33, William T. Burnett Company, Baltimore, Maryland.			
HERO ID:	1317282			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Worker activity description:	Jessup facilityActivator, Ass't. Activators, Chemical Handler, Foamer Operator, Ass't. Foamer Operators, Paper Take-off, Saw Operator, Ass't(s)Saw Operator, Hole Borer Machine Operator, Material Stackers, Poleman, Run Crew Foreman, Large and Small Peeler Machine Operators, Ass't(s) Large & Small Peeler Machine Operators,Quality Control, Ass't(s) Quality Control, Mechanical & Vacuum Compress Operator, Ass't(s) Mechanical & Vacuum Compress Operator, Shipper, Ass't(s) Shipper, Maintenance PersonnelBaler & lift Truck Operator, Janitor, Office Personnel, &OtherCompany PersonnelBush Street facilityActivator, Ass't Activator(s), Foamer Operator, Ass't Foamer Operator(s), Chemical Handler, Duplex Machine Operator, Ass't Duplex Machine Operator(s), Paper Take-off, Saw Operator, Ass'tSaw Operator(s), Punch Press Operator, Ass't Punch PressOperator(s), Large &Small Peeler Machine Operator, Ass't Large & Small Peeler Machine Operator(s), Maintenance Personnel, Machine Operator, Ass't Machine Operator(s), Various Office PersonnelLaboratory Personnel, Ass't Laboratory Personnel, Laboratory Technician(s), Janitor, and Other Company Personnel			
Exposure route:	Inhalation (Report states that the off-gases of the plume evolving from the fresh hot foam)			
Physical form:	Vapor			
Area sampling data:	Fresh urethane plume saw area 0.52 mg/m3			
Exposure duration:	The foam process is a continuous 10 to 12-hour operation, whereas the foam peeling process is an 8-hour shift, three shifts per operation. Second shift peels the most fresh foam, with a third shift peeling a lesser amount than the second. The first shift peels mostly 1-day-old foam. A limited amount of foam is peeled at Bush Street too.			
Number of workers:	234 total The Jessup facility employs 138 hourly and 13 salaried employees, plus one part time office clerk. All the hourly and all but three of the salaried personnel are males. The Bush Street facility employs 57 hourly and 7 salaried workers. Approximately 10 of the 57 hourly employees and 2 of the salaried employees are female.			
Personal protective equipment:	Respirators			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study Method P&CAN 125
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (urethane foam production) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1978 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Medium	Only one area value was provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
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Formaldehyde

Occupational Exposure

HERO ID: 1317282 Table: 1 of 1

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Study Citation:		White, G. L., Keogh, J. P. (1978). Hazard Evaluation and Technical Assistance Report No. TA-78-33, William T. Burnett Company, Baltimore, Maryland.		
HERO ID:		1317282		
Conditions of Use:		Incorporation into a formulation, mixture, or reaction product		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	Medium	The monitoring study does not address variability. The monitoring study addresses uncertainty in the exposure estimates or uncertainty canbe determined from the sampling and analytical method.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 3970612 Table: 1 of 1

Study Citation:	White, G. L., Schwartz, E. (1979). Health Hazard Evaluation Determination, Report No. HEE 79-41-594, Stout Sportswear, Queens Long Island City, New York.			
HERO ID:	3970612			
Conditions of Use:	Fabric, textile, and leather products not covered elsewhere; Photographic supplies			
EXTRACTION				
Parameter	Data			
Worker activity description:	The job categories included officer personnel, photomakers, markers , graders and cutters. Cutting is performed with reciprocating electric cutters, both straight and disc.			
Exposure route:	inhalation, dermal			
Physical form:	vapor			
Area sampling data:	Measured non-detect in office, copy machine(on, off, and off with compartments open), sewing area.			
Number of workers:	19 employees			
Engineering control:	Site had 7 exhaust fans equally distributed along exterior walls.			
Comments:	Report does not clearly indicate a source of formaldehyde and testing shows formaldehyde was not detected.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Direct reading measurement tools (drager indicator tubes) for sampling, assumed an approved NIOSH method based on type of report (NIOSH HHE).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Uninformative	No indication of a source of formaldehyde from the raw materials in the process and formaldehyde was not detected, so unknown if formaldehyde was present at site.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old.
	Metric 5:	Sample Size	High	Samples are fully characterized and the sample size is sufficient (n=4; ND).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, but lacks additional information on basis for formaldehyde testing, employee duration of tasks and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study considers variability in testing the copy machine while on and off as well as conditions expected during maintenance. Uncertainty is assumed to be considered in the sampling and analytical method.
Overall Quality Determination		Uninformative		

Study Citation:	Whitmyre, G. K., Driver, J. H., Ginevan, M. E., Tardiff, R. G., Baker, S. R. (1992). Human exposure assessment I: understanding the uncertainties. Toxicology and Industrial Health 8(5):297-320.		
HERO ID:	4635		
Conditions of Use:	Use of fabric, textile and leather products		
EXTRACTION			
Parameter	Data		
Worker activity description:	There are ten employees in the cutting department where the fabric is taken to either automatic spreading machines or to tables on which the fabric is hand-laid to match stripes. The sewing department employs about 50 individuals, who work in teams to make the clothing. The completed garments are taken to the finishing department, which has ten employees. Four employees inspect the garments for stitching, loose threads, matching stripes, spots, and stains. The maintenance department is staffed by two persons who do a wide variety of activities including machine repair and maintaining the ventilation systems.		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	Sewer trace (0.03 ppm)Sewer/Dodge City trace (0.03 ppm)Supervisor/Cutting Room trace (0.04 ppm)Sewer/Musical Chairs trace (0.04 ppm)Bundler trace (0.06 ppm)Inspector trace (0.05 ppm)Sewer/Looney Tunes trace (0.03 ppm)Cutter trace (0.05 ppm)Sewer/Looney Tunes trace (0.04 ppm)Formaldehyde on Dust-Sewer/Musical Chairs 1.2 ug/sample 0.17 mg/m3Sewer/Mash ND 0.11 – 0.1 mg/m3Sewer/Little Haiti 0.9 ug/sample 0.06 mg/m3Sewer/Looney Tunes 0.69 ug/sample 0.08 mg/m3Sewer 6:50 a.m. - 2.1 ug/sample 0.19 mg/m3		
Area sampling data:	Sewing - Adjacent to Cleaning Station trace (0.04 ppm)		
Exposure duration:	up to 10 hours per day - 6 days per week.		
Exposure frequency:	40 hours per week		
Number of workers:	85		
Engineering control:	To further reduce the employees’ exposure to the organic solvents used at this facility, the local exhaust ventilation for the spotting stations could be modified to provide the appropriate capture velocity. The portable welding station should have local exhaust ventilation (OSHA Part 1910 Subpart Q Welding, Cutting, Brazing). ⁴⁶		
Comments:	This is a general methodology for exposure via ingesting contaminants. Formaldehyde is not discussed.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH study - Methods 2541 & 5700
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for an occupational scenario (garment fabrication) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	1996 - after PEL (1992) but more than 20 years old
	Metric 5: Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH methods used.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
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Study Citation:	Whitmyre, G. K., Driver, J. H., Ginevan, M. E., Tardiff, R. G., Baker, S. R. (1992). Human exposure assessment I: understanding the uncertainties. Toxicology and Industrial Health 8(5):297-320.		
HERO ID:	4635		
Conditions of Use:	Use of fabric, textile and leather products		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 1319564 Table: 1 of 1

Study Citation:	Wieslander, G., Norback, D. (1998). Asthma, respiratory symptoms, and nasal inflammation in house painters mainly exposed to water-based paints. International Congress Series 1153:408-412.			
HERO ID:	1319564			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Painting			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	probably area sampling - <0.03-0.14 mg/m3			
Number of workers:	236 painters			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - and OECD country
	Metric 3:	Applicability	High	The data are for painters which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1998 using data from 1989-1992 & 1997, after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Only range data were provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include exposure type, but lacks additional metadata, such as sample type, sample durations, exposure durations, exposure frequency, and/or worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination		Low		

Study Citation:	Wieslander, G., Norbäck, D., Edling, C. (1994). Occupational exposure to water based paint and symptoms from the skin and eyes. Occupational and Environmental Medicine 51(3):181-186.		
HERO ID:	994035		
Conditions of Use:	Use of Paints/Coatings		
EXTRACTION			
Parameter	Data		
Worker activity description:	Painting, removal of old wall paper, manual sanding of walls with abrasive paper, manual filling, and sizing of wet room wall papers		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	0.05 mg/m3 mean (8 hours exposure) 0.04 mg/m3 geometric mean, 1.9 Geometric SD (range <0.03-0.1 mg/m3)		
Particle size characterization:	dust exposure for renovation: old building 2.1 mg/m3, new building 0.7 mg/m3		
Number of workers:	12		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Long term exposure to formaldehyde was measured by diffusion sampling, with chemosorption on 2,4-dinitrophenyl hydrazine (2,4- DNF) coated glass fiber filters. 12 Peak exposure to formaldehyde was measured with glass fiber filters impregnated with 2,4-DNF, with the air rate at 1 l/min for 15 minutes. The filters were analyzed by liquid chromatography.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden - OECD member
	Metric 3: Applicability	High	The data are for painters which is an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1993 and the data collection occurred in April of 1989, prior to the most recent PEL (1992) but more than 20 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized with a average, geometric average, geometric SD and range data.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Some metadata were provided but sample durations, exposure durations, and exposure frequency was not included.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Range and geometric SD data were provided, but uncertainty was not dicussed.
Overall Quality Determination	Medium		

Formaldehyde

Occupational Exposure

HERO ID: 180138 Table: 1 of 1

Study Citation:	Wilhelmsson, B., Holmstrom, M. (1992). Possible mechanisms of formaldehyde-induced discomfort in the upper airways. Scandinavian Journal of Work, Environment and Health 18(6):403-407.			
HERO ID:	180138			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Personal sampling data:	0.05-0.6 (mean 0.26) mg/m3; Ref. group: mean 0.09 mg/m3			
Number of workers:	66 employees; 36 control community clerks			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country (Sweden).	
	Metric 3: Applicability	High	Data are for manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Data collected before the most recent PEL (1992). Published in 1992. Sample collection before then.	
	Metric 5: Sample Size	Medium	Data characterized by mean and range, but full statistical distribution not provided.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty not addressed.	
Overall Quality Determination		Low		

Study Citation:	Williams, T.M., Levine, R.J., Blunden, P.B. (1984). Exposure of embalmers to formaldehyde and other chemicals. American Industrial Hygiene Association Journal 45(3):172-176.		
HERO ID:	1317520		
Conditions of Use:	Embalming		
EXTRACTION			
Parameter	Data		
Worker activity description:	Embalming fluid applied to femoral artery, blood drained form the formal vein. Insert trocar to the thoracic and abdominal cavities. Embalm the viscera by attaching hose to the trocar, and instill content. Seal the abdominal puncture wound using a screw-in plastic button. For autopsied bodies the process is repeated for each body section. Cauerize the Skull, thorax and abdomen, add viscera into abdomen and close the body.		
Exposure route:	inhalation		
Physical form:	vapor		
Personal sampling data:	Intact bodies: 0.27 ppm TWA mean (Range 0.18 - 0.43 ppm); Autopsied bodies: 0.88 ppm TWA mean (Range 0.0 - 2.11 ppm TWA)		
Area sampling data:	Intact bodies 0.26 ppm TWA mean (range 0.15 - 0.5 ppm TWA); Autopsied bodies 0.65 ppm TWA mean (range 0.15 - 0.92 ppm TWA)		
Particle size characterization:	Area source sampling: average 0.19 mg/m3 (range 0.06 - 0.40 mg/m3) Personal 1.8 mg/m3 during application of hardening compound.		
Personal protective equipment:	All wore rubber gloves and all but one wore laboratory jacket or apron.		
Engineering control:	ventilation systems were evaluated for this study.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	NIOSH methods were referenced for this study. Midget impinger containing bisulfide in distilled water were used to collect the samples. two impingers were used in series to obtain 95% collection efficiency. Chrmotrophic acid method.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	The study was derived from data collected in 1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	High	results from individual sampling events were provided along with Mean and range data for area and personal sampling.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Monitoring data include most critical metadata, such as sample type, exposure type, sample durations, exposure durations, exposure frequency, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	As the actual results for each sampling event are provided for intact and autopsied bod-ies it is possible to evaluate the data variability. The NIOSH method addresses uncer-tainty.

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Formaldehyde

Occupational Exposure

HERO ID: 1317520 Table: 1 of 1

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Study Citation:	Williams, T.M., Levine, R.J., Blunden, P.B. (1984). Exposure of embalmers to formaldehyde and other chemicals. American Industrial Hygiene Association Journal 45(3):172-176.		
HERO ID:	1317520		
Conditions of Use:	Embalming		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 6016950 Table: 1 of 2

Study Citation: Wills, F. K. (1983). Fumigants and sanitation: update on formaldehyde. Poultry digest 42(499):452.
HERO ID: 6016950
Conditions of Use: Hospital autopsy rooms

EXTRACTION	
Parameter	Data
Area sampling data:	2-7 ppm

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Monitoring data do not include any needed metadatato understand what the data represent and are not usable in the risk evaluation.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination **Uninformative**

Formaldehyde

Occupational Exposure

HERO ID: 6016950 Table: 2 of 2

Study Citation:	Wills, F. K. (1983). Fumigants and sanitation: update on formaldehyde. Poultry digest 42(499):452.
HERO ID:	6016950
Conditions of Use:	Disinfectant at hatchery

Parameter	Data
Area sampling data:	up to 13,000 ppm; 12 ppm for two employees for 5 minutes
Personal protective equipment:	Respirator, goggles, gloves
Engineering control:	use an air-tight box or cabinet; exhaust ventilation, check ventilation every three months

Domain	Metric	EVALUATION Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	Uninformative	The data are for an occupational scenario for non-TSCA uses which is not within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	Monitoring data do not include any needed metadatato understand what the data represent and are not usable in the risk evaluation.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.

Overall Quality Determination **Uninformative**

Study Citation:	Wooster, G., Martinez, C., Bowser, P., O’Hara, D. (2005). Human health risks associated with formalin treatments used in aquaculture: Initial study. North American Journal of Aquaculture 67(2):111-113.			
HERO ID:	1986873			
Conditions of Use:	”Use in agriculture, forestry, fishing, and hunting”			
EXTRACTION				
Parameter	Data			
Area sampling data:	For experiment 1, mean STEL was 0.76 ± 0.73 mg/L and PEL was 0.152 ± 0.10 mg/L, 10 cm from the source. One meter from the source, mean STEL and PEL were 0.45 ± 0.35 mg/L and 0.070 mg/L ± 0.013 mg/L, respectively. For experiment 2, mean STEL was 1.61 ± 0.344 mg/L and PEL was 0.143 ± 0.0122 mg/L, 10 cm from the source. One meter from the source mean STEL and PEL were 0.97 ± 0.744 mg/L and 0.172 ± 0.049 mg/L, respectively.			
Comments:	The article implies that this is an FDA regulated use			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Acculabs Technologies air monitoring system was used. This system consists of air exposure sampling cards to measure exposure for 15 min (STEL) and 8 h (PEL). The cards react and change color based on concentration, the color change is analyzed with an ATI electronic colormeter and converted to ppm.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainty
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1258228 Table: 1 of 1

Study Citation:	Wójcik, A., Luterek, I. (2003). Analysis of occupational risk due to exposure to carcinogenic factors in the work environment of a chemical plant. Annales Universitatis Mariae Curie-Skłodowska. Sectio D: Medicina 58(2):185-193.			
HERO ID:	1258228			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Area sampling data:	[Laboratory for biological water treatment] 2000: 0-0.17 (mg/m^3); 2001: 0-0.175 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Analytical methods for Sulphur compounds, chromium compounds, and benzene are specified on page 2. Analytical method for detection of formaldehyde did not appear to be specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Poland, an OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2003)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (min, max) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by data from two different years but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 3259629 Table: 1 of 1

Study Citation:	Xu, B., Wu, Y., Gong, Y., Wu, S., Wu, X., Zhu, S., Liu, T. (2016). Investigation of volatile organic compounds exposure inside vehicle cabins in China. Atmospheric Pollution Research 7(2):215-220.			
HERO ID:	3259629			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Worker activity description:	Test vehicle drivers			
Exposure route:	Inhalation			
Physical form:	vapor			
Area sampling data:	Mean concentration of formaldehyde was 16.43 ug/m3. The in-vehicle formaldehyde concentrations (ug/m3) were 8.42 (min.), 29.82 (max.), 16.43 (average), 4.95 (SD). For new vehicles, the concentrations of formaldehyde were larger than the concentrations inside old vehicles by 6.26%. The mean ambient concentrations of formaldehyde was 9.24 ug/m3.			
Number of workers:	15			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	sampling and analytical methodology is well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainty
Overall Quality Determination		Medium		

Study Citation:	Xu, W., Stewart, E. J. (2016). A comparison of engineering controls for formaldehyde exposure during grossing activities in health care anatomic pathology laboratories. Journal of Occupational and Environmental Hygiene 13(7):529-537.
HERO ID:	5936295
Conditions of Use:	lab chemical (pathology labs)

EXTRACTION	
Parameter	Data
Worker activity description:	pathology staff "large specimen grossing" (pg 3)
Exposure route:	inhalation
Physical form:	vapor
Personal sampling data:	PBZ STEL Data: Table 1, pg 5 presents data for various control types, including sample size and maximum values in ppm. Table 2, pg 5 presents data (median, mean, SD, geometric mean, geometric standard deviation, 95th %, and UCL of 95th%) for various control types as well.
Engineering control:	"General ventilation systems are often used in these situations and personal formaldehyde exposure levels in the air were reported to be as high as 3.8 parts formaldehyde per million parts air (ppm).[12] Local exhaust ventilation systems have been demonstrated to reduce the exposure levels for students (pg 2) See exposure results tables, data is grouped by control type. "
Comments:	After scrubbing out the 2,163 STEL samples with the sample type and sampling method criteria, 307 data points were left, with 294 of them collected with OSHA 52 method, and 13 with NIOSH 2541 method. Overall, 117 samples were censored and only 190 samples were above their corresponding reporting limits. These data were collected from 163 surveys at a total of 36 anatomic pathology laboratories in nine states across the organization from 1990–2014. (pg 4)Only samples collected and analyzed with OSHA Method 52 and NIOSH Method 2541 were used in this analysis (pg 3)

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for lab chemical, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (median, mean, SD, geometric mean, geometric standard deviation, 95th %, and UCL of 95th%, max) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata such as exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in analysis of collected sampling points (dealing with LODs etc.). Variability addressed by evaluating exposure by control type.

Overall Quality Determination

High

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 5936295 Table: 1 of 1

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Study Citation: Xu, W., Stewart, E. J. (2016). A comparison of engineering controls for formaldehyde exposure during grossing activities in health care anatomic pathology laboratories. Journal of Occupational and Environmental Hygiene 13(7):529-537.			
HERO ID: 5936295			
Conditions of Use: lab chemical (pathology labs)			
		EVALUATION	
Domain	Metric	Rating	Comments

Study Citation:	Yager, J.W., Cohn, K.L., Spear, R.C., Fisher, J.M., Morse, L. (1986). Sister-chromatid exchanges in lymphocytes of anatomy students exposed to formaldehyde-embalming solution. Mutation Research 174(2):135-139.			
HERO ID:	626642			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Worker activity description:	student			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	1.5 mg/m3 average, 0.99 variance (range 0.9-2.4 mg/m3). See Table 2 for individual data			
Area sampling data:	0.4 mg/m3 average; 0.21 variance (Range 0.1-0.72 mg/m3). See Table 2 for individual data.			
Exposure duration:	”The class met for two afternoons a week”			
Exposure frequency:	twice a week during a 10 week anatomy class			
Number of workers:	number of monitored subjects: 8			
Personal protective equipment:	gloves were worn			
Engineering control:	windows on one side of the room were opened during class but active general or local exhaust ventilation was not evident.			
Comments:	”Area-air samplers were randomly distributed throughout the room. Breathing-zone air samples were collected on 30 individuals at 15 tables over the course of 10 weeks. The average sampling duration was 18 min.”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	The sampling collection method correlates well (0.97) with the NIOSH impinger method. Analysis using the NIOSH standard chromotropic acid method. Back-up filters were analyzed separately to check for break-through.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1986, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized including weekly values, averages and ranges.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 626642 Table: 1 of 1

...continued from previous page

Study Citation:	Yager, J.W., Cohn, K.L., Spear, R.C., Fisher, J.M., Morse, L. (1986). Sister-chromatid exchanges in lymphocytes of anatomy students exposed to formaldehyde-embalming solution. Mutation Research 174(2):135-139.			
HERO ID:	626642			
Conditions of Use:	Embalming			
Domain		Metric		EVALUATION
				Rating
		Metric 7: Metadata Completeness		High
		The study addresses variability by including weekly data to evaluated range of values uncertainty can be determined from the sampling and analytical method.		
Overall Quality Determination				High

Study Citation:	Yahaya, R., Arif, H. M., Kamel, M., S.N. (2012). Preliminary study on indoor air quality (IAQ) on a royal Malaysian navy (RMN) ship. Defence S&T Technical Bulletin 5(1):11-20.			
HERO ID:	6032735			
Conditions of Use:	Malaysian Naval ship (could be combination of paints and coatings, fuels and related products via diesel engines, or building and construction materials)			
EXTRACTION				
Parameter	Data			
Number of sites:	12 locations in one ship			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Data presented graphically in Figure 3 (pg 6); rooms 2-3 exceeding limit of 0.1 ppm (pg 5)			
Comments:	Sampling location: Rooms 1-9, and the dining hall, kitchen and bridge. 75 to 120 cm from the floor at the centre of the rooms as per the guidelines set by DOSH (2010) (pg 2)Sampling/analytical method: Formaldemeter™ htV HCHO meter (PPM Technology Ltd.); HCHO meter uses electrochemical sensing technology to measure airborne HCHO concentrations. It collects single air samples upon initiation by the user, employs a sampling frequency of 1-3 min, and analyses the samples within 60 s. (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Malaysia, a non-OECD country.
	Metric 3:	Applicability	Medium	Data are for a naval ship, which may encompass multiple in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively (graphically).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low		

Study Citation:	Yale University, (1984). A retrospective follow-up study of mortality in anatomists with cover sheet and letter dated 031885. 85022064:#60-85022064.			
HERO ID:	5901017			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Embalmers, FA production workers, pathologists, particle board and plywood makers, and textile workers.			
Exposure route:	inhalation			
Physical form:	vapor, gas			
Area sampling data:	Airborne concentrations of FA in anatomy labs range between 1-3 ppm and where cadavers are stored 14 ppm and 31 ppm have been measured. Pathologists were exposed up to 3 ppm while autopsy technicians were exposed up to 1 ppm while performing general autopsy duties.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Data is TSCA submission overseen and conducted by Yale University and published by US Department of Health and Human Services so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is applicable to lab and anatomy uses of FA.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1984)
	Metric 5:	Sample Size	Medium	Characterized by range of data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type and exposure type, but lacks additional metadata, such as sample durations, exposure durations, and/or exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by comparing different areas but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Yamato, H., Nakashima, T., Kikuta, A., Kunugita, N., Arashidani, K., Nagafuchi, Y., Tanaka, I. (2005). A novel local ventilation system to reduce the levels of formaldehyde exposure during a gross anatomy dissection course and its evaluation using real-time monitoring. Journal of Occupational Health 47(5):450-453.			
HERO ID:	1513951			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Personal sampling data:	50 (ppb)			
Area sampling data:	405 (ppb)			
Engineering control:	Local exhaust ventilation operating at a rate of 14,800 m^3/hr (10.6 air changes/hr)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Japan is an OECD member country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Data published in 2005. More than 10 but less than 20 years old.
	Metric 5:	Sample Size	High	Real time monitoring results provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Description of activities and durations indicated on real-time monitoring results.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Yan, J., Liu, Y. S., Lu, Z. S., Chi, X., Yang, X., Zhang, B. Y. (2005). Air formaldehyde exposure and DPC in buccal cells of undergraduate students. :3593-3597.			
HERO ID:	5937677			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Medical students participating in an anatomy course			
Physical form:	Vapor from formalin (35-40% solution)			
Area sampling data:	Concentrations in lab ranged from 0.42 to 1.57 mg/m3			
Exposure frequency:	6 hr/week			
Number of workers:	37 medical students			
Engineering control:	Ventilation system			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by samples collected multiple times over the course of an hour and in different rooms.
Overall Quality Determination		Medium		

Study Citation:	Yang, T.T., Chuang, K.J., Chang, N.Y., Pan, C.H., Liao, W.H., Liao, C.C., Tsuang, Y.H., Wen, H.Y., Hsiao, T.C., Chuang, H.C. (2018). Exposure assessment of particulate and gaseous pollutants emitted during surgery in operating rooms of different specialties. Air Quality, Atmosphere and Health 11(8):937-947.			
HERO ID:	5954417			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	""""Nine specialty ORs were investigated in the present study: outpatient surgery, otolaryngology, gynecology, orthopedics, face and dentistry, cardiac surgery, gastroenterology, neurosurgery, and urology."" (2/11)"			
Exposure route:	inhalation (2/11)			
Physical form:	Surgical Smoke (1/11)			
Area sampling data:	"Nursing station: 0.00 ± 0.00 ppm Outpatient surgery: 0.52 ± 0.65 ppm Otolaryngology: 0.00 ± 0.01 ppm Gynecology: 0.03 ± 0.20 ppm Orthopedics: 0.03 ± 0.15 ppm Face and dentistry: 0.01 ± 0.06 ppm Cardiac surgery: 0.01 ± 0.06 ppm Gastroenterology: 0.80 ± 0.50 ppm Neurosurgery: 0.70 ± 0.70 ppm Urology: 0.90 ± 0.51 ppm (5/11)"			
Exposure duration:	8 hours/day for 30 years (4/11)			
Exposure frequency:	5 days/week, 260 days/year (4/11)			
Number of workers:	""""The Occupational Safety and Health Administration (OSHA) in the USA estimates that 500,000 US workers are exposed to surgical smoke annually (OSHA 2003), and many health care professionals are chronically exposed to surgical smoke."" (2/11)"			
Personal protective equipment:	"Higher levels of personal protective equipment are a second line of respiratory protection against particulate pollutants."(9/11)			
Engineering control:	"The US National Institute for Occupational Safety and Health (NIOSH) recommends the use of smoke evacuation and filtering systems to reduce exposure to surgical smoke (NIOSH 1998)." (2/11)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at nine different specialty operations in the OR.
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Formaldehyde

Occupational Exposure

HERO ID: 5954417 Table: 1 of 1

...continued from previous page

Study Citation:	Yang, T.T., Chuang, K.J., Chang, N.Y., Pan, C.H., Liao, W.H., Liao, C.C., Tsuang, Y.H., Wen, H.Y., Hsiao, T.C., Chuang, H.C. (2018). Exposure assessment of particulate and gaseous pollutants emitted during surgery in operating rooms of different specialties. Air Quality, Atmosphere and Health 11(8):937-947.		
HERO ID:	5954417		
Conditions of Use:	Laboratory Chemical		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Yau, Y.H., Poh, K.S., Badarudin, A. (2018). An investigation of thermal environment of an existing UFAD system in a high-rise office building in the tropics. Journal of Environmental Health Science & Engineering 16(2):313-322.			
HERO ID:	6183103			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office workers in a 10-year-old 55-stories skyscraper office tower in Malaysia. Floors studied were 33, 34, and 35.			
Exposure route:	Inhalation			
Area sampling data:	Formaldehyde concentrations (in ppm) measured in the office spaces in different floors were: Level 33N – max - 0.30, min - 0.21, average - 0.26; Level 33S – max - 0.29, min - 0.23, average - 0.27; Level 34N – max - 0.37, min - 0.32, average - 0.34; Level 34S – max - 0.18, min - 0.13, average - 0.15; Level 35S – max - 0.28, min - 0.24, average - 0.25. In all cases, formaldehyde concentrations exceeded the threshold limit of 0.1 ppm. The bias uncertainty for formaldehyde concentrations are in the ranges of 7–17%. These results suggested that non-uniform formaldehyde distributions were present during the field work testing. Again, this can be traced to the fact that uneven air distributions were present for all zones examined.			
Engineering control:	It was recommended that HVAC systems should be turned off during the air flushing as a higher temperature can effectively enhance the formaldehyde emission and remove it from the office space.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	Medium	data are for background exposure to office workers which may be useful for risk evaluation
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Discusses variability and uncertainty
Overall Quality Determination		Medium		

Study Citation:	Ye, X., Yan, W., Xie, H., Zhao, M., Ying, C. (2005). Cytogenetic analysis of nasal mucosa cells and lymphocytes from high-level long-term formaldehyde exposed workers and low-level short-term exposed waiters. Mutation Research 588(1):22-27.			
HERO ID:	626654			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	Eighteen workers, 11 males and 7 females, from a FA factory with occupational exposure to FA vapors during formaldehyde manufacturing process for 1–15 years (mean 8.5 years) were employed as workers group and four waiters and 12 waitresses working in a newly fitted ballroom as waiters group who were exposed to indoor air FA from building materials, tobacco smoking, and furniture			
Personal sampling data:	0.985 (mg/m^3) see table 2			
Number of workers:	34 see table 1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years old. (1992)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing worker activity description, PPE, engineering control.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Yee, K.K., Wilson, T., McDermott, R., Pribitkin, E.A., Rosen, D., Maute, C., Dalton, P. (2009). Nasal biopsy assessment of veterinary students exposed to formaldehyde in anatomy class. Chemical Senses 34(7):A101.			
HERO ID:	5948637			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Exposure to formaldehyde in gross anatomy class from formalin preserved cadavers is a health concern to both staffs and students.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	0.15-2.15 ppm			
Exposure duration:	Exposure duration: 4 hrs/day			
Exposure frequency:	Exposure frequency: 4 days/week for 20 weeks.			
Number of workers:	15 students and 13 controls			
Comments:	Sampled with 3M badges			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Yousefi, V. (1998). Formaldehyde levels in embalmers and personnel in anatomy and pathology departments. SAMJ South African Medical Journal 88(9):1056.			
HERO ID:	5937067			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Personal sampling data:	Personal monitoring of formaldehyde exposure of embalmers revealed concentrations ranging from 3 ppm (Cape Town) through to 8.36 ppm (Johannesburg) and 9.6 ppm (Durban). In the anatomy and pathology laboratories (Johannesburg) concentrations ranged from 1.87 ppm to more than 4 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from South Africa, a non-OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Report from 1998.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing sample durations, exposure duration, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by collecting samples at multiple sites, but uncertainty is not addressed.
Overall Quality Determination			Low	

Study Citation:	Zarei, F., Azari, M.R., Salehpour, S., Khodakarim, S., Omid, L., Tavakol, E. (2017). Respiratory effects of simultaneous exposure to respirable crystalline silica dust, formaldehyde, and triethylamine of a group of foundry workers. Journal of Research in Health Sciences 17(1):E1-E6.			
HERO ID:	3863942			
Conditions of Use:	foundry - core making (substances in metal products)			
EXTRACTION				
Parameter	Data			
Personal sampling data:	mean 2.91 ppm Range 0.41 to 6.47ppm			
Number of workers:	55 foundry workers			
Comments:	The concentrations of formaldehyde and triethylamine were measured using a PID instrument.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Iran, a non-OECD country.
	Metric 3:	Applicability	High	Data are for substances in metal products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata. Health metric were provided (e.g., smoking, BMI, age).
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology but variability is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 4154227 Table: 1 of 1

Study Citation:	Zendehdel, R., Abdolmaleki, P., Jouni, F.J., Mazinani, M. (2017). Genetic variation and risk of DNA damage in peripheral blood lymphocytes of Iranian formaldehyde-exposed workers. Human & Experimental Toxicology 37(7):960327117728385.			
HERO ID:	4154227			
Conditions of Use:	Processing as a Reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers in melamine dinnerware workshops.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	The median of subchronic inhalation intake was 4.73 ppm with a minimum and maximum value of 0.17 and 84.48 ppm, respectively.			
Area sampling data:	Airborne exposure concentration for formaldehyde in the exposed group ranged from 0.033 ppm to 0.14 ppm, with a median of 0.08 ppm.			
Exposure duration:	8 hr/day			
Exposure frequency:	240 days/yr			
Number of workers:	54 workers from melamine dinnerware workshops (exposed) and 34 workers from dairy production workshops (control).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Iran, a non-OECD country.
	Metric 3:	Applicability	High	Data are for plastic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (median, range, maximum, minimum) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sample durations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at 4 sites and using matched controls.
Overall Quality Determination		High		

Study Citation:	Zendehdel, R., Fazli, Z., Mazinani, M. (2016). Neurotoxicity effect of formaldehyde on occupational exposure and influence of individual susceptibility to some metabolism parameters. Environmental Monitoring and Assessment 188(11):648.			
HERO ID:	4453129			
Conditions of Use:	Plastic material and resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Melamine-dish preparation			
Exposure route:	Inhalation			
Personal sampling data:	According to personal monitoring, the median concentration of formaldehyde in MDP workers was 0.057 ppm (between 0.17 to 0.734 ppm). The median of airborne exposure values in pressing workers was 0.06 ppm, which is 1.5 times higher than the assembly groups (0.04 ppm).			
Number of workers:	35			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH method. (NIOSH 3500)	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Switzerland, an OECD country.	
	Metric 3: Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old. (2016)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Sample type and exposure type provided but missing PPE, engineering controls.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology and variability is addressed by comparing pressing workers and assembly workers.	
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 4455631 Table: 1 of 1

Study Citation:	Zendehdel, R., Jouni, F.J., Hajipour, B., Panjali, Z., Kheiri, H., Vahabi, M. (2017). DNA damage in workers exposed to formaldehyde at concentrations below occupational exposure limits. Toxicological and Environmental Chemistry 99(9-10):1409-1417.			
HERO ID:	4455631			
Conditions of Use:	Plastic material and resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Heating and compressing melamine-formaldehyde resin (pg 3)			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Full shift TWA: 0.02-0.22 mg/m3; median of 0.086 mg/m3			
Number of workers:	49 (one sample per worker; pg 4)			
Comments:	NIOSH Method 3500 (pg 4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved NIOSH (Method 3500) method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Iran, a non-OECD country
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing (melamine), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with median, but other statistics uncertain.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple workshops, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5949744 Table: 1 of 1

Study Citation:	Zendehdel, R., Vahabi, M., Sedghi, R. (2018). Estimation of formaldehyde occupational exposure limit based on genetic damage in some Iranian exposed workers using benchmark dose method. Environmental Science and Pollution Research 25(31):31183-31189.			
HERO ID:	5949744			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Life cycle description:	Melamine FA tableware workshops - dinnerware.			
Worker activity description:	Production of melamine dinnerware. Pressing of resin.			
Exposure route:	inhalation, dermal			
Physical form:	powder			
Personal sampling data:	Range from 0.04 mg/m^3 (0.032 ppm) to 0.17 mg/m^3 (0.14 ppm) w/ median of 0.1 mg/m^ (0.08 ppm).			
Comments:	NIOSH-3500 method with benchmark dose approach.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Source appears to use a high quality sampling method and is peer reviewed.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is from Iran, a non-OECD country.
	Metric 3:	Applicability	High	Data is applicable to use of FA resin in the formulation of an article.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes physical form, worker activity, COU, exposure route and personal sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by sampling over different seasons (winter and summer). Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Zey, J. N. (1985). Health hazard evaluation report: HETA-85-085-1615 - Wyoming High School, Wyoming, Ohio.			
HERO ID:	1357860			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	TeachersStudents			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	NIOSH I.H. observation of activities NDTeacher 1 NDTeacher 1 NDTeacher 2 NDTeacher 2 NDTeacher 3 NDStudent ND			
Area sampling data:	Biology Room 1, cat dissection 2 ppmBiology Room 2, earthworm dissection 0.5 ppmBiology Room 1, pig dissection (12 pigs) 4 ppmBiology Room 1, pig dissection (12 pigs) 4 ppmBiology Room 2, sheep brain dissection 1 ppmBiology Room 1, dissection of fetal pig 1.5 ppmBiology Room 1, cat dissection, breathing zone sample 7 ppmBiology Room 1, cat dissection, breathing zone sample 7 ppmBiology Room 1, cat dissection, breathing zone sample 7 ppmIn Hallway, 15' from biology rooms 0.3 ppm			
Exposure duration:	8 periods - 40 minutes each: up to 10 hours per day			
Exposure frequency:	40 hours per week			
Number of workers:	500 students plus teachers			
Personal protective equipment:	Recommended:Protective gloves			
Engineering control:	local exhaust engineering is an alternative but would be less desirable based on building layout, maintenance requirements and economics.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH study - Method 354
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	1984 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Monitoring data include all associated metadata, including sample types, exposure types, sampledurations, exposure durations worker activities, and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations/jobs. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
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Formaldehyde

Occupational Exposure

HERO ID: 1357860 Table: 1 of 1

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Study Citation:	Zey, J. N. (1985). Health hazard evaluation report: HETA-85-085-1615 - Wyoming High School, Wyoming, Ohio.		
HERO ID:	1357860		
Conditions of Use:	Laboratory Use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Zey, J. N., Anderson, K. E. (1985). Health Hazard Evaluation Report: HETA-84-466 and HETA-85-17-1640 - Federal Aviation Administration Facilities: Philadelphia, Pennsylvania and Westbury, New York.			
HERO ID:	1317844			
Conditions of Use:	Unknown			
EXTRACTION				
Parameter	Data			
Worker activity description:	Air traffic control specialists are given responsibility for aircraft that enter their sector. This action is called "handing off". The pilot identifies his aircraft to the TRACON controller who monitors it via a flash of light (blip) on his radar screen. Each blip is accompanied across the radar screen by an alpha-numeric tag supplied by a central computer which contains the plane identification, altitude and speed. The controller monitors the aircraft's relationship to other aircraft and issues instructions to the pilot concerning direction of flight and clearance for altitude changes.			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Philadelphia International AirportAll below limit of detection, therefore at minimumTower cab <0.5 ppmTRACON room <0.5 ppmLaGuardia Station >0.5 ppm			
Number of workers:	Philadelphia 140 (5-6 Tower Cab and 10-12 in the RACON room at any given time)NY TRACON 400 (35-40 air traffic control room)			
Engineering control:	Modify HVAC system to allow for outdoor air supply all year round			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Methodology is assumed to be an approved NIOSH method based on use by NIOSH IH.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Low	The data are for an occupational scenario (air traffic controller) but the source of formaldehyde or whether there is a source of formaldehyde is unclear. The report does indicate the use of lit cigarettes in table 3 and 4, which is outside of the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1984 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Medium	Multiple samples taken but samples are reported below limit of detection.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include most critical metadata, such as sample type and exposure type, and worker activities, but lacks additional metadata, such as sample durations, exposure durations, and exposure frequency. In addition, there is an inconsistency between the report where it indicates all samples were below the limit of detection (0.5ppm) but table 2 reports >0.5ppm
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual sampling events were provided which could be used to evaluate variability between locations. As this is a NIOSH study, it is assumed that uncertainty was considered in the Methods.
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Formaldehyde

Occupational Exposure

HERO ID: 1317844 Table: 1 of 1

...continued from previous page			
Study Citation:	Zey, J. N., Anderson, K. E. (1985). Health Hazard Evaluation Report: HETA-84-466 and HETA-85-17-1640 - Federal Aviation Administration Facilities: Philadelphia, Pennsylvania and Westbury, New York.		
HERO ID:	1317844		
Conditions of Use:	Unknown		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 4038955 Table: 1 of 1

Study Citation:	Zey, J. N., Todd, W. F. (1987). Health Hazard Evaluation Report HETA 85-308-1829, Kardon Industries, St. Paris, Ohio, September 1987.			
HERO ID:	4038955			
Conditions of Use:	Thermal decomposition product- Packaging			
EXTRACTION				
Parameter	Data			
Worker activity description:	Some worker activities noted are operators filling melt tanks, and maintenance and cleaning of the machines (11/19)			
Exposure route:	inhalation (11/19)			
Physical form:	gas/vapor (11/19)			
Area sampling data:	Formaldehyde was found on all field samples in the 1-5 ug range which correlated to 0.08 to 0.5 mg/m3.			
Exposure duration:	3 shifts per day			
Number of workers:	100 hourly			
Engineering control:	Site Engineering Controls: Local ventilation hoods located adjacent to the two duplex spray head operations. Another local ventilation hood is located near the top of a conveyor which carries tubes to the inspection table. Total exhaust flow is 1270 CFM.NIOSH recommendations: Improve ventilation systems install wax filter to control wax build up straight blade or backwards curved blade fan would be less susceptible to wax build upreduce the number of sharp bends in the ventilation systemextend the wax spraying hood to better loss from convection of hot wax.Install a slot hood over the inspection table and increase air flow.Automate the wax transfer process.Safety interlocks should be installed on the plexiglass shields located on each side of the auto wax machine.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	NIOSH Study, so therefore method is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (cardboard tube manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1986 - prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by a range. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data include sample type, exposure duration but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study does not address variability. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination		Medium		

Study Citation:	Zhang, L., Chung, F.L., Boccia, L., Colosimo, S., Liu, W.L., Zhang, J.F. (2003). Effects of garage employment and tobacco smoking on breathing-zone concentrations of carbonyl compounds. AIHA Journal 64(3):388-393.			
HERO ID:	2814079			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Worker activity description:	The garage workers included mechanics, garage managers and owners, and other technical staff working in automobile garages.			
Exposure route:	inhalation			
Personal sampling data:	Average formaldehyde breathing zone concentrations (ug/m3): garage worker smoker – 40.6 +/- 13.4; garage worker nonsmoker – 41.1 +/- 13.7; non-garage worker smoker – 34.6 +/- 8.65; non-garage worker nonsmoker – 30.2 +/- 9.48. The concentrations ranged from 14.1 to 80.1 ug/m3 for formaldehyde. In comparing the garage workers and the controls, it was found that the formaldehyde concentrations for the garage workers were 17 and 36% higher than for the controls in the smokers and nonsmokers, respectively.			
Number of workers:	37 subjects including 22 garage workers (9 smokers and 13 nonsmokers) and 15 nongarage workers or so-called controls (4 smokers and 11 nonsmokers).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	Medium	The data are for an occupational scenario within the scope but exposures may be aggregated with conditions outside of the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	data between 10 and 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The monitoring study addresses variability in the determinants of exposure but no discussion on uncertainties
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 626661 Table: 1 of 1

Study Citation:	Zhang, L., Steinmaus, C., Eastmond, D.A., Xin, X.K., Smith, M.T. (2009). Formaldehyde exposure and leukemia: A new meta-analysis and potential mechanisms. Mutation Research: Reviews in Mutation Research 681(2-3):150-168.			
HERO ID:	626661			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	Katrina trailers up to 1.2 ppm; Testing from Dec 2007-Jan 2008 average 0.077 ppm, peaking at 0.59 ppm			
Comments:	HUD limits the use of plywood particleboard that conforms to the 0.4 ppm formaldehyde emission limit in the construction of prefabricated and mobile homes (pg. 4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (report published 2009) after the most recent PEL (1992) establishment and is more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Monitoring data did not include critical metadata, such as sample type, sample durations, exposure durations, exposure frequency, and worker activities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Zhang, L., Tang, X., Rothman, N., Vermeulen, R., Ji, Z., Shen, M., Qiu, C., Guo, W., Liu, S., Reiss, B., Freeman, L.B., Ge, Y., Hubbard, A.E., Hua, M., Blair, A., Galvan, N., Ruan, X., Alter, B.P., Xin, K.X., Li, S., Moore, L.E., Kim, S., Xie, Y., Hayes, R.B., Azuma, M., Hauptmann, M., Xiong, J., Stewart, P., Li, L., Rappaport, S.M., Huang, H., Fraumeni, J.F., Smith, M.T., Lan, Q. (2010). Occupational exposure to formaldehyde, hematotoxicity, and leukemia-specific chromosome changes in cultured myeloid progenitor cells. Cancer Epidemiology Biomarkers and Prevention 19(1):80-88.
HERO ID:	626137
Conditions of Use:	Processing

EXTRACTION	
Parameter	Data
Exposure route:	inhalation
Physical form:	Vapor
Personal sampling data:	1.28 ppm 8 hr TWA median (10th percentile 0.63 / 90th percentile 2.51)
Exposure duration:	a full shift for 3 days over a 3 week period
Number of workers:	43 exposed workers and 51 unexposed workers (controls)

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium
			Sampling/analytical methodology is not specified though it was noted that UME 100 diffusion samplers ; analysis using gas chromatography–mass spectroscopy methods were used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low
	Metric 3:	Applicability	Medium
			Data are for formaldehyde resin production and plastic manufacture, are in-scope occupational scenarios. Unfortunately the data were merged so the different uses could not be differentiated
	Metric 4:	Temporal Representativeness	Medium
			Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2010 but the monitoring data were from 2006
	Metric 5:	Sample Size	Medium
			Sample distribution characterized by limited statistics (mean, 10th and 90th percentile of the median values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium
			Sample type and exposure type provided but data for the two different facilities not reported separately. Missing: sampling/ analysis methods, number of samples, worker activities, exposure frequency, and sampling location.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low
			The monitoring study does not address the variability or uncertainty of the exposure measurements.

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Formaldehyde

Occupational Exposure

HERO ID: 626137 Table: 1 of 1

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Study Citation:		Zhang, L., Tang, X., Rothman, N., Vermeulen, R., Ji, Z., Shen, M., Qiu, C., Guo, W., Liu, S., Reiss, B., Freeman, L.B., Ge, Y., Hubbard, A.E., Hua, M., Blair, A., Galvan, N., Ruan, X., Alter, B.P., Xin, K.X., Li, S., Moore, L.E., Kim, S., Xie, Y., Hayes, R.B., Azuma, M., Hauptmann, M., Xiong, J., Stewart, P., Li, L., Rappaport, S.M., Huang, H., Fraumeni, J.F., Smith, M.T., Lan, Q. (2010). Occupational exposure to formaldehyde, hematotoxicity, and leukemia-specific chromosome changes in cultured myeloid progenitor cells. Cancer Epidemiology Biomarkers and Prevention 19(1):80-88.		
HERO ID:		626137		
Conditions of Use:		Processing		
Domain		Metric		EVALUATION
				Rating
Overall Quality Determination				Low
				Comments

Formaldehyde

Occupational Exposure

HERO ID: 5955419 Table: 1 of 1

Study Citation:	Zhang, S., Song, F., Gao, Q., Li, J. (2011). Preparation and properties of low formaldehyde emission plywood with flame resistance. Advanced Materials Research Volume 139-141:649-652.			
HERO ID:	5955419			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation(1/4)			
Physical form:	vapor (1/4)			
Area sampling data:	All of the treated plywood had about 0.1-0.3 mg/L formaldehyde emission value, while the untreated plywood had a 3.33 mg/L value. (2/4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the use of wood products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Zhao, M., Kim, Y.S., Srebric, J. (2015). Occupant perceptions and a health outcome in retail stores. Building and Environment 93:385-394.			
HERO ID:	3023019			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	Retail employees			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	FA concentrations ranged from 2.6 +/- 0.3 ppb to 66.9 +/- 8.3 ppb. Mean FA conc was 18.1 +/- 13.8 ppb and the median was 14.5 ppb.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Unclear if source is peer reviewed but likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data sampling is based out of the US.
	Metric 3:	Applicability	Low	The data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Only specified worker activity and provided sampling data, exposure route and physical form are inferred.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Zhong, L., Batterman, S., Milando, C. W. (2018). VOC sources and exposures in nail salons: a pilot study in Michigan, USA. International Archives of Occupational and Environmental Health 92(1):141-153.			
HERO ID:	4863077			
Conditions of Use:	Personal care products (nail salons)			
EXTRACTION				
Parameter	Data			
Number of sites:	129,682 nail salons in US, 3300 in Michigan (pg 1); 17 nail salons studied (pg 2)			
Worker activity description:	final sample included 15 nail polishes (lacquers that decorate and protect the nail), 4 top coats (varnishes that preserve the polish), 7 base coats (varnishes that help the polish adhere to the nail), 2 nail powders (components of artificial nails), 5 monomers (components of artificial nails), 1 nail polish remover, and 1 cuticle oil (moisturizes the cuticle, skin and nail) (pg 3)			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	short term, 30-60 min (pg 3): non-detect (Table 1, pg 6)			
Area sampling data:	short term, 30-60 min (pg 3): <6-40 μg/m3, median of 6 μg/m3, mean of 10 μg/m3 (Table 1, pg 6)			
Personal protective equipment:	About a third of the NSTs wore non-filtering surgical masks; and somewhat fewer wore gloves, otherwise, no other personal protective equipment (PPE) was used (pg 5)			
Engineering control:	Ventilation parameters in Table 2 (pg 9)			
Comments:	analysis via GC/MS (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Nail products for both home and salon use are regulated by the Food and Drug Administration. Under the Federal Food, Drug, and Cosmetic Act (FD&C Act), these products are generally regulated as cosmetics [FD&C Act, section 201(i)].
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range, mean, median) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample type and exposure type provided but missing metadata like number of workers, exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at multiple sites and in multiple seasons, but uncertainty is not addressed.
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Formaldehyde

Occupational Exposure

HERO ID: 4863077 Table: 1 of 1

...continued from previous page

Study Citation:	Zhong, L., Batterman, S., Milando, C. W. (2018). VOC sources and exposures in nail salons: a pilot study in Michigan, USA. International Archives of Occupational and Environmental Health 92(1):141-153.		
HERO ID:	4863077		
Conditions of Use:	Personal care products (nail salons)		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Zhou, C., Zeng, Y. (2013). Optimization research on ventilation modes of anatomy laboratory. Applied Mechanics and Materials 353-356:3044-3048.		
HERO ID:	5951516		
Conditions of Use:	Laboratory chemicals		
EXTRACTION			
Parameter	Data		
Area sampling data:	No experimental course (mg/m3): Laboratory (0.243~0.677), Lab Corridor (0.116~0.368), Offices (0.068~0.200)Experimental course (mg/m3): Laboratory (0.620~1.528), Lab Corridor (0.198~0.432), Offices (0.112~0.288)		
Engineering control:	Ventilation/exhaust of room air as shown in Table 2		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Sampling and Analytical Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Data less than 10 years old.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Monitoring data include sample type (e.g., personal breathing zone) but no other meta-data.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty.
Overall Quality Determination		Low	

Study Citation:	Zielinska, B., Fujita, E., Ollison, W., Campbell, D., Sagebiel, J. (2012). Quantification of personal exposure concentrations to gasoline vehicle emissions in high-end exposure microenvironments: effects of fuel and season. Journal of the Air and Waste Management Association 62(11):1346-1357.			
HERO ID:	1641371			
Conditions of Use:	Combustion Byproduct			
EXTRACTION				
Parameter	Data			
Area sampling data:	Figures 3 and 4 contains in-cabin formaldehyde exposure concentrations			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	Medium	EPA review of information indicates the methodology is acceptable. Differences in methods are not expected to lead to lower quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US Data
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Article was published in 2012 and is less than 10 years old.
	Metric 5:	Sample Size	High	Real time data is presented in one-minute time series.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data indicate sample type and sample duration, but no other meta data is included.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study discusses seasonal differences as a source of variability, but does not address uncertainty.
Overall Quality Determination			High	

Study Citation:	Zimmer, A. T., Hadwen, G. (1993). HETA 92-287-2294 March 1993 Federal Records Center, Dayton, Ohio.			
HERO ID:	8095556			
Conditions of Use:	Chemical substances in packaging, paper, plastic, and hobby products			
EXTRACTION				
Parameter	Data			
Worker activity description:	office workers at a records storage center; NIOSH believed most likely source of formaldehyde was carbonless copy paper			
Exposure route:	inhalation			
Physical form:	offgas			
Area sampling data:	Outside: 0.006 mg/m3Admin Area:0.011 mg/m3Archives Area:0.024 mg/m3Bay area D:0.034 mg/m3Valut Area:0.023 mg/m3*Outside: 0.006 mg/m3			
Number of workers:	70			
Engineering control:	NIOSH recommended increasing ventilation exchange rate (via HVAC system) and exhaust fans.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling and analytical is approved by NIOSH (NIOSH Method 3500).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The data are for an occupational scenario (Use of Paper Products) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data measured in 1992, more than 20 years ago and around the time of the most recent PEL establishment(~May 1992).
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Monitoring data include most critical metadata, such as sample type, worker activities, and exposure type, but lacks additional metadata, such as exposure durations and exposure frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The monitoring study addresses variability in the determinants of exposure for the sampled site by measuring different locations. The monitoring study addresses uncertainty in the exposure estimates in the 'results and discussion' section and additional uncertainty can be determined from the sampling and analytical method.
Overall Quality Determination			High	

Study Citation:	Zwack, L. M., Chiu, S., LeBouf, R. F. (2018). Evaluation of chemical exposures at two vape shops in texas.			
HERO ID:	8683492			
Conditions of Use:	Electronic cigarettes			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees hand-mixed custom e-liquid blends according to customer taste. They also refilled small bottles of nicotine, propylene glycol, and vegetable glycerin. (8/34) Employees and customers vaped inside the shop. (10/34) Employees reported that they cleaned floors, counters, displays, and the counter with cleaning agents including Clorox® wipes and sprays, Pine-Sol® surface cleaner, and glass cleaners.			
Exposure route:	inhalation (7/34)			
Physical form:	vapor (7/34)			
Personal sampling data:	Personal samples for formaldehyde ranged from 3.3-17 ppb. (Table 3) (14/34)			
Area sampling data:	Area samples for formaldehyde ranged from 3.4-17 ppb. (Table 4, specific locations are reported in the table) (14/34)			
Exposure duration:	Shift lengths were variable, with most employees working up to 10 hours, depending upon the day (7/34); Employees reported working a median of 42.5 hours per week (range: 36–50 hours). (16/34)			
Exposure frequency:	The shops were open from 10 a.m. to 8 p.m. Monday through Saturday. On Sunday, they were open from 12 p.m. to 5 p.m.			
Number of workers:	17 employees (7/34)			
Personal protective equipment:	The company provided employees with nitrile gloves for use when mixing e-liquids and when working with chemicals. (11/34) Closed toed shoes and long pants were also reported by employees. (17/34)			
Engineering control:	Ventilation in shop A was provided by two air handling units attached to the ceiling that delivered ducted supply air to the entire shop. Employees in the shop reported that they periodically changed the air handling unit filters. In shop B, supply air vents in the ceiling provided conditioned air. At both shops, we observed that the flavoring chemicals and nicotine used at the mixing counters were stored in secondary containers. (11/34)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling and Analytical Methodology	High	Sampling/analytical methodology is an approved OSHA method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Uninformative	Data are for electronic cigarettes, which isn’t in the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at multiple vape shops.
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Formaldehyde

Occupational Exposure

HERO ID: 8683492 Table: 1 of 1

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Study Citation:	Zwack, L. M., Chiu, S., LeBouf, R. F. (2018). Evaluation of chemical exposures at two vape shops in texas.
HERO ID:	8683492
Conditions of Use:	Electronic cigarettes

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		Uninformative	

Study Citation:	[Redacted] (2014). [Redacted] Prop 65 exposure risk assessment for formaldehyde in XXX.			
HERO ID:	10605388			
Conditions of Use:	Formulating semiconductor industry cleaning agents			
EXTRACTION				
Parameter	Data			
Worker activity description:	2 gal product spill and assume all FA is immediately released into 100 m3 room for 8 hr, worker remains (pg 2) Customers receive drums of product which are opened immediately prior to connecting to a chemical delivery system within a semiconductor MFG facility. Anticipated exposure is less than 5 minutes/day. The product is then further diluted 50:1 with water and then used inside enclosed and exhausted equipment. (pg 2)			
Exposure route:	inhalation			
Personal sampling data:	3 ug/m3 (pg 3)			
Exposure duration:	8 hours			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Model is peer-reviewed and free of mathematical errors, based on sound approaches/methods, and uses appropriate equations and parameters.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for processing into formulation, which is in-scope for multiple COUs	
	Metric 4: Temporal Representativeness	High	Model is based on current industry conditions and based on data no more than 10 years old.	
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent. Rationales for choice of approach, equations, and parameter values provided.	
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	Low	Variability and uncertainty are not addressed	
Overall Quality Determination		High		

Study Citation:	Chan, W.R., Parthasarathy, S., Fisk, W.J., Mckone, T.E. (2015). Estimated effect of ventilation and filtration on chronic health risks in U.S. offices, schools, and retail stores. Indoor Air 26(2):331-343.		
HERO ID:	2964715		
Conditions of Use:	Office Environment		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Area sampling data:	Table 4 provides predicted mean indoor concentrations of various VOCs: Formaldehyde (ug/m^3) - current VR: office - 12.6, school - 11.8, retail store - 25.0, grocery store - 9.6; VR/2: office - 22.3, school - 20.5, retail store - 47.1, grocery store - 16.0; VR 2x: office - 7.8, school - 7.4, retail store - 14.1, grocery store - 6.3. Figure 3 shows graphs of the percentage of building that would be above RfC guidelines.		
Exposure duration:	Office workers: 10 hrs/day; Teachers: 7 hrs/day; retail and grocery store workers: 10 hrs/day.		
Exposure frequency:	Office workers: 250 days, Teachers: 170 days; retail and grocery store workers: 250 days.		
Number of workers:	Workers in Offices: 41 million; Teachers in Schools: 4 million; Workers in Grocery: 2.5 million, Workers in Retail: 7.5 million workers.		
Engineering control:	Figure 2 provides measured air exchange rates (1/h) in offices, schools, retail stores and grocery stores. Offices range between ~0.5-1.0, mean ~0.8 median ~0.7. Schools had range ~0.25-0.5, mean & median ~0.45; Retail had range ~0.4-0.75, mean ~0.75, median ~0.5; Grocery stores had range ~0.8-1.2, mean ~1.0, median~0.9. Air exchange rates were calculated from ventilation rates however those numbers are not specifically listed. Model used assumed filter efficiencies between 20 to 80%."Minimum ventilation standards, for example, ASHRAE(2013) Standard 62.1 and the California Energy Com-mission Building Energy Efficiency Standards Title 24(CEC, 2013), specify VRs with the intention to main-tain acceptable IAQ in buildings(p.2)"		
Comments:	Contains supplemental document; Provides ventilation rates for commercial buildings		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Source is peer reviewed so model calculations are likely sound as well as appropriate parameters.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data is for US
	Metric 3: Applicability	Medium	Data is for commercial/consumer uses in offices, schools, retail and grocery stores. Could be applied to commercial scenarios or other buildings with similar ventilation or air exchange rates.
	Metric 4: Temporal Representativeness	High	Data is from 2015, so less than 10 years old.
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	High	Model approach, equations and parameter values are transparent and clear and can be evaluated. Rationale is provided for approach, equations and parameters.
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	Medium	Variability is addressed by testing across different indoor environments and at different ventilation rates. Does not address uncertainty. (Uncertainty is addressed in health risk in terms of years of life lost due to exposure but does not address uncertainty in model for airborne exposure.)
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Formaldehyde

Occupational Exposure

HERO ID: 2964715 Table: 1 of 1

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Study Citation:		Chan, W.R., Parthasarathy, S., Fisk, W.J., Mckone, T.E. (2015). Estimated effect of ventilation and filtration on chronic health risks in U.S. offices, schools, and retail stores. Indoor Air 26(2):331-343.		
HERO ID:		2964715		
Conditions of Use:		Office Environment		
Domain	Metric	EVALUATION		Comments
		Rating		
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 3603006 Table: 1 of 1

Study Citation:	Chen, H., Carter, K.E. (2017). Modeling potential occupational inhalation exposures and associated risks of toxic organics from chemical storage tanks used in hydraulic fracturing using AERMOD. Environmental Pollution 224:300-309.		
HERO ID:	3603006		
Conditions of Use:	”Processing aids, specific to petroleum production in: oil and gas drilling, extraction, and support activities and all other basic inorganic chemical manufacturing”		
EXTRACTION			
Parameter	Data		
Worker activity description:	Workers involved in hydraulic fracturing		
Exposure route:	Inhalation		
Area sampling data:	Average concentration of formaldehyde was less than 0.5 mg/m3. Details in Supplemental file indicate air dispersion concentrations based on the models used are listed. Emissions data are from Chen and Carter, 2017. (1.23, 7.09e-03, 4.54e+00 µg m-3)		
Comments:	Information in supplementary file.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The model is free of mathematical errors and is based on scientifically sound approaches or methods. Equations and choice of parameter values are appropriate for the model’s application.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The model can be appropriately applied to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	High	no more than 10 years old.
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent and clear and can be evaluated.
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	Medium	The model characterizes variability and but limited discussion on uncertainty in the results
Overall Quality Determination		High	

Study Citation:	Dimitroulopoulou, C., Trantallidi, M., Carrer, P., Efthimiou, G.C., Bartzis, J.G. (2015). EPHECT II: Exposure assessment to household consumer products. Science of the Total Environment 536:890-902.			
HERO ID:	2993418			
Conditions of Use:	Use of Cleaning and Furniture Care Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Only worker listed is a housekeeper.			
Exposure route:	inhalation			
Area sampling data:	[Modeled area concentration based on other cited study of emissions from chamber testing] Background exposure levels in private homes across Europe (ug/m^3): Northern Europe: min - 11, max - 45; Western Europe: min - 4, max - 57; Eastern Europe: min - 11, max - 41; Southern Europe: min - 7, max - 52; EU mean - 22. Table 6 provides exposure levels for housekeepers using products such as all purpose cleaners, electric air fresheners, and perfumes (ug/m^3): 24-h mean conc - 10, <1, <1 (0.5 ach), max 30-min conc - 33, <1, 16 (0.5 ach); 24-h mean conc - 19, <1, 1 (0.1 ach); max-30 min conc - 60, <1, 28 (0.1 ach). Figures 3A and 4A provides graphical data of 24 h exposure stated in the tables.			
Exposure duration:	6			
Exposure frequency:	250			
Engineering control:	Ventilation rates of 0.3, 0.35, 0.5 and 0.75 ach were used depending on the regional data in Europe.			
Comments:	Exposure duration listed in Table 3. Frequency is assumed to be daily. Table 7 provides the same data but prioritizes exposure to retirees: 24 hour mean conc (0.5 ach) - 3, 1, 2, 2, <1; Max 30-min conc - 20, 6, 16, 11, 6; 24-h mean conc (0.1 ach) - 7, 2, 6, 4, 2; Max 30-min conc (0.1 ach) - 21, 7, 16, 11, 12 (consumer exposure)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Model is published an peer-reviewed journal, and appears scientifically sound.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data is for EU and various OECD countries such as Sweden, Germany, Denmark, France, UK, Spain, Greece and Czech Republic.	
	Metric 3: Applicability	High	The model, CONC-CPM, can be used for occupational exposure scenarios within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The model is based on operations, equipment, and worker activities expected to be representative of current conditions. The model is based on data that are generally no more than 10 years old.	
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	Medium	Includes exposure type, exposure route, ventilation rates, worker activity, exposure duration and frequency.	
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	High	Addresses variability by looking at ventilation rates and data across multiple European countries. Addresses uncertainty by comparing with alternative model.	
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Formaldehyde

Occupational Exposure

HERO ID: 2993418 Table: 1 of 1

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Study Citation:	Dimitroulopoulou, C., Trantallidi, M., Carrer, P., Efthimiou, G.C., Bartzis, J.G. (2015). EPHECT II: Exposure assessment to household consumer products. Science of the Total Environment 536:890-902.		
HERO ID:	2993418		
Conditions of Use:	Use of Cleaning and Furniture Care Products		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Fiserova-Bergerova, V., Pierce, J.T., Droz, P.O. (1990). Dermal absorption potential of industrial chemicals: Criteria for skin notation. American Journal of Industrial Medicine 17(5):617-635.			
HERO ID:	32206			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	dermal			
Physical form:	liquid			
Dermal exposure data:	Dermal exposure data			
Comments:	This data source also contains a discussion of the relationship of dermal and inhalation exposure of a chemical.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The equation and choice of parameters are not fully described but are referenced.	
Domain 2: Representativeness	Metric 2: Geographic Scope	N/A	the data need not be geographically specific, dermal rate of absorption does not vary by region.	
	Metric 3: Applicability	High	The model pertains to dermal exposure to a chemical in a saturated aqueous solution and is presumably relevant to the the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The date of the reference for the model is 1987 and presumably improved models have been developed since then.	
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent and clearand can be evaluated. Rationale for selection of approach, equations, and parameter values isprovided.	
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	High	The model characterizes variability and uncertainty in the results, by including the actual data points for recalculated and measured values and the uncertainty of the regression analysis.	
Overall Quality Determination		High		

Study Citation:	Frasch, H.F., Bunge, A.L. (2015). The transient dermal exposure II: post-exposure absorption and evaporation of volatile compounds. Journal of Pharmaceutical Sciences 104(4):1499-1507.			
HERO ID:	3230538			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	dermal			
Physical form:	Liquid			
Comments:	Model is good for transient exposures and skin contact of a finite dose such as a splash exposure and pharmaceutical and cosmetic product applications.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Model is peer reviewed and is mathematically sound with no errors.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data is for US.	
	Metric 3: Applicability	High	Model can be applied to any type of dermal exposure as long as it is contact with skin of a volatile or semi-volatile compound of which formaldehyde falls into volatile.	
	Metric 4: Temporal Representativeness	High	Model is less than 10 years old.	
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent and clear and can be evaluated. Rationale for selection of approach, equations and parameter values are provided.	
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	Medium	Addresses variability by testing model on various chemicals, does not address uncertainty.	
Overall Quality Determination		High		

Study Citation:	Hauptmann, M., Stewart, P.A., Lubin, J.H., Freeman, L.E., Hornung, R.W., Herrick, R.F., Hoover, R.N., Fraumeni, J.F., Blair, A., Hayes, R.B. (2009). Mortality from lymphohematopoietic malignancies and brain cancer among embalmers exposed to formaldehyde. Journal of the National Cancer Institute 101(24):1696-1708.
HERO ID:	626498
Conditions of Use:	Embalming

EXTRACTION	
Parameter	Data
Worker activity description:	embalming
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	exposure was linked to earlier study Cincinnati College of Mortuary Sciences This was validated and a model was developed to estimate geometric mean = $\exp(1.976 - 0.092 x_1 - 0.488 x_2 - 0.894 x_3 + 0.4592/2)$, where x_1 is the number of air changes per hour, x_2 is equal to 1 for an intact corpse and 0 for an autopsied corpse, and x_3 is equal to 1 if no spill and to 0 if a spill occurred, and 0.4592/2, which was used to estimate the arithmetic mean, is one half of the variance. The model explained 74% of the variability. An additional model was developed to estimate peak exposure which ranged from 3.7-12.3 ppm.
Exposure duration:	duration ,1, 1-2 >2 or >3 hrs; Frequency of spills >1 per week, few per month, few per year, never
Number of workers:	6808 embalmers and funeral directors

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Model is peer-reviewed and free of mathematical errors, based on sound approaches/methods, and uses appropriate equations and parameters.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Article published in 2009, interviews held 1990-1992
Domain 3: Accessibility/ Clarity	Metric 5:	Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent. Rationales for choice of approach, equations, and parameter values provided.
Domain 4: Variability and Uncertainty	Metric 6:	Metadata Completeness	High	Uncertainty is addressed by though the regression analysis; Variability addressed by a sensitivity analysis of key parameters.

Overall Quality Determination

High

Study Citation:	Inoue, A., Ono, H.K., Chiba, Y. (1991). Prediction of formaldehyde concentrations in air originating from wood-based materials: Comparison of desiccator method with chamber method and perforator method. Bulletin of the Forestry and Forest Products Research Institute 0(360):21-34.			
HERO ID:	6008525			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Area sampling data:	Fujii et al., 1973 equation for estimating formaldehyde in air under ventilated conditions; Hoetjer & Lehman et al., 1987 also have an equation for estimating formaldehyde in air with ventilation.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The model is free of mathematical errors and is based on scientifically sound approaches or methods. However, equations and choice of parameter values are not fully described.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data appears to be from an OECD country, Japan.
	Metric 3:	Applicability	High	The model is broad so model could be applicable to multiple occupational scenarios
	Metric 4:	Temporal Representativeness	Low	Model is more than 20 years old.
Domain 3: Accessibility/ Clarity	Metric 5:	Metadata Completeness	Medium	Model approach, equations, and choice of parameter values are transparent. However, rationale for selection of approach, equations, and parameter values is not provided.
Domain 4: Variability and Uncertainty	Metric 6:	Metadata Completeness	Medium	The study has limited characterization of the variability of parameter values. The model has limited characterization of the uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	Lavoué, J., Gérin, M., Vincent, R. (2011). Comparison of formaldehyde exposure levels in two multi-industry occupational exposure databanks using multimodel inference. Journal of Occupational and Environmental Hygiene 8(1):38-48.			
HERO ID:	1512643			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Liquid			
Personal sampling data:	0.075-0.125 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Model is free of mathematical errors and based on sound approaches/methods; however, choice of equations and parameters are not described.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from France, an OECD country.	
	Metric 3: Applicability	High	Model can be applied to fabric, textile and leather products not covered elsewhere, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Model is based on current industry conditions and based on data no more than 10 years old.	
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	Low	Model approach and parameters described but the underlying equations and parameter values are not provided. Rationales for choice of approach and parameters are not provided.	
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	Medium	Variability addressed by testing two different models, but uncertainty is not addressed	
Overall Quality Determination		Medium		

Study Citation:	Ng, M. G., Tongeren, van, M., Semple, S. (2014). Simulated Transfer of Liquids and Powders from Hands and Clothing to the Mouth. Journal of Occupational and Environmental Hygiene 11(10):633-644.		
HERO ID:	3222353		
Conditions of Use:	Multiple		
EXTRACTION			
Parameter	Data		
Exposure route:	hand/object to mouth (inadvertent ingestion)		
Physical form:	liquid and powder		
Dermal exposure data:	Dermal exposure data		
Exposure frequency:	pg. 2/13: Observational studies of adults have shown average hand-to-mouth contact frequencies of 2–5 contacts per hour		
Comments:	This data source contains data that are the values of a variable in an equation for calculating oral exposure resulting from inadvertent ingestion. This inadvertent ingestion results from hand/object -to-mouth transfer. The variable is transfer efficiency pertaining to hand/object -to-mouth transfer. The data are laboratory measurements of transfer efficiency. pg. 12/13: "This study has provided evidence that transfer of chemicals from the hands or objects to the mouth is influenced by parameters including physical state, chemical/physical properties, and use of protective clothing. These findings may have implications for exposure modeling and exposure control. This work was preliminary in nature and additional study is required to obtain a greater understanding of the parameters that can affect transfer and the possible interactions between them."		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The model is based on scientifically sound approaches, however, the model does not take into account evaporation or absorption. The experimentally determined TEs may be useful and the model may be adapted to account for those factors.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The geographic attribute is not relevant in the case of a mathematical model and data obtained via laboratory experiments.
	Metric 3: Applicability	High	Model can be applied to occupational scenarios where inadvertent oral exposure is likely.
	Metric 4: Temporal Representativeness	High	Data was published in 2014, so generally no more than 10 years old.
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent and clear and can be evaluated. Rationale for selection of approach, equations, and parameter values (where given) is provided.
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	High	The model characterizes variability (e.g., study tests several different factors in varying transfer efficiencies) and uncertainty in the results(contains a limitation section).
Overall Quality Determination		High	

Study Citation:	Offermann, F.J. (2017). Formaldehyde emissions from laminate flooring. ASHRAE Journal 59(3):102-105.		
HERO ID:	5943040		
Conditions of Use:	Use of Floor coverings		
EXTRACTION			
Parameter	Data		
Worker activity description:	MDF core of laminate flooring		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	Modeling data (Monte Carlo Simulations (pg 2), used measured emission data) Initial formaldehyde concentration 50th percentile 189 ug/m3, 95th percentile 929ug/m3. Concentration at 78 years 50th percentile 39 ug/m3, 95th percentile 194ug/m3. After 10 years: median of 76 μg/m3, 95% of 372 μg/m3; Also presents some monitoring data from California New Home Study of 108 homes (no other metadata): mean of 36 μg/m3, 95th% of 100 μg/m3, max of 136 μg/m3 (pg 2-3)		
Engineering control:	increasing the ventilation of the residence (e.g., opening windows) can produce small reductions in the indoor formaldehyde concentrations (e.g., 20% to 30%) (pg 3)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Model is free of mathematical errors and based on sound approaches/methods (based on CDC modeling with some corrections, which are described); however, choice of equations and parameters are not described in full.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Model is based on current industry conditions and based on data no more than 10 years old.
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	Low	Model approach and parameters described but the underlying equations and parameter values are not provided. Rationales for choice of approach and parameters are not provided.
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	Medium	Variability addressed by Monte Carlo simulation using various different input parameters but uncertainty is not addressed.
Overall Quality Determination		Medium	

Study Citation:	Persoons, R., Maitre, A., Bicout, D.J. (2012). Modelling occupational inhalation exposure to concentration peaks of chemicals and associated health risk assessment. Annals of Occupational Hygiene 56(8):934-947.			
HERO ID:	1070249			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Decanting operations performed in a pathology laboratory			
Exposure route:	Inhalation			
Personal sampling data:	1.69-19.4 (mg/m^3)			
Exposure duration:	~20 mins			
Personal protective equipment:	No respiratory protective equipment			
Engineering control:	Local exhaust ventilation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Model is peer-reviewed and free of mathematical errors, based on sound approaches/methods, and uses appropriate equations and parameters.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from France, an OECD country.	
	Metric 3: Applicability	High	Model can be applied to laboratory chemical use, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Model is based on current industry conditions and based on data no more than 10 years old.	
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent. Rationales for choice of approach, equations, and parameter values provided.	
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	Medium	Variability addressed by varying input parameters, but uncertainty is not addressed	
Overall Quality Determination		High		

Study Citation:	Tichenor, B.A., Sparks, L.E. (1996). Managing exposure to indoor air pollutants in residential and office environments. Indoor Air 6(4):259-270.			
HERO ID:	95691			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Area sampling data:	Modeled exposure (Indoor air quality (IAQ) model) separate equations are provided for each exposure source (painting, waxing, and installing furniture/cabinets), sinks (carpet and other absorbent surfaces) and decay rate. The article notes that exposure concentrations are specific for each situation and can vary by office configuration, occupant activity (client/receptionist/janitor), day of the week (weekday/weekend), shift (normal day / night), air exchange rates, activity (waxing, painting, installation of new furniture/ cabinets)			
Exposure duration:	Exposures durations are hypothetical and vary by occupation and shift			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Modeled exposure (Indoor air quality (IAQ) model) separate equations are provided for each exposure source (painting, waxing, and installing furniture/cabinets), sinks (carpet and other absorbent surfaces) and decay rate.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.	
	Metric 3: Applicability	High	The model can be appropriately applied to an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Monitoring data are greater than 20 years old but after the PEL- published 1996	
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent and clear and can be evaluated. Rationale for selection of approach, equations, and parameter values is provided.	
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	Low	model results are not validated therefore variance and uncertainty is not quantified.	
Overall Quality Determination		Medium		

Study Citation:	[Redacted] (2014). [Redacted] Formaldehyde exposure risk assessment for XXX.			
HERO ID:	10605383			
Conditions of Use:	Textile finishing			
EXTRACTION				
Parameter		Data		
Exposure route:		inhalation, dermal		
Area sampling data:		0.014 - 0.11 mg/m3 (Table 1-2) (pg 2)Measured data from three production facilities performing steam pressing, cutting and sewing with fabrics having 60-80 ppm formaldehyde from the wet extraction method (Japanese Law Test) was reported. There were 5 measurements and the range offormaldehyde concentration in the air was 0.05 – 0.11 mg/m3 (Priha, 1995). Therefore based on this publication, when the Oeko-Tex results for formaldehyde are below 75 ppm, air concentrations in the workplace are not anticipated to exceed 0.11 mg/m3. (pg 4)		
Dermal exposure data:		Dermal exposure data		
Exposure duration:		8 hour		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Medium	The assessment uses high quality data and/or techniques or sound methods that are not from a frequently used source, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
		Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
		Metric 5: Sample Size	Low	Distribution of samples is qualitative
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	[Redacted] (2012). [Redacted] Prop 65 exposure risk assessment for formaldehyde and acetaldehyde in XXX.			
HERO ID:	10605387			
Conditions of Use:	Unknown			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Personal sampling data:	CONSEXPO constant release rate exposure estimation for staple handling = 0.11 mg/m³; Service life CONSEXPO instantaneous release rate exposure estimation for worker = 0.014 mg/m³			
Exposure frequency:	11 ug/day inhalation exposure (pg 2)			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	[Redacted] (2012). [Redacted] Screening level exposure and risk assessment of formaldehyde in XXX.			
HERO ID:	10605391			
Conditions of Use:	coating application			
EXTRACTION				
Parameter		Data		
Worker activity description:		fabricating, processing at high temperature (100-150C) and storing in warehouses prior to use; spray application, dip coatings (pg 3);application, offgasing during high temp processing, offgasing during storage (pg 3)		
Exposure route:		inhalation, dermal		
Area sampling data:		Modeled-0.051 mg/m3, 8 hr TWA using local ventilation to minimize exposure (pg 3)Inhalation exposure results for 7200 m2 (one day of processing) placed in storage were 0.24 mg/m3, 8 hr TWA, assuming all the formaldehyde is all instantaneously released the day it is placed in storage. This is a conservative exposure estimate given are stored in rolls and migration out is limited to the outer layers and edges of the rolls. After 30 days of processing, assuming formaldehyde accumulates as additional is placed in storage, the exposure estimate is 7.2 mg/m3, 8 hr TWA. (pg 4)		
Engineering control:		Local ventilation (e.g. fixed capturing hood) or containment resulting in 90% exposure reduction (pg 3)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment uses REACH models from EU, which is a frequent source and is generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario(coating application) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old (2012).
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Information related to product and product use are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The assessment does not address variability or uncertainty.
Overall Quality Determination			High	

Study Citation:	[Redacted] (2014). [Redacted] Prop 65 exposure risk assessment for XXX (formaldehyde, antimony trioxide).			
HERO ID:	10608176			
Conditions of Use:	Fabric finishing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Sewing garments: There is one company that does small piece work in their CA facility.			
Exposure route:	inhalation			
Personal sampling data:	CONSEXPO constant release rate exposure estimation for worker = 0.18 mg/m³ (pg 4)Modeled- Inhalation Lifetime Exposure Estimate [ug/day]Workers: Sewing Garments= 34 ug/dayWorkers: Wearing Coveralls= 20 ug/day-assumes all formaldehyde present offgases the first day of its entirety (pg. 3)			
Exposure duration:	8 hr for sewing garment workers; 8-12 hr for industrial workers wearing overalls** (pg. 4-5)			
Exposure frequency:	Sewing garments is expected to be nonroutine, therefore it is estimated that they have workers sewing garments less than 1 day per week (12 days/yr)Wearing overalls- since all formaldehyde is expected to be offgassed during first wear and report assumes 6 coveralls/worker is used within a year. Exposure frequency is set at 6 days/yr.			
Comments:	**Report states assumption of 12 hours but later calculation state 8 hours, likely 12 hours was used in the resulting calculation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The assessment is for an occupational scenario (fabric finishing) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The completed risk assessment is generally no more than 10 years old (2014).
	Metric 5:	Sample Size	Low	Estimates are characterized by any statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report provides results, methods and assumptions, but the underlying model and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The assessment provides only limited discussion of the uncertainty in the results and no discussion on variability.
Overall Quality Determination		Medium		

Study Citation:	Akbar-Khanzadeh, F., Pulido, E.V. (2003). Using respirators and goggles to control exposure to air pollutants in an anatomy laboratory. American Journal of Industrial Medicine 43(3):326-331.			
HERO ID:	1313879			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Medical students in gross anatomy course			
Exposure route:	Inhalation			
Personal sampling data:	0.9 (ppm)			
Area sampling data:	0.6 (ppm)			
Personal protective equipment:	Three sizes (small, medium, large) of half-mask respirators (MSA, Model Comfo), three sizes (small, medium, large) of full-face respirators (MSA, Models Ultra Elite and Ultra Twin), and chemical goggles (Encon, Model 502Q and American AllSafe Company, Mono-goggle model)			
Engineering control:	General ventilation system supplying a total air flow rate of 9,696 m^3/hr (9.9 air changes/hr).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2003)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (min, max, mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling both personal breathing zone and area but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1518802 Table: 1 of 1

Study Citation: Alexandersson, R. (1988). Decreased lung function and exposure to formaldehyde in the wood working industry. A five-year follow-up. Arhiv za Higijenu Rada i Toksikologiju 39(4):421-424.	
HERO ID:	1518802
Conditions of Use:	Compressed Wood Product Manufacturing
EXTRACTION	
Parameter	Data
Worker activity description:	glueing workers
Exposure route:	Inhalation
Area sampling data:	0.4-0.5 (mg/m^3)
Number of workers:	47
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Methodology
Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Medium	Data are from Sweden, an OECD country.
Metric 3:	Applicability
High	Data are for adhesive and sealant chemical in wood product manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness
Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1980)
Metric 5:	Sample Size
Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
Low	Variability and uncertainty are not addressed.
Overall Quality Determination	Medium

Study Citation:	Arashidani, K., Nivukoski, U., Inoue, W., Otani, H., Kunugita, N., Kim, H., Katoh, T., Uchiyama, I. (2005). Investigation of air pollution in restaurants and of employees’ personal exposure level. :2718-2722.			
HERO ID:	1949176			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Personal sampling data:	30-60 (ppb)			
Area sampling data:	41-114 (ppb)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Japan, an OECD country.	
	Metric 3: Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2005)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling during and after working hours but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Arnold, S.M., Fontaine, D.D., Hwang, H., Krygsman, A., Miller, P.R., Woods, W.B., Shah, H.C. (2011). The use of Henry’s Law to estimate formaldehyde inhalation exposure concentrations. Human and Ecological Risk Assessment 17(3):745-751.			
HERO ID:	5953154			
Conditions of Use:	Use (Biocide)			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Area sampling data:	”0.01% Formaldehyde in Solution: 0.0007 ppm 0.1% Formaldehyde in Solution: 0.0060 ppm”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for the use as a biocide in products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		High		

Study Citation:	Bello, A. (2008). Assessment of exposures to cleaning product ingredients used in common cleaning tasks.			
HERO ID:	9551179			
Conditions of Use:	Cleaning and personal care products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Common cleaning tasks performed in the daily bases included patient room cleaning, bathroom cleaning and floor cleaning. Patient room cleaning and bathroom cleaning involved several tasks such as mirror cleaning, toilet bowl cleaning, counter cleaning and floor cleaning. Each task typically involves a series of process steps such as mixing, spraying or wiping.			
Exposure route:	Inhalation and dermal.			
Physical form:	Liquid.			
Area sampling data:	Total VOC samplingSmall washroomSink cleaning: 2.55-6.43 (ppm)mirror cleaning: 0.76-5.54 (ppm)toilet bowl cleaning: 0.56-1.05 (ppm)Large washroomSink cleaning: 0.6-1.39 (ppm)mirror cleaning: 0.02-0.30 (ppm)toilet bowl cleaning: 0.11-0.35 (ppm)Table 3, pg. 121/162			
Exposure duration:	Cleaning tasks were sampled at 10-minutes per task.			
Number of workers:	54,000 female cleaners and 203,000 administrative workers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	Data are for cleaning and personal care products, an in-scope occupational scenario; however, data are for total VOCs, not just formaldehyde.	
	Metric 4: Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by sampling multiple worker activities.	
Overall Quality Determination		High		

Study Citation:	Bessonneau, V., Mosqueron, L., Berrubé, A., Mukensturm, G., Buffet-Bataillon, S., Gangneux, J.P., Thomas, O. (2013). VOC Contamination in Hospital, from Stationary Sampling of a Large Panel of Compounds, in View of Healthcare Workers and Patients Exposure Assessment. PLoS ONE 8(2):e55535.			
HERO ID:	1500965			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Area sampling data:	(5.864.0 mg/m3)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2013)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Bikas, G., Zervas, E. (2007). Nonregulated pollutants emitted from Euro 3 diesel vehicles as a function of their mileage. Energy and Fuels 21(5):2731-2736.			
HERO ID:	1956422			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter		Data		
Exposure route:		Inhalation		
Physical form:		Vapor		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Greece, an OECD country.
	Metric 3:	Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2007)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1222890 Table: 1 of 1

Study Citation:	Bono, R., Romanazzi, V., Munnia, A., Piro, S., Allione, A., Ricceri, F., Guarrera, S., Pignata, C., Matullo, G., Wang, P., Giese, R.W., Peluso, M. (2010). Malondialdehyde-deoxyguanosine adduct formation in workers of pathology wards: the role of air formaldehyde exposure. Chemical Research in Toxicology 23(8):1342-1348.				
HERO ID:	1222890				
Conditions of Use:	Laboratory Use				
EXTRACTION					
Parameter	Data				
Worker activity description:	Pathology ward workers (reduction room and other areas)				
Exposure route:	Inhalation				
Personal sampling data:	Reduction room workers (ug/m^3): 212.4 (mean) and 128.6 (median); Workers working in other areas (ug/m^3): 32.4 (mean) and 23.3 (median) [Table 1]				
Exposure duration:	8 hrs				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	journal article	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.	
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.	
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2010)	
	Metric 5:	Sample Size	High	Distribution characterized.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling different work areas but uncertainty is not addressed.	
Overall Quality Determination			High		

Study Citation:	Byeon, S.H., Lee, B., Afanasyev, V. (2008). Exposure of auto-mechanic and gas station workers to fine particles, heavy metals and aldehyde. :672-675.			
HERO ID:	1956938			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Automobile shop repair mechanics, and gas station workers.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	The average exposure concentrations of the workers in the gas station and autorepair shop during the summer period were 751 and 1255 ppb			
Exposure duration:	8 hours			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Korea, an OECD country.
	Metric 3:	Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2008)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling during different times of the year but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Chen, Y.C., Ramachandran, G., Alexander, B.H., Mandel, J.H. (2012). Retrospective exposure assessment in a chemical research and development facility. Environment International 39(1):111-121.			
HERO ID:	1986315			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Exposure route:	Dermal, inhalation			
Physical form:	Liquid			
Personal sampling data:	0.05-0.5 (ppm)			
Area sampling data:	0.026 (ppm)			
Personal protective equipment:	Gloves, safety glasses, respirators, protective clothing			
Engineering control:	Hood ventilation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for paints and coatings, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2011)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (min, max) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by area sampling, personal breathing sampling, and modelling data but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	Clark, R.P. (1983). Formaldehyde In Pathology Departments. Journal of Clinical Pathology 36(8):839-846.			
HERO ID:	1316339			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Area sampling data:	It has been estimated that iron foundry workers might be exposed to formaldehyde concentrations between 0-02-18*3 ppm whilst dye stuff operatives and people working in plywood industries would be exposed to between 0-1-5-9 and 1-0-2-5 ppm respectively. By comparison, it was thought that hospital necropsy rooms produced concentrations between 2*2-7-9 ppm.			
Engineering control:	Local exhaust ventilation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from the United Kingdom, an OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1511770 Table: 1 of 1

Study Citation:		Coleman, R. (1995). Reducing the levels of formaldehyde exposure in gross anatomy laboratories. Anatomical Record 243(4):531-533.		
HERO ID:		1511770		
Conditions of Use:		Laboratory Use		
EXTRACTION				
Parameter		Data		
Worker activity description:		Lab students and staff performing dissections and embalming operations		
Exposure route:		Inhalation		
Area sampling data:		0.03-0.09 (ppm)		
Engineering control:		dissection “beds” in which there was a motor to create a downflow to suck all the formaldehyde fumes from the cadaver into the bed, where they would be absorbed by special active carbon filters. The air exiting the beds and recycled into the laboratory would be virtually formaldehyde-free (Fig. 1)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data are from Israel, an OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1995)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	Cook, C. K., Page, E. H. (2000). Health hazard evaluation report, HETA 99–0137–2810: World Color Press, Effingham, Illinois, September 2000.			
HERO ID:	8016661			
Conditions of Use:	Use of ink, toner, and colorant products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Use of blanket wash solutions and wetting agents as solvent cleaners to remove ink from printing press equipment.			
Exposure route:	Dermal and inhalation			
Physical form:	gas			
Personal sampling data:	Press #231 operator: 0.02-0.027 (ppm)Press #227 operator: 0.013-0.016 (ppm)Press #226 operator: 0.011-0.016 (ppm)Premelter #263 operator: 0.017 (ppm)			
Area sampling data:	Area sample at Press #227: 0.009-0.016 (ppm)Area sample at Press #226: 0.011-0.016 (ppm)Area sample at Press #231: 0.013-0.014 (ppm)Area sample at Premelter #263: 0.011-0.017 (ppm)Area sample at Premelter #264: 0.005-0.011 (ppm)Area sample at Hot-Melt Pot #264: 0.023 (ppm)			
Number of workers:	1,000			
Personal protective equipment:	Latex and nitrile rubber gloves.			
Engineering control:	Local exhaust ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for use of ink, toner, and colorant products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Monitoring data are greater than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by multiple personal and area samples, but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	Costa, S., Pina, C., Coelho, P., Costa, C., Silva, S., Porto, B., Laffon, B., Teixeira, J.P. (2011). Occupational exposure to formaldehyde: genotoxic risk evaluation by comet assay and micronucleus test using human peripheral lymphocytes. Journal of Toxicology and Environmental Health, Part A: Current Issues 74(15-16):1040-1051.			
HERO ID:	1222910			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Hospital pathology/anatomy lab workers			
Exposure route:	Inhalation			
Personal sampling data:	mean 0.43 ± 0.06 ppm			
Exposure frequency:	> 1 year			
Number of workers:	48			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Portugal, an OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2011)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling for both personal and area concentrations but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	DCC, (2007). Niosh health hazard evaluation report.		
HERO ID:	8684531		
Conditions of Use:	Metal products not covered elsewhere		
EXTRACTION			
Parameter	Data		
Worker activity description:	Metalworking fluid maintenance, storage, and use.		
Exposure route:	Dermal and inhalation		
Physical form:	Gas		
Exposure duration:	8 hours/day		
Number of workers:	520		
Personal protective equipment:	Dust masks, nitrile gloves, heavy cotton over-gloves, and Tyvex sleeves.		
Comments:	Formaldehyde was found at 207 $\mu\text{g/mL}$ in the aqueous layer and 14.3 $\mu\text{g/mL}$ in the oil layer. The middle emulsion layer was not analyzed for formaldehyde. (p. 10/15)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for metal working fluids, which is an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The assessment does not address variability or uncertainty.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 5965207 Table: 1 of 1

Study Citation:	Dias-Teixeira, M., Domingues, V., Dias-Teixeira, A., Teles, T., Delerue-Matos, C. (2016). Risk of exposure to formaldehyde in pathological anatomy laboratories. Advances in Intelligent Systems and Computing :379-385.		
HERO ID:	5965207		
Conditions of Use:	Laboratory Chemicals (e.g., specimen preservation, medical samples, mortuary science)		
EXTRACTION			
Parameter	Data		
Worker activity description:	macroscopic examination of surgical pieces or biopsy, tissue processing and chemical waste disposal		
Exposure route:	inhalation		
Physical form:	liquid		
Personal sampling data:	0.3-7.3 ppm		
Exposure duration:	Based on tabular presentation of the exposure values, it could be assumed that the exposures were for 8 hours per day.		
Exposure frequency:	nan		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors may impact exposures or releases relative to the U.S.
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The assessment captures operations, equipment, and worker activities expected to be representative of current conditions. EPA has no reason to believe exposures have changed. The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 10602388 Table: 1 of 1

Study Citation: Dow Chemical, (2017). [Redacted] 2016 Personal exposure monitoring for XXX formaldehyde XXX at the Kankakee Site, Kankakee, Illinois, USA.
HERO ID: 10602388
Conditions of Use: Processing: byproduct (Accidental formation)

EXTRACTION

Parameter	Data
Exposure route:	inhalation (p. 2)
Personal sampling data:	0.00667 ppm, <0.0053 ppm (p. 10), 0.0071 ppm, 0.0071 ppm (p.14)
Personal protective equipment:	SCBA respiratory protection was worn during all sampling tasks associated with formaldehyde. (p. 2)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Used known method, NIOSH 2016.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	Uninformative	The assessment is from an occupational scenario that involves the chemical being produced accidentally as a byproduct, not within the scope of risk evaluation.
	Metric 4: Temporal Representativeness	High	The assessment captures operations, equipment, and worker activities expected to be representative of current conditions. EPA has no reason to believe exposures have changed. The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5: Sample Size	Medium	Statistical distribution of samples is fully characterized. However, the small sample size is insufficiently representative
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.

Overall Quality Determination **Uninformative**

Study Citation:	Dunn, D. W., Johnson, M. L., Holmes, L., Hedley, W. H., Barrett, G. J., Mckinnnery, W. N. (1983). Detailed industrial hygiene survey formaldehyde production, Celanese Chemical Company, Inc., Bishop, Texas.			
HERO ID:	1144185			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	Operator; maintenance worker			
Number of workers:	11			
Personal protective equipment:	Safety glasses, hard hats, respirators, ear protection, gloves, boots, body suits, overalls. Details on PDF Pg. 7-28.			
Engineering control:	Double mechanical seals on distillation columns and absorbers, single mechanical seal on methanol supply pump.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			Medium	

Study Citation:	ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.			
HERO ID:	6302987			
Conditions of Use:	Formulation			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Personal sampling data:	long-term (90th):0.11(n=13)short-term(95th):0.23 (estimation)			
Comments:	Table I-5 provides further industrial breakdown of the monitoring data			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S.(EU).	
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by percentiles with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.	
Overall Quality Determination		High		

Study Citation:	ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.			
HERO ID:	6302987			
Conditions of Use:	Lab Use/ Healthcare Sector			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Personal sampling data:	0.174 mg/m3			
Comments:	Table I-5 provides further industrial breakdown of the monitoring data			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.(EU).
	Metric 3:	Applicability	Medium	The data is unclear if it a non-TSCA (embalming) or TSCA activity in the healthcare sector.
	Metric 4:	Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by percentiles with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent. Activities covered in health-care sector are unclear.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 6302987 Table: 3 of 13

Study Citation:		ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.		
HERO ID:		6302987		
Conditions of Use:		Processing- Incorporation into an article- Paper Manufacturing		
EXTRACTION				
Parameter		Data		
Exposure route:		Inhalation		
Personal sampling data:		[mg/m3]long-term (90th):0.65 (n=13)short-term(95th):1.43 (estimation)		
Comments:		Table I-5 provides further industrial breakdown of the monitoring data		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S.(EU).
		Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
		Metric 5: Sample Size	Medium	Distribution of samples is characterized by percentiles with uncertain statistics.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.			
HERO ID:	6302987			
Conditions of Use:	Processing-Incorporation into an article- Finishing agents in Textile, Leather, and Apparel Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Personal sampling data:	long-term (90th):0.59(n=126)short-term(95th):2.29 (n=50)			
Comments:	Table I-5 provides further industrial breakdown of the monitoring data			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.(EU).
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by percentiles with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:		ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.		
HERO ID:		6302987		
Conditions of Use:		Furniture Manufacturing		
EXTRACTION				
Parameter		Data		
Exposure route:		Inhalation		
Personal sampling data:		personal & stationary long &short-term (90th): 0.88 (n=36) mg/m3		
Comments:		Table I-5 provides further industrial breakdown of the monitoring data		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S.(EU).
		Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
		Metric 5: Sample Size	Medium	Distribution of samples is characterized by percentiles with uncertain statistics.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.		
HERO ID:	6302987		
Conditions of Use:	Other (chemical substances in products not described by other codes): Laboratory Chemicals (e.g., specimen preservation, medical samples, mortuary science)		
EXTRACTION			
Parameter	Data		
Exposure route:	Embalmers are likely to be exposed by skin contact through spills or splashes onto skin or eyes during handling processes, such as dilution, arterial and cavity embalming, cleansing and disinfections of body surfaces and orifices, and equipment cleaning by hosing. Spills and splashes during embalming were observed at the site visited (IRSST, 2006c).The likelihood of exposure by inhalation is also high during embalming, such as during dilution of concentrated formalin solutions, application of the solution by spraying, and WORKER EXPOSURE TO FORMALDEHYDE AND FORMALDEHYDE RELEASERS 10 handling viscera covered with paraformaldehyde powder. The duration of embalming a body varies depending on body conditions and customers’ requirements, but usually takes 1-3 hours. The majority of the embalmers operate on a daily basis and exposure durations vary from 1-10 hours a day. Other staff involved in handling embalmed bodies, such as body dressing up and body lifting, may also be exposed to formaldehyde(NICNAS, 2006).		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors may impact exposures or releases relative to the U.S.
	Metric 3: Applicability	Medium	The assessment is for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and workactivities.
	Metric 4: Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5: Sample Size	N/A	N/A- qualitative
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		Medium	

Study Citation: ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.	
HERO ID: 6302987	
Conditions of Use: Tyre and rubber production	
EXTRACTION	
Parameter	Data
Exposure route:	Inhalation (pg. 12)
Personal sampling data:	In chemicals, rubber and plastic industries workers' average exposure decreased from 0.27 for the 2000-2006 period to 0.15 mg/m3 for the 2007-2013 period. (pg. 24)Tyre & Rubber ManufacturingPersonal Long-term (90th): 0.26 (n=10)Personal Short-term (95th): 0.52 (estimation)
EVALUATION	
Domain	Metric
Domain 1: Reliability	
Metric 1:	Methodology
	High
	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Metric 3:	Applicability
Metric 4:	Temporal Representativeness
Metric 5:	Sample Size
	High
	High
	High
	Medium
	The data are from an OECD country other than the U.S.(EU).
	The assessment is for an occupational scenario within the scope of the risk evaluation.
	The completed exposure or risk assessment is generally no more than 10 years old.
	Distribution of samples is characterized by percentiles with uncertain statistics.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	Medium
	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	Medium
	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination	
High	

Formaldehyde

Occupational Exposure

HERO ID: 6302987 Table: 8 of 13

Study Citation:	ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.			
HERO ID:	6302987			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation (pg. 12)			
Personal sampling data:	PBZ Personal Long-term: 0.23 (n=94)Personal Short-term: 0.30 (n=39)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from an OECD country other than the U.S.(EU).	
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by percentiles with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.	
Overall Quality Determination		High		

Study Citation:		ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.		
HERO ID:		6302987		
Conditions of Use:		Chemical substances in furnishing,treatment/care products: Floor coverings; Foam seating and bedding products; Furniture and furnishings not covered elsewhere		
EXTRACTION				
Parameter		Data		
Exposure route:		Inhalation (pg. 12)		
Personal sampling data:		In wood, paper, furniture, textile, clothes, leather and hide, and earthenware industries, the average exposure decreased from 0.48 mg/m3 for the 2000-2006 period to 0.4 mg/m3 for the 2007-2013 period. (pg. 24)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	The data are from an OECD country other than the U.S.(EU).
		Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
		Metric 5: Sample Size	Medium	Distribution of samples is characterized by percentiles with uncertain statistics.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 6302987 Table: 10 of 13

Study Citation:		ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.		
HERO ID:		6302987		
Conditions of Use:		Processing as a reactant		
EXTRACTION				
Parameter		Data		
Exposure route:		Inhalation (pg. 12)		
Personal sampling data:		PBZPersonal Long-term (90th): 0.37(n=116)Personal Short-term (95th): 0.64(n=17)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.(EU).
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by percentiles with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.		
HERO ID:	6302987		
Conditions of Use:	Processing- Incorporation into Article-Adhesives and sealant chemicals in wood product manufacturing		
EXTRACTION			
Parameter	Data		
Exposure route:	Inhalation (pg. 12)		
Personal sampling data:	PBZ(mg/m3)Personal Long-term (90th): 0.075 (n=81)Personal Short-term(95th): 0.15 (Estimation)In wood, paper, furniture, textile, clothes, leather and hide, and earthenware industries, the average exposure decreased from 0.48 mg/m3 for the 2000-2006 period to 0.4 mg/m3 for the 2007-2013 period. (pg. 24)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S.(EU).
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by percentiles with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		High	

Study Citation:	ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.			
HERO ID:	6302987			
Conditions of Use:	Industrial Use: Non-incorporative articles: Used in: construction			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Personal sampling data:	In the construction industry and civil engineering average workers’ exposure to formaldehyde by inhalation dropped from 1.54 mg/m3 for the 2000-2006 period to 0.48 mg/m3 for the 2007-2013 period.			
Comments:	Table I-5 provides further industrial breakdown of the monitoring data			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.(EU).
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by percentiles with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:		ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.		
HERO ID:		6302987		
Conditions of Use:		Fertilizer granules production		
EXTRACTION				
Parameter		Data		
Exposure route:		Inhalation (pg. 12)		
Personal sampling data:		PBZ Personal Long-term: 0.15 (n=1)Personal Short-term: <0.25 (n=39)		
Comments:		Table I-5 provides further industrial breakdown of the monitoring data		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Monitoring data from French registrants and COLCHIC, report uses sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	The data are from an OECD country other than the U.S.(EU).
		Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	High	The completed exposure or risk assessment is generally no more than 10 years old.
		Metric 5: Sample Size	Medium	Distribution of samples is characterized by percentiles with uncertain statistics.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1958980 Table: 1 of 1

Study Citation:	Elia, V. J., Messmer, R. A. (1992). Evaluation of methods for estimating formaldehyde released from resin-containing paper and wood product dusts. American Industrial Hygiene Association Journal 53(10):632-638.			
HERO ID:	1958980			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	0.1 (ppm)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1992)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 5901020 Table: 1 of 1

Study Citation:	Formaldehyde Institute, (1985). Letter from the formaldehyde institute responding to USEPA request for comments on ICF draft reports with attachments.			
HERO ID:	5901020			
Conditions of Use:	Building/construction materials - wood and wood engineered products			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Area sampling data:	0.09-0.85 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1985)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by sampling mobile homes in multiple locations and states. Variability is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 2400931 Table: 1 of 1

Study Citation:	Fornander, L., Graff, P., Wahlen, K., Ydreborg, K., Flodin, U., Leanderson, P., Lindahl, M., Ghafouri, B. (2013). Airway Symptoms and Biological Markers in Nasal Lavage Fluid in Subjects Exposed to Metalworking Fluids. PLoS ONE 8(12):e83089.			
HERO ID:	2400931			
Conditions of Use:	Use of metal products			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	0.1 (mg/m^3)			
Area sampling data:	0.04 (mg/m^3)			
Number of workers:	271 metal working fluids workers, and 24 metal workers not exposed to MWF			
Engineering control:	Improved the ventilation system which reduced formaldehyde levels by 50%			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data are for metal products not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2013)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by both personal and area sampling but uncertainty is not addressed.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 6195086 Table: 1 of 1

Study Citation:	GAO, (1998). Air pollution: Prior indoor air quality problems at the National Institute of Environmental Health Sciences.			
HERO ID:	6195086			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office workers at National Institute of Environmental Health Sciences. (3/22)			
Exposure route:	inhalation (2/22)			
Area sampling data:	”The agency found that formaldehyde levels ranged from 0.1 to 0.34 parts per million (ppm). However, with the available data as input for a formaldehyde decay curve, the expert’s mathematical extrapolation showed that the initial formaldehyde levels probably ranged between 1.2 and 7.5 ppm when the employees first moved into module A (6/22) ”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for ambient air in an office, which is similar to the in-scope occupational scenario use of furniture products.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range (and graphs) with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by discussing sources of error in sampling, and by factors that could cause different results. Variability isn’t addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1231414 Table: 1 of 1

Study Citation:	General Motors Co (1982). Die-cast operations benzo(a)pyrene plating operations asbestos nitrosamines with cover letter.			
HERO ID:	1231414			
Conditions of Use:	Processing aid			
EXTRACTION				
Parameter	Data			
Area sampling data:	All area samples at nickel plating tanks and solution attendant’s workplace were non-detects.			
Engineering control:	Ventilation system with side draft hoods for the control of airborne contaminants.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for application of surface treating agents, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability addressed by comparing results from different areas, uncertainty is addressed with the given sampling method.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1579710 Table: 1 of 1

Study Citation:	General Motors Co, (1980). Total particulate gases and vapors (general) nitrosamines formaldehyde miscellaneous with cover letter.			
HERO ID:	1579710			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Liquid			
Area sampling data:	ND			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1981)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple areas of the plant but uncertainty is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1321428 Table: 1 of 1

Study Citation:	Goris, J.A., Ang, S., Navarro, C. (1998). Laboratory safety: Minimizing the toxic effects of formaldehyde. Laboratory Medicine 29(1):39-42.			
HERO ID:	1321428			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Area sampling data:	>0.5 (ppm)			
Exposure duration:	30 (43%) reported exposures from 1 to 5 hours per day, and 29 (42%) from 6 to 10 hours per day.			
Number of workers:	37,000 out of 2.2 million workers exposed to formaldehyde			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1998)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 8016648 Table: 1 of 1

Study Citation:	Hall, R. M., Bernard, B., Harney, J., McCleery, R., Gillen, M., Hess, J. E., Kiefer, M., Mattorano, D., Delaney, L., Mead, K. (2002). Health Hazard Evaluation Report 2002–0136, United States Senate and House of Representatives, Washington, D.C., July 2002.			
HERO ID:	8016648			
Conditions of Use:	Industrial processing aids and solvent			
EXTRACTION				
Parameter	Data			
Worker activity description:	Handling and opening mail			
Exposure route:	Dermal and inhalation			
Physical form:	Gas			
Area sampling data:	Mail handling area (russell building): 0.009-0.01 (ppm)Mail handling area (dirksen building): 0.006-0.008Control area: 0.005-0.008 (ppm). Table 8			
Number of workers:	389			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for industrial process aids and solvents, which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability addressed by taking samples at various areas within the plant and different temperatures, uncertainty is addressed by sampling methods.
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 9551210 Table: 1 of 1

Study Citation:	Harley, K. G., Calderon, L., Nolan, S., J.E., Maddalena, R., Russell, M., Roman, K., Mayo-Burgos, S., Cabrera, J., Morga, N., Bradman, A. (2021). Changes in Latina women’s exposure to cleaning chemicals associated with switching from conventional to ”green” household cleaning products: The LUCIR intervention study. Environmental Health Perspectives 129(9):97001.		
HERO ID:	9551210		
Conditions of Use:	Cleaning and furniture care products		
EXTRACTION			
Parameter	Data		
Worker activity description:	Cleaning surfaces; cleaning mirrors, windows, or other glass; cleaning toilets; cleaning tubs or showers; and cleaning floors.		
Exposure route:	Inhalation		
Physical form:	Gas.		
Personal sampling data:	Pre-intervention visit15.63 (ug/m^3)Post-intervention (using ”green” cleaning products) visit13.22 (ug/m^3)Table 3, pg 6/9		
Exposure duration:	Bathroom cleaning sessions last 10 minutes.		
Exposure frequency:	Home cleaning product frequencies range from a few times a month to every day. See Table 1 on PDF Pg. 5 for more detail.		
Number of workers:	50 workers were part of the study population.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for cleaning and furniture care products, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by
Overall Quality Determination		High	

Study Citation:	Harney, J. M., Tapp, L. (2016). Health Hazard Evaluation Report: HHE-2013-0075-3264, December 2016. Investigation of Dermal and Respiratory Exposures to Metalworking Fluids at an Automotive Parts Manufacturer.		
HERO ID:	4455212		
Conditions of Use:	Metal products not covered elsewhere		
EXTRACTION			
Parameter	Data		
Worker activity description:	Machine operators, production employees handling parts		
Exposure route:	Inhalation		
Physical form:	Liquid, vapor		
Personal sampling data:	0.041-0.19 (ppm)		
Number of workers:	20-40		
Personal protective equipment:	Safety glasses and steel toe boots for all employees. Hearing protection for machining department employees. Breathable fabric gloves coated in polyurethane on the palm and fingers for machine operators. When handling parts coated in MWF, employees must wear extended mid-forearm length, cuffed, heavy nitrile gloves		
Engineering control:	Engineering control suggestions included on Pg. 27.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for metal products not covered elsewhere, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2016)
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		High	

Study Citation:	Hensten-Pettersen, A., Jacobsen, N. (1990). The role of biomaterials as occupational hazards in dentistry. International Dental Journal 40(3):159-166.			
HERO ID:	1983158			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Dentists using local anesthetics containing formaldehyde			
Exposure route:	Dermal			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Norway, an OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1990)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 5901019 Table: 1 of 1

Study Citation:	HHS, (2000). Estimating historical exposures to formaldehyde in a retrospective mortality study.			
HERO ID:	5901019			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Operators, mechanics, chemists, industrial hygienists, sifters, batch men, administration workers. Full list of job titles wasn’t included. (5/21)			
Exposure route:	inhalation (6/21)			
Physical form:	gas only (7/21)			
Personal sampling data:	Estimated exposures were 0.50 ppm for the sifters and 0.45 ppm for batch men. (6/21) The report also says that ”About 150 jobs had an exposure of 2.0 ppm or greater.” (10/21)			
Exposure duration:	8 hours/day (5/21)			
Number of workers:	30,000 workers exposed since 1930. (4/21)			
Personal protective equipment:	Respirators were worn by some job categories. (7/21)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	Low	Sample distribution is described qualitatively.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in the data collection and consolidation explanation. Variability is addressed by explaining differences in monitoring methods and job classifications by site.	
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 1793130 Table: 1 of 5

Study Citation:	Ho, S., Ip, H., Ho, K., Ng, L., Chan, C., Dai, W., Cao, J. (2013). Hazardous airborne carbonyls emissions in industrial workplaces in China. Journal of the Air and Waste Management Association 63(7):864-877.			
HERO ID:	1793130			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Liquid			
Area sampling data:	10.6 ppm (ink mfg) and 115 ppm (paint mfg)			
Number of workers:	366 for paint and 197 for ink			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for paint and coating manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2013)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at multiple locations but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Ho, S., Ip, H., Ho, K., Ng, L., Chan, C., Dai, W., Cao, J. (2013). Hazardous airborne carbonyls emissions in industrial workplaces in China. Journal of the Air and Waste Management Association 63(7):864-877.			
HERO ID:	1793130			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Liquid			
Area sampling data:	83.3-99.6 (ppb)			
Exposure duration:	nan			
Exposure frequency:	nan			
Number of workers:	313			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for finishing agents in textiles, apparel, and leather manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2013)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at multiple locations but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1793130 Table: 3 of 5

Study Citation:	Ho, S., Ip, H., Ho, K., Ng, L., Chan, C., Dai, W., Cao, J. (2013). Hazardous airborne carbonyls emissions in industrial workplaces in China. Journal of the Air and Waste Management Association 63(7):864-877.			
HERO ID:	1793130			
Conditions of Use:	Processing aid			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Liquid			
Area sampling data:	16.7-22.9 (ppb)			
Number of workers:	165			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.	
	Metric 3: Applicability	High	Data are for oxidizing/reducing agents, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2013)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling at multiple locations but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1793130 Table: 4 of 5

Study Citation:	Ho, S., Ip, H., Ho, K., Ng, L., Chan, C., Dai, W., Cao, J. (2013). Hazardous airborne carbonyls emissions in industrial workplaces in China. Journal of the Air and Waste Management Association 63(7):864-877.			
HERO ID:	1793130			
Conditions of Use:	Non-TSCA			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Liquid			
Area sampling data:	56.1-124.2 (ppb)			
Number of workers:	503			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for food packaging, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2013)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at multiple locations but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1793130 Table: 5 of 5

Study Citation:	Ho, S., Ip, H., Ho, K., Ng, L., Chan, C., Dai, W., Cao, J. (2013). Hazardous airborne carbonyls emissions in industrial workplaces in China. Journal of the Air and Waste Management Association 63(7):864-877.		
HERO ID:	1793130		
Conditions of Use:	”Processing aids, specific to petroleum production in: oil and gas drilling, extraction, and support activities and all other basic inorganic chemical manufacturing”		
EXTRACTION			
Parameter	Data		
Exposure route:	Inhalation		
Physical form:	Liquid		
Area sampling data:	66.4-103.2 (ppb)		
Number of workers:	267		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3: Applicability	High	Data are for processing aids, specific to petroleum production in all other basic chemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2013)
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling at multiple locations but uncertainty is not addressed.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 6766299 Table: 1 of 1

Study Citation:	Horn, G. P., Kerber, S., Fent, K. W., Fernhall, B., Smith, D. L. (2016). Interim Report: Cardiovascular & Chemical Exposure Risks in Modern Firefighting.		
HERO ID:	6766299		
Conditions of Use:	Building and construction materials		
EXTRACTION			
Parameter	Data		
Worker activity description:	Fire fighting		
Exposure route:	Dermal and inhalation		
Exposure duration:	12 hour work periods		
Personal protective equipment:	Positive-pressure self-contained breathing apparatus (SCBA)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for building and construction materials, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The assessment does not address variability or uncertainty.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1579019 Table: 1 of 1

Study Citation:	Hosgood, H.D., Zhang, L., Tang, X., Vermeulen, R., Hao, Z., Shen, M., Qiu, C., Ge, Y., Hua, M., Ji, Z., Li, S., Xiong, J., Reiss, B., Liu, S., Xin, K.X., Azuma, M., Xie, Y., Freeman, L.B., Ruan, X., Guo, W., Galvan, N., Blair, A., Li, L., Huang, H., Smith, M.T., Rothman, N., Lan, Q. (2013). Occupational exposure to formaldehyde and alterations in lymphocyte subsets. American Journal of Industrial Medicine 56(2):252-257.				
HERO ID:	1579019				
Conditions of Use:	Plastic Manufacturing				
EXTRACTION					
Parameter		Data			
Worker activity description:		in a factory that produced formaldehyde-melamine resins and a factory that used formaldehyde-melamine resins to manufacture plastic utensils			
Exposure route:		Inhalation			
Personal sampling data:		mean 1.28 (ppm)			
Number of workers:		43			
EVALUATION					
Domain		Metric		Rating	Comments
Domain 1: Reliability		Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness		Metric 2:	Geographic Scope	High	Data are from the U.S.
		Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
		Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2013)
		Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination				High	

Formaldehyde

Occupational Exposure

HERO ID: 1518555 Table: 1 of 1

Study Citation:	Imbus, H.R. (1988). A review of regulatory risk assessment with formaldehyde as an example. Regulatory Toxicology and Pharmacology 8(3):356-366.			
HERO ID:	1518555			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Manufacturing apparel			
Area sampling data:	3 (ppm)			
Number of workers:	777,000			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for finishing agent in apparel, textile and leather manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1987)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Infante, P. F., Pohl, G. K. (1988). Living in a chemical world actions and reactions to industrial carcinogens. Teratogenesis, Carcinogenesis, and Mutagen- esis 8(4):225-249.			
HERO ID:	1010380			
Conditions of Use:	Disposal			
EXTRACTION				
Parameter	Data			
Worker activity description:	RCRA site workers and HAZMAT workers			
Area sampling data:	0.18-1.16 (ppm)			
Number of workers:	72,500			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Could not determine the condition of use from the article.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1988)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	Järvholm, B., Ljungkvist, G., Lavenius, B., Rodin, N., Peterson, C. (1995). Acetic aldehyde and formaldehyde in cutting fluids and their relation to irritant symptoms. Annals of Occupational Hygiene 39(5):591-601.			
HERO ID:	1318480			
Conditions of Use:	Use of Lubricant			
EXTRACTION				
Parameter	Data			
Exposure route:	Dermal, inhalation			
Area sampling data:	Department A: 0.008-0.078 (mg/m^3); Department B: <0.005-0.009 (ppm)			
Number of workers:	108			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data are for lubricants and greases, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1995)
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling two different departments over multiple weeks but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Karstadt, M. (1984). Formaldehyde: science and regulation. American Journal of Industrial Medicine 5(6):485-487.			
HERO ID:	6199954			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation (2/3)			
Area sampling data:	”Embalming rooms: 0.09- 5.26 ppm Paper conditioning: 0.9 - 1.6 ppm Dress shop: 0.13- 0.45 ppm Tannery-finishing department: 1.0 - 8.6 ppm Laminating plants: 0.04- 10.9 ppm Sheepskin dyeing: 4.07-63.4 1 ppm Clothing factory: 0.9 - 2.7 ppm (2/3)”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for a variation of occupational scenarios, but the majority of the article describes animal exposure.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by mentioning how animal data doesn’t correlate to human data. Variability addressed by including various human studies in the report.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1314703 Table: 1 of 2

Study Citation:	Kilburn, K.H., Warshaw, R., Boylen, C.T., Johnson, S.J., Seidman, B., Sinclair, R., Takaro, T. (1985). Pulmonary and neurobehavioral effects of formalde- hyde exposure. Archives of Environmental Health 40(5):254-260.			
HERO ID:	1314703			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	Phenol formaldehyde batt making			
Exposure route:	Inhalation, dermal			
Physical form:	Liquid			
Area sampling data:	5 (ppm)			
Exposure duration:	nan			
Number of workers:	110 fiberglass batt makers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data and methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupa- tional scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2012)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1314703 Table: 2 of 2

Study Citation:	Kilburn, K.H., Warshaw, R., Boylen, C.T., Johnson, S.J., Seidman, B., Sinclair, R., Takaro, T. (1985). Pulmonary and neurobehavioral effects of formaldehyde exposure. Archives of Environmental Health 40(5):254-260.				
HERO ID:	1314703				
Conditions of Use:	Laboratory Use				

Parameter		EXTRACTION		
Worker activity description:		Laboratory histology technicians		
Exposure route:		Inhalation, dermal		
Physical form:		Liquid		
Area sampling data:		0.4-1.9 (ppm)		
Exposure duration:		nine had 1-3 hr/day and nine were exposed for at least 4 hr/day		
Number of workers:		18		

Domain		Metric		EVALUATION	
				Rating	Comments
Domain 1: Reliability		Metric 1:	Methodology	High	Assessment uses high quality data and methods from frequently-used sources.
Domain 2: Representativeness		Metric 2:	Geographic Scope	High	Data are from the U.S.
		Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
		Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2012)
		Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination	High

Study Citation:	Lee, E. G., Magrm, R., Kusti, M., Kashon, M. L., Guffey, S., Costas, M. M., Boykin, C. J., Harper, M. (2017). Comparison between active (pumped) and passive (diffusive) sampling methods for formaldehyde in pathology and histology laboratories. Journal of Occupational and Environmental Hygiene 14(1):31-39.
HERO ID:	4453119
Conditions of Use:	Chemical substances in products not described by other codes:Laboratory Chemicals (e.g., specimen preservation, medical samples, mortuary science)

EXTRACTION

Parameter	Data
Worker activity description:	After receiving organs, the autopsy technician filled the containers with a 20% buffered formalin solution, covered each with a lid, and placed them on a cart. The technician also cleaned the fume hoods for the residents' dissecting work. For the rest of the shift, the technician delivered the filled containers to other laboratories, brought organs to the histology laboratory, and printed and placed labels on small cassettes. The two laboratory technicians made sample slides by imbedding tissue samples in wax, placing the sliced samples on slides, putting the slides through automatic staining and cover-slipping machines, and then labelling and storing them for the doctors to examine. (p.4)
Exposure route:	Inhalation (p.4)
Physical form:	liquid (p. 4)
Personal sampling data:	At the pathology laboratory, samples were collected in two campaigns: 15 personal and 10 area sample pairs (one active sampler and one passive badge) in one and 21 personal and 4 area sample pairs in the other (Figure 2). At the histology laboratory, 13 personal and 3 area sample pairs were collected. (p.4)
Area sampling data:	At the pathology laboratory, samples were collected in two campaigns: 15 personal and 10 area sample pairs (one active sampler and one passive badge) in one and 21 personal and 4 area sample pairs in the other (Figure 2). At the histology laboratory, 13 personal and 3 area sample pairs were collected. (p.4)
Number of workers:	The laboratory personnel included five full-time employees (three laboratory coordinators and two pathologist assistants [PAs]) and a few residents and doctors performing dissecting work. One laboratory coordinator and the two PAs voluntarily participated in our study. (p. 3)
Engineering control:	fume hood (p. 3)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (NIOSH).
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The assessment captures operations, equipment, and worker activities expected to be representative of current conditions. EPA has no reason to believe exposures have changed.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 4453119 Table: 1 of 1

...continued from previous page

Study Citation:	Lee, E. G., Magrm, R., Kusti, M., Kashon, M. L., Guffey, S., Costas, M. M., Boykin, C. J., Harper, M. (2017). Comparison between active (pumped) and passive (diffusive) sampling methods for formaldehyde in pathology and histology laboratories. Journal of Occupational and Environmental Hygiene 14(1):31-39.		
HERO ID:	4453119		
Conditions of Use:	Chemical substances in products not described by other codes:Laboratory Chemicals (e.g., specimen preservation, medical samples, mortuary science)		
Domain		EVALUATION	
Metric		Rating	Comments
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 1314768 Table: 1 of 1

Study Citation:	Levine, R.J., Dalcorso, R.D., Blunden, P.B., Battigelli, M.C. (1984). The effects of occupational exposure on the respiratory health of West Virginia morticians. Journal of Occupational Medicine 26(2):91-98.			
HERO ID:	1314768			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter		Data		
Worker activity description:		Morticians		
Exposure route:		Inhalation		
Physical form:		Liquid, vapor		
Personal sampling data:		Intact bodies: 0.3 (ppm); autopsied bodies: 0.9 (ppm); peak half-hour concentrations: 0.4 (ppm) (intact) and 2.1 (ppm) (autopsied)		
Number of workers:		112		
Personal protective equipment:		Apron and rubber gloves		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing both intact and autopsied bodies but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Levy, L. S., Lee, W. R. (1994). Aliphatic chemicals. :139-190.			
HERO ID:	664424			
Conditions of Use:	Processing as a Reactant			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation, dermal			
Physical form:	gas, aqueous solution			
Personal protective equipment:	Absorption, if through the respiratory tract, might have been diminished by 'protective' measures such as, masks, airline hoods or, if through the skin, by gloves, impermeable aprons, etc.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for processing as an intermediate in resins, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by addressing conflicting study results. Variability is not addressed.	
Overall Quality Determination		High		

Study Citation:	Lin, D., Guo, Y., Yi, J., Kuang, D., Li, X., Deng, H., Huang, K., Guan, L., He, Y., Zhang, X., Hu, D., Zhang, Z., Zheng, H., Zhang, X., Mchale, C.M., Zhang, L., Wu, T. (2013). Occupational exposure to formaldehyde and genetic damage in the peripheral blood lymphocytes of plywood workers. Journal of Occupational Health 55(4):284-291.			
HERO ID:	1988068			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Providing wood scraps, spreading and grinding wood scraps, sanding boards and post processing, pressing ground wood scraps with glue at high temperature and stacking up boards, making glue			
Exposure route:	Inhalation			
Physical form:	vapor			
Area sampling data:	0.09-1.48 (mg/m^3)			
Exposure duration:	8 hours			
Number of workers:	240			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2013)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability addressed by testing multiple areas of the facility but uncertainty is not addressed.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1320071 Table: 1 of 1

Study Citation:	Linnainmaa, M., Kiviranta, H., Laitinen, J., Laitinen, S. (2003). Control of workers’ exposure to airborne endotoxins and formaldehyde during the use of metalworking fluids. AIHA Journal 64(4):496-500.			
HERO ID:	1320071			
Conditions of Use:	Use of Metalworking fluid			
EXTRACTION				
Parameter	Data			
Exposure route:	Dermal, inhalation			
Physical form:	Liquid			
Personal sampling data:	0.052 (mg/m^3)			
Area sampling data:	0.008-0.24 (mg/m^3)			
Engineering control:	Local exhaust ventilation (recirculating air cleaners): 4 filtration and 3 electrostatic precipitation units.			
Comments:	18 sites measured			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Finland, an OECD country.	
	Metric 3: Applicability	Uninformative	Data are for biocide, triazine which forms formaldehyde, added to metal working fluids, this is an occupational scenario not within the scope of the risk evaluation (i.e., due to non-TSCA).	
	Metric 4: Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2003)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling both personal breathing zone and areas at 18 different sites but uncertainty is not addressed.	
Overall Quality Determination		Uninformative		

Formaldehyde

Occupational Exposure

HERO ID: 2443638 Table: 1 of 1

Study Citation:	Lu, H., Wen, S., Feng, Y., Wang, X., Bi, X., Sheng, G., Fu, J. (2006). Indoor and outdoor carbonyl compounds and BTEX in the hospitals of Guangzhou, China. Science of the Total Environment 368(2-3):574-584.			
HERO ID:	2443638			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Liquid			
Area sampling data:	5.3 ± 1.5 (ug/m^3) - 13.4 ± 3.7(ug/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.	
	Metric 3: Applicability	High	Data are for laboratory chemicals, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2006)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling multiple hospitals but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Madaras, G. W. (1980). Chemical hazards in the textile industry. American Dyestuff Report 69(5):28.			
HERO ID:	6020609			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Machinists, operatives handling steam-operated presses, fabric converters, and retailers. (5/8)			
Exposure route:	inhalation, dermal, ingestion (5/8)			
Physical form:	vapor (5/8)			
Area sampling data:	”In the incubation method, a weighed fabric sample is suspended over a known volume of water in a closed container under standard conditions. Dr. Lund states that free formaldehyde levels of 600-700 ppm (extraction method) and released formaldehyde levels of 1000-1500 ppm (incubation method) may be considered realistic levels for fabrics satisfactorily finished with about 5% resin.” (6/8)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from the U.K., an OECD country.
	Metric 3:	Applicability	High	Data are for textile finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Main, D.M., Hogan, T.J. (1983). Health effects of low level exposure to formaldehyde. Journal of Occupational and Environmental Medicine 25(12):896-900.			
HERO ID:	626541			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	office workers in mobile trailers			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	0.12-1.6 (ppm) Table 1 contains data by trailer and office within each trailer and the ambient temperature during monitoring.			
Number of workers:	Number of monitored subjects: 21			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	commercial use of wood products is a COU
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple sites but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1234591 Table: 1 of 1

Study Citation:	Moen, B. E., Hollund, B. E., Berntsen, M., Flo, R., Kyvik, K. R., Riise, T. (1995). Occupational exposure of deck crews to carcinogenic agents on crude oil tankers. American Journal of Industrial Medicine 27(4):555-564.			
HERO ID:	1234591			
Conditions of Use:	”Processing aids, specific to petroleum production in: oil and gas drilling, extraction, and support activities and all other basic inorganic chemical manufacturing”			
EXTRACTION				
Parameter	Data			
Worker activity description:	The connection and disconnection of hoses and lines from land to the manifold and surveillance of the loading/unloading on deck.-Crude oil sector			
Exposure route:	Inhalation			
Physical form:	Liquid, vapor			
Area sampling data:	Pumproom in ship #1: 0.02 (ppm); At manifold and pumproom in ship #4: 0.08 (ppm); All other ships: ND			
Exposure duration:	sampling period was restricted to 8 hours			
Exposure frequency:	The mean time spent performing suchwork was 20 hours each week			
Personal protective equipment:	Plastic or rubber gloves, air line full face mask, gas filter mask			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Norway, an OECD country.
	Metric 3:	Applicability	High	Data are for processing aid in oil and gas drilling, extraction and support activities, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1995)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling in multiple ships but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Monsanto Research Corp, (1984). A survey of health hazard control systems for formaldehyde production facilities.		
HERO ID:	8728027		
Conditions of Use:	Manufacture		
EXTRACTION			
Parameter	Data		
Worker activity description:	In general the formaldehyde unit operators perform a wide variety of operations, including monitoring and control of the process, the taking and analysis of process samples, blending and loading the formaldehyde, and the unloading of methanol. [additional info on PDF Pg. 11]. One chief operator is assigned per shift to operate the controls for the formaldehyde unit and for another chemical manufacturing unit. The controls for both units were located within the same building. This control building was located across the street from the formaldehyde unit in the blending/control laboratory building where the unit operator worked. One of the plants visited employed blender operators who operate the controls from a blending control building. It was their job to transfer formaldehyde solutions between tanks within a central tank farm and to load rail cars or tank car trucks while using inline blending to insure uniformity of product. One of the plants employed loading operators, whose job it was to load formaldehyde and other chemicals manufactured by that same plant. These operators were assigned at the central loading location for the plant and were assigned to either load the tank trucks or rail cars. At one of the plants, production supervisors supervised the formaldehyde operation during the day shift. Their office is across the street from the formaldehyde unit and is next to the unit control building where the chief operator works. Each plant provides maintenance personnel for upkeep of the formaldehyde unit. At most of the plants the maintenance personnel are responsible for maintenance of the entire plant in addition to the formaldehyde unit itself. At one of the plants the maintenance personnel were responsible for maintenance for the entire plant complex. [additional info on PDF Pg. 13]		
Exposure route:	Inhalation		
Physical form:	Gas/Vapor		
Personal sampling data:	Long-Term Personal Samples Operator Plant A: 0.38-0.68 (ppm); mean - 0.55 (ppm) Plant B: 0.09-0.36 (ppm); mean - 0.23 (ppm) Plant C: 0.11-0.56 (ppm); mean - 0.31 (ppm) Chief Operator Plant C: <0.13-0.24 (ppm); mean - <0.19 (ppm) Production Supervisor Plant C: 0.30-0.32 (ppm); mean - 0.30 (ppm) Maintenance Worker Plant A: <0.05-0.32 (ppm); mean - <0.15 (ppm) Plant B: 0.09-2.22 (ppm); mean - 0.61 (ppm) Short-Term Personal Samples Process Sampling and Analysis Plant A: 0.31-1.89 (ppm); mean - 0.87 (ppm) Plant B: <0.05-0.64 (ppm); mean - <0.27 (ppm) Plant C: <0.05-1.76 (ppm); mean - <1.02 (ppm) Product Loading Plant A: 0.19-0.55 (ppm); mean - 0.32 (ppm) Plant B: 0.86-1.07 (ppm); mean - 1.00 (ppm) Plant C: 0.96-1.79 (ppm); mean - 1.22 (ppm) Aftercooler Sampling Plant B: mean - 1.34 (ppm)		
Area sampling data:	Long-Term Area Samples Production Area Plant A: 0.05-1.38 (ppm); mean - 0.27 (ppm) Plant B: 0.01-0.64 (ppm); mean - <0.18 (ppm) Plant C: <0.06 - 3.63 (ppm); mean - <0.61 (ppm) Formaldehyde Storage Plant B: 0.56-1.06 (ppm); mean - 0.78 (ppm) Plant C: 0.17-0.35 (ppm); mean - 0.24 (ppm) Formaldehyde Blending Plant A: 0.27-1.02 (ppm); mean - 0.69 (ppm) Plant C: 0.11-0.16 (ppm); mean - 0.13 (ppm) Formaldehyde Loading Plant A: 0.28-8.62 (ppm); mean - 4.32 (ppm) Plant C: <0.05-1.55 (ppm); mean Control Lab - General Plant A: 0.38-0.69 (ppm); mean - 0.50 (ppm) Plant C: 0.13-0.69 (ppm); mean - 0.39 (ppm) Control Lab - Hood Area Plant A: <0.01-1.14 (ppm); mean - <0.58 (ppm) Plant C: 0.53-2.60 (ppm); mean - 1.46 (ppm)		
Exposure duration:	Unloading takes between 8-10 hours at one plant and 8 hours at another.		
Personal protective equipment:	Most plants surveyed require workers to wear hardhats and safety glasses on the premises. During formaldehyde loading, most plants require employees to wear gloves. Half (5 out of 9) of the plants required respiratory protection in the form of a half or full-face organic vapor cartridge respirator. Respirators are also required at most plants during formaldehyde gas sampling. Fit testing was only done at one of the plants. During process sampling and analysis, most plants require gloves. Only one plant required the wearing of a full-face acid gas cartridge respirator during sample collection. No PPE is required during sample analysis. Formaldehyde gas sample required gloves and either half or full-face organic vapor cartridge respirator. During formaldehyde tank storage entry, workers are required to wear a full-protective suit, gloves, and boots along with respiratory protection. Maintenance usually wore gloves and respirators. (pg. 14-15)		
Engineering control:	One plant surveyed used a modified closed dome system and a passive ventilation system to remove gaseous emissions during tank loading and unloading. Another plant had an active ventilation system without a closed dome. This system was not as effective as the closed dome system because vapors can escape along the edge of the hatch where the ventilation duct is inserted. All of the plants visited had automatic delivery systems that should allow the operator to set the required load then leave the area, thus preventing exposure during loading. This system also prevents overfilling, which often results in spills; Scrubbers		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 8728027 Table: 1 of 1

...continued from previous page

Study Citation:	Monsanto Research Corp, (1984). A survey of health hazard control systems for formaldehyde production facilities.			
HERO ID:	8728027			
Conditions of Use:	Manufacture			
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by sampling method. Variability addressed by taking personal and area samples.
Overall Quality Determination			High	

Study Citation:	Monsanto Research Corp, (1983). Detailed industrial hygiene survey: Formaldehyde production, Reichhold Chemicals, Incorporated, Hampton, South Carolina.		
HERO ID:	8728034		
Conditions of Use:	Manufacture		
EXTRACTION			
Parameter	Data		
Worker activity description:	Operators monitor and control the process, sample the process and analyze the samples, blend the 50% formaldehyde solution to meet customer specifications, unload methanol and load formaldehyde, and assist maintenance when necessary. Maintenance workers are responsible for process maintenance - including catalyst preparation, daily process area hosedowns, groundskeeping, and general maintenance of the plant.		
Exposure route:	Inhalation and dermal.		
Physical form:	Liquid.		
Personal sampling data:	Long-term samplingOperator: 0.38-0.68 (ppm), mean - 0.55 (ppm)Maintenance Worker 1: non-detect-0.32 (ppm), mean - 0.16 (ppm)Maintenance Worker 2: 0.13-0.19 (ppm), mean - 0.14 (ppm)Short-term samplingFormaldehyde truck loading: 0.55 (ppm)Formaldehyde rail car loading: 0.19 (ppm)Process Sampling: 0.31-1.89 (ppm), mean - 0.87 (ppm)		
Area sampling data:	Formaldehyde truck loading area: 8.62 (ppm)Formaldehyde tank car loading area: 0.28 (ppm)Spray box area: 0.14-0.16 (ppm), mean - 0.15 (ppm)Distillation column area: 0.05-0.34 (ppm), mean - 0.17 (ppm)Converter area (north end): 0.17-0.22 (ppm), mean - 0.20 (ppm)Converter area (south end): 0.11-0.28 (ppm), mean - 0.17 (ppm)Spray tower #1: 0.16-1.38 (ppm), mean - 0.60 (ppm)Control/lab room: 0.38-0.69 (ppm), mean - 0.56 (ppm)Blending building area: 0.27-1.02 (ppm), mean - 0.69 (ppm)Control lab/room hood area: non-detect-1.14 (ppm), mean - 0.57 (ppm)MeOH shift storage/interim product storage area: 0.12 (ppm)Source samplingFormaldehyde interim product pump: 8-50.9 (ppm), mean - <27.3 (ppm)Spray tower #2 pump: 4.33-4.77 (ppm), mean - 4.56 (ppm)Distillation column pump: 1.20-2.78 (ppm), 2.04 (ppm)Blending pump: <95.2-193.9 (ppm), mean - <127 (ppm)Spray box pump - fluid sealed: 17.8-18.9 (ppm), mean - 18.4 (ppm)Spray box pump - nonfluid sealed: <55.2 (ppm)		
Exposure duration:	Work occurs 24 hours/day in 3 shifts (8-hour long shifts).Operators spend 70-80% of their time in the control/lab monitoring the process and analyzing samples.Formaldehyde loading takes 40 minutes. (operator only spends 3 minute/truck)Rail car loading takes 2 hours per rail car.		
Exposure frequency:	Depressed economic conditions have reduced this normal operation schedule to 5 days per week.		
Number of workers:	Currently, the plant has 8 employees: 2 supervisory personnel, 2 maintenance workers, and 4 operators		
Personal protective equipment:	Emergency eye wash and shower units are located at the formaldehyde truck loading area, next to the refrigeration unit in the production unit, and at the methanol unloading/formaldehyde rail car loading area.Specific PPE requirements are as follows:Formaldehyde loading: Water-proofed cotton gloves.Formaldehyde solution sample withdrawal: neoprene gloves.Formaldehyde storage tank entry: air-supplies respirator, water-proofed cotton gloves.Maintenance formaldehyde or methanol leak repair: Full-face gas mask approved for acid gases, organic vapors, dusts, and mists for a major leak, water-proofed cotton gloves if there is a potential for formaldehyde skin contact.		
Engineering control:	Nonfluid seals for pumps. Laboratory hoods are used in the sampling area.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
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Formaldehyde

Occupational Exposure

HERO ID: 8728034 Table: 1 of 1

...continued from previous page			
Study Citation:	Monsanto Research Corp, (1983). Detailed industrial hygiene survey: Formaldehyde production, Reichhold Chemicals, Incorporated, Hampton, South Carolina.		
HERO ID:	8728034		
Conditions of Use:	Manufacture		
Domain	Metric	EVALUATION Rating	Comments
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by sampling multiple areas and worker activities.
Overall Quality Determination		High	

Study Citation:	Monsanto Research Corp, (1982). Preliminary plant visit: Industrial hygiene report, formaldehyde production facility, Reichhold Chemicals Incorporated, Moncure, North Carolina.
HERO ID:	8728037
Conditions of Use:	Manufacture

EXTRACTION	
Parameter	Data
Worker activity description:	Operators’ responsibilities include unloading the methanol, operation of the formaldehyde and resin units, transferring the formaldehyde to blending and storage tanks, and sampling and analyzing the formaldehyde solution.
Exposure route:	Inhalation
Physical form:	Vapor
Personal sampling data:	Chief operator - formaldehyde and resin units: 0.11 (ppm)Operator - formaldehyde and resin units: 0.27 (ppm)Maintenance worker: 0.24 (ppm)Operator loading formaldehyde into a tank truck: 0.05 (ppm)
Exposure duration:	8 hour shifts/day
Number of workers:	The plant employs 29 workers including 14 workers that are involved with -formaldehyde and resin production.
Personal protective equipment:	All employees are required to wear safety shoes and hard hats inthe operating area. Workers performing formaldehyde loading also wear splash proof goggles and rubber gloves. Other PPE available for use at the worker discretion includes earplugs, face shields, supplied air respirators, self-contained breathing apparatus, and cartridge gas masks. The plant has a written respiratory program that is currently being revised to accommodate the new OSHA workplace air standards applicable to the plant.
Engineering control:	Vaporizer and Converter: The operations are located in the open air structure which allows adequate ventilation of the area. Flanges and high temperature gaskets are used on all connective piping and fittings from the vaporizer to the reactor.Aftercooler: The hot formaldehyde gases from the converter are cooled in an aftercooler before entering the absorber. The aftercooler is completely enclosed with limited worker exposure hazard.Absorber: This Gould centrifugal, single mechanical seal transfer pump showed evidence of minimal formaldehyde leakage. The seal worked well, but still allowed some leakage as evidenced by small paraformaldehyde deposits.Truck loading area: The loading area is equipped with a blower that blows the vapors from the open truck port away from the operator.Control Room and Laboratory Area: Ventilation consists of an air conditioning vent in the ceiling as well as an exhaust/ventilation fan unit in the ceiling.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				

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Formaldehyde

Occupational Exposure

HERO ID: 8728037 Table: 1 of 1

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Study Citation:	Monsanto Research Corp, (1982). Preliminary plant visit: Industrial hygiene report, formaldehyde production facility, Reichhold Chemicals Incorporated, Moncure, North Carolina.			
HERO ID:	8728037			
Conditions of Use:	Manufacture			
		EVALUATION		
Domain		Metric	Rating	Comments
	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by sampling multiple workers.
Overall Quality Determination			High	

Study Citation:	Monsanto Research Corp, (1981). Preliminary plant visit industrial hygiene report: Formaldehyde production facility, Monsanto Plastics and Resins Company, Eugene, Oregon.			
HERO ID:	8728039			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	Operators handle all aspects of formaldehyde production including unloading methanol from railroad tank cars, sampling and analysis of the process streams at several points, and operating and monitoring the process from the control room.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	(1977) 0.7-1.98ppm; (1980) 0.09-0.19ppm, Two short-term personal samples (38 and 30 minutes duration) were taken by the production supervisor on formalin operators while they were drawing product samples for analysis in the production lab. Results were 0.12 and 0.14 ppm; (1981) 0.21ppm short term sample done by OSHA			
Area sampling data:	An area sample was taken in the production lab (Tenex sample tube, 427 minute sample duration) with results of 0.25 ppm.			
Exposure duration:	Each crew works an 8-hour shift.			
Number of workers:	The entire plant, including formaldehyde and resin productionoperations, laboratory research, and a sales group, totals 31 nonunion employees.			
Personal protective equipment:	Safety glasses and hard hats are required for anyone working in orobserving any of the production facilities. All production workers are furnished safety glasses, safety shoes, and hard hats, as well as work clothes, which are laundered weekly by the plant. Chemical goggles, a face shield, and protective gloves are provided for routine operations, such as unloading of methanol or formalin. Cabinets of protective clothes are located throughout the facilities for easy use. Entry into the formalin bulk storage tank for the purpose of cleaning and removal of paraformaldehyde requires that the operator wear a complete protective suit, boots, and a self-contained breathing apparatus.			
Engineering control:	Ventilation in the reactor room is provided by two roof vents in theceiling. The control room/laboratory is located directly adjacent to the reactor room. Here, the operator tests the solutions for formaldehyde concentration and monitors the process. The area isequipped with chemical hoods, which vent to the outside, as wellas a 12-15 inch diameter fan in a side wall. All sample preparationand analysis work is done inside the hoods except for determiningthe refractive index.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 8728039 Table: 1 of 1

...continued from previous page

Study Citation:		Monsanto Research Corp, (1981). Preliminary plant visit industrial hygiene report: Formaldehyde production facility, Monsanto Plastics and Resins Company, Eugene, Oregon.		
HERO ID:		8728039		
Conditions of Use:		Manufacture		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by area and personal sampling.
Overall Quality Determination			High	

Study Citation:	Mundt, K.A., Gentry, P.R., Dell, L.D., Rodricks, J.V., Boffetta, P. (2018). Six years after the NRC review of EPA’s Draft IRIS Toxicological Review of Formaldehyde: Regulatory implications of new science in evaluating formaldehyde leukemogenicity. Regulatory Toxicology and Pharmacology 92:472-490.			
HERO ID:	4454061			
Conditions of Use:	Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Garment workers			
Area sampling data:	geometric mean 0.15; geometric standard deviation: 1.90 (1988); ”The formaldehyde resins used to treat permanent press fabrics had been reformulated over time, and as a result, the formaldehydeconcentrations measured in the early 1980s were believed to be lower than the approximately 4 ppm estimated by NRC for yearsprior to 1970 ”(p.480) ”Zhang et al. (2010a) and Lan et al. (2015) in which the median exposures to 43 workers were 1.28 ppm (10th and 90th percentile: 0.63, 2.51 ppm)”(p.485)			
Number of workers:	11,043 garment workers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for finishing agents in fabric, textile, and leather manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1980s)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent. Its unclear for some estimates if they are measured, does not provide sampling or methodology details.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Musak, L., Smerhovsky, Z., Halasova, E., Osina, O., Letkova, L., Vodickova, L., Polakova, V., Buchancova, J., Hemminki, K., Vodicka, P. (2013). Chromosomal damage among medical staff occupationally exposed to volatile anesthetics, antineoplastic drugs, and formaldehyde. Scandinavian Journal of Work, Environment and Health 39(6):618-630.		
HERO ID:	1597510		
Conditions of Use:	Laboratory Use		
EXTRACTION			
Parameter	Data		
Worker activity description:	Preparation of cytostatics for pathology laboratory use		
Exposure route:	Inhalation		
Area sampling data:	0.32 (mg/m^3)		
Number of workers:	Per Table 3A, 105 total are exposed to formaldehyde		
Personal protective equipment:	Protective clothing and gloves		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from the Slovak Republic, an OECD country.
	Metric 3: Applicability	High	Data are for Laboratory chemical use, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Assessment is based on current industry conditions and data no more than 10 years old. (2013)
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1254211 Table: 1 of 1

Study Citation:	(1998). Health Hazard Evaluation Report HETA 97-0154-2693, Siemens Energy and Automation, Inc., Distribution Products Division, Urbana, Ohio.			
HERO ID:	1254211			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	The formation of circuit breaker cases are formed by compression molding presses using styrene and vinyl toluene-based molding compounds.			
Exposure route:	inhalation, ingestion			
Physical form:	liquid, dust			
Personal sampling data:	«0.45 micrograms per cubic meter to 2.6 ug/m3			
Area sampling data:	0.025 and 0.018 (ppm)			
Engineering control:	Local exhaust ventilation			
Comments:	see table 3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for plastic material and resin production, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1998)	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by personal and area sampling.	
Overall Quality Determination		High		

Study Citation:	National Toxicology Program (NTP), (2016). Report on carcinogens, fourteenth edition: Formaldehyde.			
HERO ID:	5160139			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	"Occupational exposure to formaldehyde is highly variable and can occur in numerous industries... In the past, the highest continuous exposure levels were measured during the varnishing of furniture and wooden floors, during the finishing of textiles, in the garment industry, during the treatment of furs, and in certain jobs in manufactured board mills and foundries. Short-term exposure to high levels of formaldehyde has been reported for embalmers, pathologists, and paper workers. Lower levels of exposure have usually been reported for the manufacture of synthetic vitreous fibers, abrasives, and rubber, and in formaldehyde production (IARC 2006)." (7/11)			
Exposure route:	inhalation, dermal, ingestion (6/11)			
Physical form:	Gas & particulates, liquid resins (7/11)			
Personal sampling data:	"In the United States, high exposure levels were reported for formaldehyde-based resin production (mean concentrations of up to 14.2 ppm), plastic product production (up to 38.2 ppm) (Stewart et al. 1987), embalming (up to 2.6 ppm) (Stewart et al. 1992), biology teaching laboratories (up to 8.3 ppm) (EPA 1981), and pathology autopsy laboratories (up to 4.35 ppm)" (7/11)			
Number of workers:	""In the late 1980s, OSHA estimated that over 2 million U.S. workers were exposed to formaldehyde, about 45% of whom worked in the garment industry (USDL 2009)."" (7/11)"			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are from numerous different industries and situations, all of which are in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on current industry conditions but data is generally between 10 and 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	operators could be exposed to formaldehyde during abnormal operations, such as mechanical failure of hoses or seals and failure to ensure all hatches and chutes are closed. Exposure could also occur during the following activities or events: sample collection and testing, truck loading and unloading, filling of drums, equipment cleaning and maintenance, opening of tanks and equipment, and spills.			
Exposure route:	Inhalation, Dermal			
Physical form:	Vapor, liquid			
Personal sampling data:	Almost all long-term personal monitoring results (except at site number 7 in Table 15.2a) were 0.5 ppm, with the majority of them (88 out of 95) 0.2 ppm. One high reading (1.96 ppm) was measured when formaldehyde vapours were released during flushing of the formaldehyde pump and opening of tanker hatches by a driver. The data from site number 7, which has the most number of samples (176), showed a similar pattern, with 76 out of 89 showing readings 0.5ppm , in which 63 readings were 0.2ppm. The company claimed that exposures in the plant operating environment and laboratory were typically less than 0.1 ppm for the duration of 12 hour (operators) and 8 hour (laboratory staff) shifts. Similarly, most of the short-term measurement results were less than 0.5 ppm (66 out of 87).			
Area sampling data:	out of 50 sample results are 0.2 ppm (Table 15.2b). The majority of short-term static measurements were also 0.2 ppm, with 11 out of 74 samples in the result band of > 0.5 ppm to 2 ppm. Weekly static monitoring (100 samples in total between year 2001 and April 2003) was undertaken at site number 9 and most of readings were < 0.2 ppm. The company reported that the highest routine exposures are 0.5 ppm to 1 ppm during sampling and testing.			
Exposure duration:	At large resin manufacturing sites, typically 10 to 20 samples per shift are taken manually from sample ports of the reactors and tested for viscosity and pH. Sampling takes less than 5 minutes. Small amounts of resin (as samples) are also made in the laboratory approximately 2 times per shift and take 4 to 5 hours to test each time.			
Exposure frequency:	The frequency of the reaction tower cleaning varies from site to site and ranges from once every 6 months to 3 years.			
Personal protective equipment:	workers are required to wear safety glasses, gloves, overalls and safety footwear when handling formaldehyde or formaldehyde resins at all sites. Full-face air supplied respirators or breathing masks are worn during truck loading at two companies. Local exhaust ventilation and general ventilation are used for loading and packaging areas at the majority of workplaces. Equipment cleaning: the tasks are conducted by specially trained personnel while the manufacturing operation is shut down. The required personal protective equipment (PPE), such as air- supplied breathing apparatus for working in confined spaces, is used.			
Engineering control:	All laboratories have fume hoods. Local exhaust ventilation is also available in a laboratory which houses experimental resin reactors.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The report provides sampling method and is from a frequently used source, which is generally accepted by the scientific community (NICNAS)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 192040 Table: 1 of 17

...continued from previous page			
Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Processing as a reactant		
Domain	Metric	EVALUATION Rating	Comments
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	The report provides limited discussion on variability but no discussion of uncertainty.
Overall Quality Determination		High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Manufacture		
EXTRACTION			
Parameter	Data		
Worker activity description:	production and maintenance, quality control, laboratory and storage; includes workers in the resin manufacturing plants as workers have dual roles in formaldehyde and resin production at most sites; workers’ exposure could result from truck loading and/or drum filling and from situations where there is a need to break open or enter the enclosed system, such as sample collecting and testing, equipment cleaning and maintenance.		
Exposure route:	Inhalation, Dermal		
Physical form:	Vapor, liquid		
Personal sampling data:	”The majority of the personal sample results (40 out of 41) were less than or equal to 0.2 ppm during 8 to 12 hours shifts. A result of 0.5 ppm (measured for about half an hour) was found during formaldehyde drum filling.”		
Area sampling data:	”The majority of 8h TWA static samples (13/16) and short-term (15 minutes) static samples (24/28) were less than or equal to 0.2 ppm. Four out of 16 peak static samples had readings above 0.5 ppm and up to 2 ppm. There were two high peak static readings (2.67 and 6.08 ppm) measured at a formaldehyde plant bund and a storage area. No information on the interpretation of these high readings is available.” ”In the 1980s, the mean levels of formaldehyde in workroom air at formaldehyde manufacture plants ranged from 0.2 ppm to 0.7 ppm (IARC, 1995).”		
Exposure frequency:	Sampling: 3 to 4 times per shift; maintenance is about once every one to three years		
Number of workers:	120		
Personal protective equipment:	Operators wear overalls, helmet, gloves, safety glasses and boots during normal duties at production plants. Respiratory protection equipment is available and used where exposures are likely to be high, such as reaction chamber/absorber tower cleaning (confined spaces) and dealing with major spills.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The report provides sampling method and is from a frequently used source, which is generally accepted by the scientific community (NICNAS)
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The data used is from (1998-2002) and 1980s, therefore more than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides limited discussion on variability but no discussion of uncertainty.
Overall Quality Determination		Medium	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Distribution in Commerce		
EXTRACTION			
Parameter	Data		
Worker activity description:	Due to off-gassing of formaldehyde resin products, such as from furniture and pressed wood panels, the levels of formaldehyde in transport containers can build up.		
Exposure route:	inhalation		
Physical form:	gas		
Area sampling data:	An incident was reported when workers opened a truck container of trestle tables imported from overseas and immediately fell sick and vomited. Air monitoring of the container (using NIOSH Method 2016) was conducted for a number of substances and found only formaldehyde levels (3.1 mg/m ³) exceeded the current occupational exposure standard (Personal communication, 2004).		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (NICNAS report) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country (Australia) other than the U.S.
	Metric 3: Applicability	High	The assessment is for an occupational scenario (unloading) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The completed exposure or risk assessment is generally, more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The assessment does not address variability or uncertainty on the extracted data.
Overall Quality Determination		Medium	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Incorporation into formulations, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Worker activity description:	Dermal: manual charging of mixing vessels, mixing and inspection, filling of product containers and equipment cleaning. Inhalation:especially during charging of formalin into open vessels, heated blending processes and high-speed mechanical stirring in open tanks. Sampling is usually conducted at the end of mixing and samples are taken through a sampling tap at the bottom of the mixing vessel. Equipment is cleaned between different productsby hosing with pressured water or using cleaning solvents.			
Exposure route:	Inhalation, Dermal			
Physical form:	Liquid, Vapor			
Personal sampling data:	There were few long-term personal samples, and mostof those reported were < 0.2 ppm. Short-term sampling results ranging from 0.3 ppm to 2 ppm were measured during raw material weigh-up, equipment cleaning and maintenance.Full data is provided in Table 15.3 (pg. 194)			
Area sampling data:	Static results measured at a blending platform, mixingtank opening and filling line range from 0.5 ppm to 1.5 ppm, with measurement duration of 10 minutes. One static reading of 2.24 ppm was found during bulky box tank filling.Full data is provided in Table 15.3 (pg. 194)			
Exposure duration:	usually an intermittent process of a few hours			
Exposure frequency:	varies, formaldehyde products may not always be used.			
Personal protective equipment:	The majority of formulators reported that workers wear safety glasses and gloves when handling formalin and products containing formaldehyde. At some workplaces workers are required to wear overalls, safety footwear and aprons.Respiratory protection equipment, such as half-face masks, full-face visors and full-face powered air respirators, are available at most of the workplaces, and are worn when exposure is likely to be high, such as manual loading and open mixing.			
Engineering control:	Exhaust ventilation above the mixing tank is used at the majority of the workplaces. Some sites have roof exhaust ventilation and industrial fans. Six formulators reported that the workplace relies on natural ventilation only and four did not provide any information on engineering controls.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The report provides sampling method and is from a frequently used source, which is generally accepted by the scientific community (NICNAS)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides limited discussion on variability but no discussion of uncertainty.
Overall Quality Determination		High		

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Repackaging		
EXTRACTION			
Parameter	Data		
Worker activity description:	Exposure of workers to formaldehyde is limited to accidental spills or leakages during repackaging as the processes are usually fully or partially enclosed, of relatively short duration and usually infrequent. Both skin and inhalation exposures to formaldehyde are likely during the manual repackaging of paraformaldehyde powder because formaldehyde-containing dusts can be generated during the process		
Exposure route:	dermal and inhalation		
Physical form:	liquid, dust		
Personal protective equipment:	PPE (such as gloves, overalls, safety glasses or goggles) is reportedly used at five repackaging companies. One company reported that all activities are conducted in a booth fitted with an extraction fan system and all workers wear respirators with gas and particle cartridges, rubber gloves, goggles, hair cover and dust coat.		
Engineering control:	Of 5 reported repackaging sites: 3 had exhaust ventilation while 2 had general ventilation and use of industrial fans.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses sound collection methods that are from a frequently used source (NICNAS report) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country (Australia) other than the U.S
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	N/A	N/A- no sampling data extracted.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides discussion on variability between sites but no discussion of uncertainty.
Overall Quality Determination		High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Laboratory Use		
EXTRACTION			
Parameter	Data		
Worker activity description:	Formalin solutions containing 4% formaldehyde are commonly used in the forensic /hospital mortuaries and pathology laboratories including histopathology and anatomical laboratories. However, solutions containing higher levels of formaldehyde (up to 32%) are also handled during dilution. There is a potential for dermal exposure to formalin products through spills or splashes onto skin or eyes during some processes, such as manual dilution of the concentrated formalin solutions and dispensing solutions from storage tanks to specimen jars. There is also potential for inhalational exposure to formaldehyde fumes during fixing and accessioning human tissues and organs.		
Exposure route:	inhalation, dermal		
Physical form:	liquid		
Personal sampling data:	Personal sampling results ranged from 0.02 ppm to 3.15 ppm. Full data provided in Table 15.6a (pg. 202)		
Area sampling data:	Static monitoring results ranged from <0.1 to >4 ppm. Full data provided in Table 15.6b (pg. 203-204) and Table 15.7 (pg. 205)		
Exposure duration:	varies depends on role		
Exposure frequency:	Usually daily for staff at forensic/hospital mortuaries and pathology but other staff varies		
Personal protective equipment:	Examination gloves, safety glasses and laboratory gowns are worn at the majority of laboratories/mortuaries. It was reported that respirators are also used when preparing large amounts of formalin solutions used in forensic medicine areas or anatomy laboratories.		
Engineering control:	The majority of laboratories/mortuaries are equipped with local exhaust systems and some also have an exhaust system for the whole area.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Sampling methods are provided but vary from NIOSH methods to formaldehyde meters, the assessment is from a frequently used source (NICNAS report) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., Australia.
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Report is between 10 years and 20 years old but most of the data sources of cited monitoring data is prior to 2002 (20 years old).
	Metric 5: Sample Size	Medium	characterized by a ranges or means with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 192040 Table: 6 of 17

...continued from previous page			
Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Laboratory Use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	incorporation into the article: Wood Products		
EXTRACTION			
Parameter	Data		
Worker activity description:	During particleboard and MDF manufacture, operators are likely to be exposed to formaldehyde from the hot press procedure and onwards (see Figure 7.5), as the formaldehyde resins are handled in enclosed systems in the processes before the hot press. However, potential exposure could occur in situations where there is a need to break open or enter the enclosed system, such as equipment cleaning and maintenance. Typically, filters in the resin storage tanks are cleaned manually 1 to 2 times per shift and the task takes about 10 minutes each time. The storage tanks are cleaned yearly for melamine urea formaldehyde resin and once in 3 to 4 years for urea formaldehyde resin.		
Exposure route:	inhalation, dermal		
Physical form:	liquid, solid		
Personal sampling data:	In plywood mills, most long-term personal monitoring results (61/71) were < 0.3 ppm. No short-term personal monitoring data was provided. It appears that formaldehyde levels are higher at mills using urea formaldehyde resin. In particleboard and MDF mills, limited data showed that most of long-term samples were < 0.3 ppm (5/8 for personal samples, 12/17 for static samples). No short-term data was available.Full monitoring data provided in Table 15.4 and Table 15.5 (pg. 197-199).		
Area sampling data:	Most of the long- term static data (31/34) showed levels < 0.3 ppm.Full monitoring data provided in Table 15.4 and Table 15.5 (pg. 197-199).		
Number of workers:	500 operative staff work in the processes of glue mixing, glue spreading, panel lay-up and pressing for plywood manufacturing(Australia).		
Personal protective equipment:	Basic PPE (gloves, safety glasses and clothing) is worn at most sites during handling of formaldehyde resin products. Some reported use of respiratory protection during glue mixing. One company using formaldehyde resin in making hardboards reported that it does not use any PPE.		
Engineering control:	Half the number of companies using formaldehyde resins or products containing formaldehyde resins have local or roof exhaust ventilation in place. Others rely on general ventilation.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Most of the monitoring data cites NIOSH studies, the assessment is from a frequently used source, and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ processtechnologies) may impact exposures or releases relative to the U.S.
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Most of the data is from more than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a ranges or maximums with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 192040 Table: 7 of 17

...continued from previous page			
Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	incorporation into the article: Wood Products		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Furniture manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	Pressed wood products are used industrially in furniture and cabinet making and also have do-it-yourself (DIY) applications. The atmosphere created by machining the products, such as fitting, sawing/cutting and sanding, contains a mixture of wood dusts, free formaldehyde, dust particles onto which formaldehyde is absorbed and, potentially, the resin binder itself and derivatives. Therefore, workers are likely to inhale airborne formaldehyde.		
Exposure route:	inhalation		
Physical form:	gas, dust		
Personal sampling data:	The data in 2001-2003 were provided and are summarised in Table15.4 (pg. 197-199). The majority of personal samples (154 out of 159) showed formaldehyde levels < 0.2 ppm in workers’ breathing zones.Full monitoring data provided in Table 15.4 and Table 15.5 (pg. 197-199).		
Personal protective equipment:	Basic PPE (gloves, safety glasses and clothing) is worn at most sites during handling of formaldehyde resin products. Some reported use of respiratory protection during glue mixing. One company using formaldehyde resin in making hardboards reported that it does not use any PPE.		
Engineering control:	Half the number of companies using formaldehyde resins or products containing formaldehyde resins have local or roof exhaust ventilation in place. Others rely on general ventilation.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is cited but not NIOSH/OSHA/EPA methods, assessment is from a frequently used source (NICNAS) and are generally accepted by the scientific community, andassociated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ processtechnologies) may impact exposures or releases relative to the U.S.
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The completed risk assessment is more than 10 years but less than 20 years old (2006), however, monitoring data is more than 20 years old (~2000).
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.
Overall Quality Determination		Medium	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Use of paints/coating			
EXTRACTION				
Parameter	Data			
Worker activity description:	The use process of formaldehyde resins in other industries (Section 7.3.3) involves basically dilution and/or mixing with other ingredients and then a drying process to make the resin set. Some uses, such as paper treating and coating, also involve hot pressing after drying. The methods of application of the resin product vary largely and include dipping/bathing (paper treating and coating, textile finishing and leather tanning), brushing (composite construction), spraying (fibreglass industry and anti-graffiti wall sealer manufacture), use of mop/bristle rollers, and use of mechanical equipment, such as print screen and dyeing machines in textile printing and dyeing.			
Exposure route:	inhalation, dermal			
Physical form:	liquid			
Area sampling data:	Static levels of up to 0.5 ppm were measured in coater rooms using paints containing formaldehyde.Full data provided in Table 15.4 and Table 15.5 (pg. 197-199)			
Exposure duration:	ranges from couple of minutes to continuous use.			
Personal protective equipment:	Basic PPE (gloves, safety glasses and clothing) is worn at most sites during handling of formaldehyde resin products. Some reported use of respiratory protection during glue mixing.			
Engineering control:	half the number of companies using formaldehyde resins or products containing formaldehyde resins have local or roof exhaust ventilation in place. Others rely on general ventilation.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Monitoring data used NIOSH 2541 and he assessment are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., Australia
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Core-making			
EXTRACTION				
Parameter	Data			
Worker activity description:	The use process of formaldehyde resins in other industries (Section 7.3.3) involves basically dilution and/or mixing with other ingredients and then a drying process to make the resin set. Some uses, such as paper treating and coating, also involve hot pressing after drying. The methods of application of the resin product vary largely and include dipping/bathing (paper treating and coating, textile finishing and leather tanning), brushing (composite construction), spraying (fibreglass industry and anti-graffiti wall sealer manufacture), use of mop/bristle rollers, and use of mechanical equipment, such as print screen and dyeing machines in textile printing and dyeing.			
Exposure route:	inhalation, dermal			
Physical form:	liquid, solid			
Personal sampling data:	Long-term personal sampling during core making indicated that most samples (13/17) were >0.3 ppm. It was noted that the formaldehyde levels reduced significantly after process modification.Full data provided in Table 15.4 and Table 15.5 (pg. 197-199)			
Personal protective equipment:	Basic PPE (gloves, safety glasses and clothing) is worn at most sites during handling of formaldehyde resin products. Some reported use of respiratory protection during glue mixing.			
Engineering control:	half the number of companies using formaldehyde resins or products containing formaldehyde resins have local or roof exhaust ventilation in place. Others rely on general ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Monitoring data used other methods than NIOSH/OSHA methods, risk assessment is generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Australia
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Firelighter Manufacturing		
EXTRACTION			
Parameter	Data		
Worker activity description:	The use process of formaldehyde resins in other industries (Section 7.3.3) involves basically dilution and/or mixing with other ingredients and then a drying process to make the resin set. Some uses, such as paper treating and coating, also involve hot pressing after drying. The methods of application of the resin product vary largely and include dipping/bathing (paper treating and coating, textile finishing and leather tanning), brushing (composite construction), spraying (fibreglass industry and anti-graffiti wall sealer manufacture), use of mop/bristle rollers, and use of mechanical equipment, such as print screen and dyeing machines in textile printing and dyeing.		
Exposure route:	inhalation, dermal		
Physical form:	liquid		
Area sampling data:	Static levels <0.5 ppm were measured .Full data provided in Table 15.4 and Table 15.5 (pg. 197-199)		
Exposure duration:	ranges from couple of minutes to continuous use.		
Personal protective equipment:	Basic PPE (gloves, safety glasses and clothing) is worn at most sites during handling of formaldehyde resin products. Some reported use of respiratory protection during glue mixing.		
Engineering control:	half the number of companies using formaldehyde resins or products containing formaldehyde resins have local or roof exhaust ventilation in place. Others rely on general ventilation.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Monitoring data used detector tubes and he assessment are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., Australia
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.
Overall Quality Determination		Medium	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Photographic film processing		
EXTRACTION			
Parameter	Data		
Worker activity description:	Aerial and commercial film processing use products containing formaldehyde. Although the formaldehyde concentrations in the products used in aerial film processing are high (20% to 35%), the potential for workers’ exposure to formaldehyde is limited as the film processing is conducted in an enclosed machine. Short exposures are possible during the connection of the drum to the machine and during drum changeover. There is a potential for exposure during manual film processing when handling solutions containing 10% formaldehyde, as this operation is usually conducted in open trays in a dark room. However, the operation occurs only occasionally as trials in aerial film processing.		
Exposure route:	inhalation, dermal		
Physical form:	liquid		
Personal sampling data:	Measured data: range of formaldehyde levels from < 0.01 ppm to 0.9 ppm in film processing plants. (cited data from IARC,1999)Modeled data: The predicted inhalational exposure to formaldehyde during film processing is 0 to 0.1 ppm (0-0.12 mg/m3). (EASE model)		
Number of workers:	The number of workers involved in aerial film processing is unknown, but is limited as the number of specialised film processing companies is small. However, there are more than 1000 commercial film processing machine operators in Australia using final baths and stabilisers containing formaldehyde.		
Personal protective equipment:	At aerial film processing sites- besides the basic PPE (gloves, goggles and protective clothing), respiratory protection is also used during changing of drums at some workplaces. Commerical- Workers wear gloves during handling formaldehyde products.		
Engineering control:	Exhaust systems inside the processing machines and floor level exhaust systems are available at aerial film processing sites. At the commercial film site visited, roof exhaust fans, industrial fans and general ventilation were used for ventilation		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Data source is provided for monitoring data but not the methodology; the assessment are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., Australia
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	Monitoring data is more than 20 years old but modeling results are more than 10 years but less than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.
Overall Quality Determination		Medium	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Leather Tanning			
EXTRACTION				
Parameter		Data		
Worker activity description:		Workers may be potentially exposed for short durations to formaldehyde during dilution and loading of the working solution. The leather tanning process using formalin solutions is described in Section 7.3.3 and the concentrations of formaldehyde range from 10% to 37%, although they are diluted into a 1:10 working solution for treating leather.		
Exposure route:		inhalation, dermal		
Physical form:		liquid		
Personal protective equipment:		Workers normally wear gloves, apron, rubber boots and safety glasses.		
Engineering control:		It was reported in one workplace that a local exhaust fan is in place and all lids are closed during dilution		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., Australia
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The assessment is more than 10 years but less than 20 years old.
	Metric 5:	Sample Size	N/A	N/A- no sampling data extracted.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 192040 Table: 14 of 17

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Use of Lubricant			
EXTRACTION				
Parameter	Data			
Worker activity description:	Although some lubricant products contain > 0.2% formaldehyde, the working solutions are usually diluted before use and used in an enclosed system (Section 7.3.3). Therefore, the potential for worker exposure is limited to time spent in dilution of the product, which is a short and infrequent operation. Monitoring data were not identified, but the exposure to formaldehyde is considered negligible.			
Physical form:	liquid			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., Australia
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is more than 10 years but less than 20 years old.
	Metric 5:	Sample Size	N/A	N/A- no sampling data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	non-TSCA			
EXTRACTION				
Parameter	Data			
Worker activity description:	Although formalin (containing 37% to 40% formaldehyde) is used as an additive to sanitise water treatment plants, this operation is only undertaken occasionally (about once a year). Workers may be exposed to formalin solutions during sanitisation of bins and portable toilets, especially exposure by the skin through spills and splashes. The concentrated formalin solutions are diluted to 1% before end use.It is unlikely that workers are exposed to formaldehyde gas during workplace fumigation, as access to the area is restricted and activation of the fumigation generators and air conditioning is remote controlled. The levels of formaldehyde are monitored and must be less than 0.2 ppm before access is allowed. Workers may be exposed to formaldehyde during transfer of the paraformaldehyde granules into gas generators and during disposal of the residue, but the durations are short for these activities.			
Exposure route:	inhalation, dermal			
Physical form:	liquid			
Exposure frequency:	once a year (sanitizing)			
Personal protective equipment:	It was reported that rubber gloves, face shield and apron are used during the operation. Respirators are available for use in situations when high levels of formaldehyde fumes may occur, for example, cleaning up spills.Fumigation: latex gloves, overalls and airflow helmet with cartridge filter are used by operators			
Engineering control:	Local exhaust ventilation is available for dilution and dispensing of the solutions. It			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., Australia	
	Metric 3: Applicability	Uninformative	The assessment is from an occupational scenario that does not apply to any occupational scenario within the scope of the risk evaluation (non-TSCA).	
	Metric 4: Temporal Representativeness	Medium	The assessment is more than 10 years but less than 20 years old.	
	Metric 5: Sample Size	N/A	N/A- no sampling data extracted.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.	
Overall Quality Determination		Uninformative		

Formaldehyde

Occupational Exposure

HERO ID: 192040 Table: 16 of 17

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Other Uses: Garage, Metalworking fluid, Analytical Lab			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Personal sampling data:	Garage: 0.04ppm; Metal working fluid: 0.04ppm; Monitoring data conducted in analytical laboratories at resin and wood product manufacturing sites (Table 15.2a, 15.2b and Table 15.4) showed formaldehyde levels ranging from < 0.1 ppm to up to 0.2 ppm. A study measuring formaldehyde in chemical and dental laboratories using passive sampler technique showed results of 0.02 ppm to 0.03 ppm (Gillett, 2000).			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Monitoring data used passive samplers and portable pumps and the assessment are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., Australia
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data is more than 10 years old but less than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a mean with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Worker activity description:	Embalmers are likely to be exposed by skin contact through spills or splashes onto skin or eyes during handling processes, such as dilution, arterial and cavity embalming, cleansing and disinfections of body surfaces and orifices, and equipment cleaning by hosing. Spills and splashes during embalming were observed at the site visited. The likelihood of exposure by inhalation is also high during embalming, such as during dilution of concentrated formalin solutions, application of the solution by spraying, and handling viscera covered with paraformaldehyde powder. Other staff involved in handling embalmed bodies, such as body dressing up and body lifting, may also be exposed to formaldehyde.			
Exposure route:	inhalation, dermal			
Physical form:	liquid			
Personal sampling data:	Ranges from <0.1 to 3.9 ppm Monitoring data during embalming in funeral homes and anatomy dissection laboratories were provided and are summarized in Table 15.8a and 15.8b, respectively (pg. 207-208).			
Area sampling data:	Ranges from 0.21 to 1.1 ppmMonitoring data during embalming in funeral homes and anatomy dissection laboratories were provided and are summarized in Table 15.8a and 15.8b, respectively (pg. 207-208).			
Exposure duration:	The duration of embalming a body varies depending on body conditions and customers’ requirements, but usually takes 1 to 3 hours. The majority of the embalmers operate on a daily basis and exposure durations vary from 1 to 10 hours a day.			
Number of workers:	approximately 350 embalmers in Australia.			
Personal protective equipment:	Embalmers wear PPE during embalming including safety goggles, surgical gloves, theatre gown, disposable apron and rubber boots. Respiratory protection equipment is not usually used, although half masks and air-supplied respirators are available at some funeral homes.			
Engineering control:	Ventilation systems installed in embalming rooms vary at different funeral homes. In general, new premises are fitted with an airflow system that blows fumes away from embalmers, together with an exhaust fan to extract the fumes. Whereas, in old buildings, usually only an exhaust fan is available. It was reported that some mortuaries do not have exhaust ventilation.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Monitoring data uses various methods but most follow NIOSH or OSHA methods; The assessment are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., Australia
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 192040 Table: 17 of 17

...continued from previous page			
Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Embalming		
		EVALUATION	
Domain	Metric	Rating	Comments
	Metric 7: Metadata Completeness	Medium	The assessment addresses variability but not uncertainty in the results.
Overall Quality Determination		Medium	

Study Citation:	NIOSH, (1973). Health hazard evaluation: union pacific railroad.			
HERO ID:	1317912			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Area sampling data:	11/9/72 (Shift 1)Station 1: 0.015 ppmStation 3: 0.015 ppmStation 5: 0.015 ppmStation 7: 0.015 ppmStation 9: 0.015 ppm11/9/72 (Shift 2)Station 1: 0.02 (ppm)Station 3: 0.02 (ppm)Station 5: 0.2 (ppm)Station 7: 0.02 (ppm)Station 9: 0.05 (ppm)11/10/72 (Shift 1)Station 1: 0.07 (ppm)Station 3: 0.06 (ppm)Station 5: 0.045 (ppm)Station 7: 0.07 (ppm)Station 9: 0.05 (ppm)			
Exposure frequency:	The facility is in operation 7 days/week.			
Number of workers:	125 employees			
Engineering control:	Ten ceiling exhaust fans are used.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for fuels and related products, which is an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by considering different areas of the facility.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-054-1010. Environmental Protection Agency, San Francisco, CA.		
HERO ID:	8585844		
Conditions of Use:	Exposure to diesel exhaust.		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation		
Physical form:	vapor		
Area sampling data:	Six area air samples were collected for formaldehyde; however, none was detected on either section of the impregnated charcoal tube. The analytical limit of detection was four and two micrograms for the front and backup section of the charcoal tube respectively.		
Exposure duration:	8 hours per day		
Exposure frequency:	40 hours per week		
Number of workers:	400		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	Low	The assessment is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The assessment does not address variability or uncertainty.
Overall Quality Determination		Low	

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-056-854. New Carolina Industries, Weldon, NC.			
HERO ID:	8586872			
Conditions of Use:	fabric, textile, and leather products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers at a garment production store cutting fabric, sorting pieces, operating sewing machines, inspecting garments, and moving throughout the plant. (3/11)			
Exposure route:	inhalation, dermal (2/11)			
Physical form:	gas (2/11)			
Personal sampling data:	Personal sampling results (8h TWA) ranged from 0.20 ppm for cutters/spreaders to 0.63 ppm for inspectors/ironers. (9/11)			
Area sampling data:	Area samples ranged from 0.20 ppm in the cutting/spreading area and blouse department to 0.42 ppm in the cutting/spreading area. The instantaneous maximum was 1.12 ppm in the middle of the shirts and blouses department. (8/11)			
Exposure duration:	8 hours (3/11)			
Number of workers:	127 employees (2/11)			
Engineering control:	The heating, ventilation and air conditioning system of the work area consists of 8 units hung from the ceiling. These have outlet filters for particulates which are cleaned periodically. Air is recycled within the building and the only make-up air drawn into the building is through natural spaces around doors and windows. There are no air exhaust or supply vents. (4/11)			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	The data are from the United States.
		Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
		Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-103-964. United Nations, New York, NY.			
HERO ID:	8587958			
Conditions of Use:	Building and construction products			
EXTRACTION				
Parameter	Data			
Worker activity description:	The staff includes clerks, secretaries, technical "officers" and advisors, consultants, and supervisors. Duties involve typical administrative and office operations, including use of telephones, typewriters~ and duplicating machines. No "chemicals" are routinely used in the offices. There are a few duplicating machines and word processors on several of the floors, but no unusual complaints are associated with their use.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Environmental sampling resulted in all non detect results for formaldehyde.			
Number of workers:	1,500			
Engineering control:	Ventilation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.	
	Metric 3: Applicability	Low	The assessment is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The assessment does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-164-982. Pacific Telephone Company, San Francisco, CA.			
HERO ID:	8588840			
Conditions of Use:	Building and construction products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Telephone office workers.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Sampling for formaldehyde returned non-detect results.			
Exposure duration:	8 hours/day			
Exposure frequency:	5 days/week			
Number of workers:	125			
Engineering control:	Ventilation			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	Low	The assessment is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The assessment does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-241-970. National Park Service, Patchogue, New York.			
HERO ID:	8591916			
Conditions of Use:	Urea-formaldehyde (UF) foam insulation			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	House #1 Bedroom: 0.07 (mg/cm^3)House #1 Dining Area: 0.09 (mg/cm^3)House #3 Living Room: 0.18-0.19 (mg/cm^3)House #3 Master Bed Room: 0.12-0.18 (mg/cm^3)House #3 Left Bed Room: 0.19 (mg/cm^3)House #3 Right Bed Room: 0.09 (mg/cm^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Low	The assessment is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Monitoring data are greater than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Variability addressed by multiple sampling locations and uncertainty is addressed by sampling methods.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81 -098-941. Lab-Crest Scientific Glass Company. Subsidiary of Fischer & Porter Company, Warminster, PA.			
HERO ID:	8607447			
Conditions of Use:	Paints and coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Curing decals on glass tubes using ovens.			
Exposure route:	Dermal and inhalation			
Physical form:	Liquid or gas			
Personal sampling data:	Operator: 510 ug/cm^3			
Area sampling data:	Top of 26HW34 Oven: 550 ug/cm^3Top of 1101 Oven: 780 ug/cm^3			
Engineering control:	Forced mechanical ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for paints and coatings, which is an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by taking area and personal samples.	
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 8607873 Table: 1 of 1

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-153-884. Bureau of Land Management, Cheyenne, WY.			
HERO ID:	8607873			
Conditions of Use:	Ink, toner, and colorant products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Use of a blueprint copying machine.			
Exposure route:	Dermal and Inhalation.			
Physical form:	Gas			
Area sampling data:	Formaldehyde samples in the film developing room, printing room, and 4th floor offices were all non-detects.			
Engineering control:	NIOSH recommends that ventilation be installed mainly to reduce the emissions coming from the blueprint copying machine and the film developer.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for ink, toner, and colorant products, which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by taking samples at multiple locations.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HHE 80-192-828. Rock Hill Printing and Finishing Company, Rock Hill, NC.			
HERO ID:	8610851			
Conditions of Use:	Textile finishing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Unpacking, bleaching, drying, heat setting, dying and printing of woven cloth made from fibers.			
Exposure route:	Dermal and inhalation			
Physical form:	Vapor			
Personal sampling data:	Greige Operator: 0.01 mg/m^3Greige Operator: 0.21 mg/m^3Knapping Roller Operator: 0.02 mg/m^3Packing Attendant: 0.04 mg/m^3Unloading Floor Person: 0.02 mg/m^3Ager Operator: 1.15 (8-hr TWA ppm)Chemical Finisher: 0.66 (8-hr TWA ppm)Starch Mixer: 0.30 (8-hr TWA ppm)			
Area sampling data:	Greige Operator: 0.82 mg/m^3Unloading Floor Person: 0.25 mg/m^3Chemical Finishing: <0.12 - 0.29 ppmAgeing Operation: 0.75-1.04 ppmStarch Mezzanine: 0.18 ppm			
Exposure frequency:	5 days/week			
Number of workers:	1,700			
Personal protective equipment:	Gloves, aprons, and goggles			
Engineering control:	Ventilation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality information/data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for textile finishing, which is an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by considering different worker activities.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HHE 80-106-963. Union Carbide, Sistersville, WV.			
HERO ID:	8610852			
Conditions of Use:	Lubricating oil and grease manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Operators and maintenance workers. Equipment cleaning is performed.			
Exposure route:	Inhalation			
Number of workers:	32 operators and 8 maintenance workers.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for lubricating oil and grease manufacturing, which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by sampling methods, variability is not addressed.
Overall Quality Determination			High	

Study Citation:		NIOSH, (1980). Health hazard evaluation report: HHE 80-126-777. St. Regis Paper Company, Bucksport, ME.	
HERO ID:		8623043	
Conditions of Use:		Paper manufacturing	
EXTRACTION			
Parameter	Data		
Worker activity description:	Tending mixing vats.		
Exposure route:	Inhalation		
Area sampling data:	#1 Mix tank: 0.1 - 0.5 mg/m^3#4 Mix tank: 3 ppm#4 Hot storage: non-detect#1 Mix tank: 2 ppm#5 mix tank: 2 ppm#2 mix tank: non-detect#2 hot storage: non-detectOperators table: non-detect#1 mix tank: 0.51 mg/m^3#5 hot storage: 0.49 mg/m^3		
Number of workers:	20		
Engineering control:	Plans were being completed for the installation of a ventilation system designed to create a negative pressure inside the mix tanks.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for paper manufacturing, which is an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by sampling multiple locations at the facility.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 8623594 Table: 1 of 1

Study Citation:	NIOSH, (1980). Health hazard evaluation report: HHE 79-148-716. Briggs and Stratton Corporation, Milwaukee, WI.			
HERO ID:	8623594			
Conditions of Use:	Metal products not covered elsewhere			
EXTRACTION				
Parameter	Data			
Worker activity description:	Winding together wires from the coil and dipping them into the solder pot; attaching terminals to the coils; repairing the coils with a hand soldering iron; attaching fine copper wires to the core of the coil using solder.			
Exposure route:	Dermal and inhalation			
Physical form:	Gas			
Area sampling data:	Detectable levels of formaldehyde were not observed using Drager tubes.			
Number of workers:	9 employees perform twist and strip operation3 employees perform solder dial operations8 employees perform coil repair operations			
Engineering control:	Ventilation is provided by a partial hood covering the operating area. A cone exhaust hood is located above the solder dial. A slot exhaust is located above the area where soldering occurs.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for metal products not covered elsewhere, which is an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 83-254-1393. United Uniform Manufacturing Company of Memphis, Inc., Memphis, TN.			
HERO ID:	8639343			
Conditions of Use:	Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Steam-pressing and oven-curing of permanent press uniform pants.			
Exposure route:	Dermal and inhalation			
Physical form:	Vapor			
Personal sampling data:	TWA Concentrations in ppmOperator, Press #1: 0.45Operator, Press #2: 0.42Operator, Press #3, #4: 0.45Operator, Curing Oven: 0.50			
Area sampling data:	TWA Concentration in ppmPress #1: 0.49Press #2: 0.53Press #3: 0.34Curing Oven: 0.50Support Pole: 0.47			
Number of workers:	125 (p. 4/18)			
Comments:	check Table 1 and Table 2. Exposure duration not given, just assumed exposure duration for 8-hr TWA.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for finishing agents in textiles, apparel, and leather manufacturing, which is an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling multiple workers and areas.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA 83-312-1400. Champion Technology Center, Hamilton, OH.		
HERO ID:	8646314		
Conditions of Use:	Laboratory chemical		
EXTRACTION			
Parameter	Data		
Exposure route:	Dermal and inhalation		
Physical form:	Gas		
Area sampling data:	Main Entrance: <0.3 - 1.6 (ppm)Ground Level below exhaust fan: <0.3 - 0.3 (ppm)North end of the building: <0.3 (ppm)2nd floor exit where exhaust fan is located: 1.6 - 3.9 (ppm)At plastic partition, mill side: <0.3 (ppm)Samples taken with different methods (ORBO-22, 3M Badge, DuPont Badge, Impinger)Lab 119, east top bench: 1.22-2.00 (ppm)Office 132, west table top: 1.04-2.14 (ppm)Receptionist office, south cabinet top: 0.79-0.98 (ppm)Lab 220, center bench top: 1.15-1.61 (ppm)Office 212, east table top: 1.03 - 2.03 (ppm)Lab 207A, east wall: 0.87 - 2.36 (ppm)		
Exposure duration:	Decontamination efforts last 6 hours per day.		
Number of workers:	70 (P. 4/18)		
Personal protective equipment:	Self contained breathing apparatuses were available to workers.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for laboratory chemicals, which is an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by considering various areas within the building.
Overall Quality Determination		High	

Study Citation:	NIOSH, (1976). Health hazard evaluation determination: corhart refractories.			
HERO ID:	8687978			
Conditions of Use:	Plastic and rubber products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Mold filling, off bearer, mold waxer, striking off, assembling VF forms, topping molds, driving fork lifts.			
Exposure route:	Dermal and inhalation			
Physical form:	Vapor			
Personal sampling data:	Roll Over (October 29-30; AM and PM measurements): 0.4-0.7 mg/m^3Mold filler (Oct. 29-30; AM and PM): 0.1-0.4 mg/m^3Off bearer (Oct. 29; AM and PM): 0.3 mg/m^3Mold Waxer (Oct. 29; AM and PM): 0.1-0.2 mg/m^3VF Strike Off (Oct. 29; AM and PM): 0.1-0.2 mg/m^3VF Form Assembly (Oct. 29; AM and PM): 0.1-0.6 mg/m^3Strike Off Man (Oct. 29; AM and PM): 0.1 mg/m^3Mold Topper (Oct. 30; AM and PM): 0.3 mg/m^3			
Area sampling data:	Between Mixers (Oct. 29-30; AM and PM): 0.2 mg/m^3Mold Topping Area (Oct. 29; AM and PM): 0.2 mg/m^3Near Roll-Over (Oct. 30; AM): 0.5 mg/m^3Mold Topper (AM and PM): nondetect - 1.1 mg/m^3Mixer Operator (AM and PM): nondetectStrike-Off (Am and PM): nondetect - 0.2 mg/m^3Roll-Over (Am and PM): 0.1-0.2 mg/m^3Off-Bearer (AM and PM): nondetect - 0.1 mg/m^3VF Form Assembly (AM and PM): nondetect - 0.3 mg/m^3Area Sample Near Roll-Over Machine (AM and PM): nondetectArea Sample Near VF Roll-Over Machine (AM and PM): nondetect			
Number of workers:	16			
Engineering control:	NIOSH recommends additional general area ventilation in the no-bake area to further reduce employee irritation from vapors.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic and rubber products, which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by considering various areas and worker activities when sampling.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 8689109 Table: 1 of 1

Study Citation:	NIOSH, (1973). Health hazard evaluation: Gates Rubber Company.			
HERO ID:	8689109			
Conditions of Use:	Rubber product manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Coating fibers with chemical formulations.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	All environmental samples of formaldehyde were non-detect.			
Number of workers:	70			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for rubber product manufacturing, which is an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling method. Variability addressed by multiple samples.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1983). Preliminary survey report: Control technology for formaldehyde emissions at Baker Furniture Company, Mocksville, North Carolina.			
HERO ID:	8728029			
Conditions of Use:	Adhesive and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Loading the feed-through press; stacking boards on a filter press.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	With this arrangement and under the condition on the day of the survey, half-shift time-weighted-average formaldehyde concentrations were all less than 0.5 ppm. Some peak concentrations were measured to be greater than 1 ppm around both the feed-through press and the glue-mixing area, but none were greater than 3 ppm.			
Exposure duration:	There is one shift, running from 7:00 in the morning until 3:30, with a half-hour lunch break at 11 : 30. [8 hours/day]			
Number of workers:	The total plant employment of 150 included 15 administrative and 2 maintenance employees.			
Engineering control:	A canopy hood, measuring approximately 13 by 7 1/2 feet, is installed over the feed-through press. This hood has a center baffle blocking about a fourth of the opening. The baffle was inserted to reduce rollout around the outer margin of the canopy. There is also a canopy hood over the shuttle press. Each hood is vented through a 14- or 16-inch circular duct to a separate fan on the roof. These hoods have been in place for about 1 year.General ventilation is provided mainly by open doors at the north end of the building and the extensive local exhaust ventilation for controlling sawdust from the wood-working operations elsewhere in the plant. The general airflow around the feed-through press is from north to south, although the velocity is low (less than 100 ft/min) and variable.Auxiliary fans are used to provide additional cooling air. Some of these are attached to roof-support columns; the others are floor models, which may be positioned by the workers.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesive and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1973). Industrial hygiene survey of Owens Corning Fiberglas, Kansas City, Kansas.			
HERO ID:	8728044			
Conditions of Use:	Construction (including roofing materials)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Hand mixing raw materials to make glass batch and hand dumping the glass batch into the hopper.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	Oven Control Panel, J-6: 0.42 (ppm)Forehearth, J-6: 0.34 (ppm)Forming Room, RM-1: 0.02 (ppm)Forehearth, #71 aerocor: 0.13 (ppm)Entrance to J-5 Curing Oven: 1.14 (ppm)End of Curing Oven, #71: 0.09 (ppm)			
Number of workers:	The Kansas City facility began operation in 1946 and presently employs approximately 1250 persons with about 1100 of these persons being blue collar workers.			
Engineering control:	In the glass batch house. all material transfer points and the hand mixing station are provided with local exhaust ventilation. Two ”sly” bag collectors rated at 30>000 cfm each are used-in connection with this exhaust system. Velocity measurements at the hand mixing hood showed the face velocity to be greater than 150 fpm.Resin curing oven exhaust containing phenol and formaldehyde arecontrolled by the use of afterburners and wet scrubbers.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	Data are from the U.S.
		Metric 3: Applicability	High	Data are for construction including roofing materials, an in-scope occupational scenario.
		Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
		Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by sampling multiple locations.
Overall Quality Determination			High	

Study Citation:	OECD, (2011). Emission scenario document on coating application via spray-painting in the automotive refinishing industry.			
HERO ID:	3808976			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	transferring and mixing liquid products, container cleaning, transferring mixed coating to application equipment, overspray			
Exposure route:	dermal and inhalation. dermal: Provides methods for modeling exposures to non-volatile liquids Inhalation: Provides methods for modeling exposures to mists.			
Exposure frequency:	dermal: surrogate measured skin loading conditions inhalation: 8-hr TWA surrogate data			
Number of workers:	PBZ samples.Exposure Frequency: 250 days/yr			
Personal protective equipment:	8 workers/site			
	air-purifying respirators or air-supplied respirators, Gloves (typically latex or nitrile), paint suits, and face masks/eye protection			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old and less than 20
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (min, max, mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple coating types.
Overall Quality Determination			High	

Study Citation:	OECD, (2009). Emission scenario document on adhesive formulation.			
HERO ID:	3827299			
Conditions of Use:	Processing: Formulation of Adhesives			
EXTRACTION				
Parameter	Data			
Worker activity description:	Unloading, container cleaning, mixing operations, sampling, equipment cleaning, packaging			
Exposure route:	dermal and inhalation. dermal: Provides methods for modeling exposures to both solids and non-volatile liquids Inhalation: Provides methods for modeling exposures to both solids and volatile liquids			
Exposure frequency:	days/yr equal to number of bt/yr			
Number of workers:	22 workers/site			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Low	Model results characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and types of adhesives.
Overall Quality Determination			Medium	

Study Citation:	OECD, (2013). Emission scenario document on the industrial use of adhesives for substrate bonding.			
HERO ID:	3827300			
Conditions of Use:	Industrial Use of Adhesives for Substrate Bonding			
EXTRACTION				
Parameter	Data			
Worker activity description:	unloading, container cleaning, adhesive application, equipment cleaning, curing/drying			
Exposure route:	dermal and inhalation. dermal: Provides methods for modeling exposures to solids and non-volatile liquids Inhalation: Provides methods for modeling exposures to mists and volatile liquids			
Exposure frequency:	Exposure Frequency: 50-250 days/yr			
Number of workers:	26-106 workers/site			
Personal protective equipment:	Chemical-resistant gloves. Heat-resistant gloves are used when applying hot-melt adhesives. Safety glasses with side shields or goggles			
Engineering control:	Spray booths.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This ESD was developed by EPA based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions, types of adhesives, and end use markets.	
Overall Quality Determination		High		

Study Citation:	OECD, (2017). Emission Scenario Document (ESD) on the use of textile dyes.			
HERO ID:	3828838			
Conditions of Use:	Processing: Textile Dyeing			
EXTRACTION				
Parameter	Data			
Worker activity description:	unloading, container cleaning, dyeing machine operation			
Exposure route:	Dermal: Provides methods for modeling exposures to non-volatile liquids and solids Inhalation: Provides methods for modeling exposures to solids			
Exposure frequency:	Exposure Frequency: 31-250 days/yr			
Number of workers:	1-6 workers/site/day			
Personal protective equipment:	safety glasses, goggles, aprons, respirators, and/or masks			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This ESD was developed by EPA based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment from 2015 but uses lot of data that is greater than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical functions	
Overall Quality Determination		Medium		

Study Citation:	OECD, (2010). Emission scenario document on formulation of radiation curable coatings, inks and adhesives.			
HERO ID:	3840003			
Conditions of Use:	Adhesives and Sealants; Paint and coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	6 Activity descriptions provided			
Exposure route:	inhalation, dermal			
Physical form:	liquids, solids			
Exposure duration:	varies by activity, see Table B-2			
Exposure frequency:	250 max			
Number of workers:	Coatings formulators avg of 76 workers/facility, with 51% (39 employees) being production workers with possible exposure. Ink/adhesive formulators avg 20-32 production workers/facility.			
Personal protective equipment:	fabric or non-woven long sleeved shirts and pants, coveralls, and neoprene or rubber gloves. Barrier creams may be used to facilitate hand washing when materials or products penetrate gloves or other PPE. A rubber apron or rubber suit and rubber boots may also be worn in cases where there is potential for splashing on or penetration through clothing			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The assessment captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The completed exposure or risk assessment is generally, more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized
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Formaldehyde

Occupational Exposure

HERO ID: 3840003 Table: 1 of 1

...continued from previous page			
Study Citation:	OECD, (2010). Emission scenario document on formulation of radiation curable coatings, inks and adhesives.		
HERO ID:	3840003		
Conditions of Use:	Adhesives and Sealants; Paint and coatings		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	OECD, (2010). Emission Scenario Document on Photoresist Use in Semiconductor Manufacturing.			
HERO ID:	3840005			
Conditions of Use:	Commercial Use (Electrical and electronic products (including semiconductors))			
EXTRACTION				
Parameter	Data			
Worker activity description:	change-out of containers, container cleaning, equipment cleaning, change-out of excess (spun-off) photoresist collection containers, change-out of waste solvent collection containers			
Exposure route:	Dermal and inhalation. dermal: Provides methods for modeling exposures to the chemical. Inhalation: Not expected			
Exposure frequency:	Exposure Frequency: 250 days/yr maximum			
Number of workers:	EPA previously estimated that an average of 20 to 25 workers per facility routinely handle the photoresist chemicals and therefore may be exposed.			
Personal protective equipment:	full-body coveralls (i.e., “space suits”), respirators, face shields, and gloves or solvent-resistant gloves, aprons, and/or goggles, respirators with organic vapor cartridges			
Engineering control:	Cleanrooms			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This ESD was developed by EPA based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple facility sizes.	
Overall Quality Determination		High		

Study Citation:	OECD, (2020). Emission scenario document on chemical additives used in automotive lubricants.		
HERO ID:	6385735		
Conditions of Use:	Processing and Use (Additive chemicals used in automotive finished lubricants)		
EXTRACTION			
Parameter	Data		
Worker activity description:	PROC: unloading, container cleaning, formulation, sampling, equipment cleaning, loading USE: Unloading, container cleaning		
Exposure route:	dermal and inhalation. dermal: Provides methods for modeling exposures to non-volatile liquids Inhalation: Provides methods for modeling exposures to volatile liquids		
Exposure frequency:	Exposure Frequency:Processing: 203-360 days/yrUse: 253 days/yr		
Number of workers:	PROC: 22 workers/site USE: 4 workers/site		
Personal protective equipment:	”PROC: Respirators, gloves, safety glasses, close-toe shoes USE: gloves, protective footwear, protective headwear, dust masks or respirators”		
Engineering control:	LEV, scrubbers		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3: Applicability	Medium	Data is for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	Medium	Model results characterized by no statistics, however some of the model input parameters can be varied based on the scenario.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.
Overall Quality Determination		High	

Study Citation:	OECD, (2012). Emission scenario document on chemicals used in oil well production.			
HERO ID:	6387322			
Conditions of Use:	Processing: Petroleum Production			
EXTRACTION				
Parameter	Data			
Worker activity description:	More specific industry data on worker exposure from 1983 estimated that 3-4 workers handle chemicals used as corrosion or scale inhibitors, 6-7 workers handle chemicals used for fracturing and acid treatment, and 5 workers handle chemicals used for enhanced oil recovery (EPA, 1983).Work activity include Unloading Transport Containers, Transport Container Cleaning, Equipment or Storage Tank Cleaning.			
Exposure route:	There is potential for dermal exposure during both pumping and manual loading. Exposure to liquid may occur during container cleaning. Exposure to oil well chemical may occur periodically during equipment cleaning.			
Dermal exposure data:	nan			
Number of workers:	Recent industry data estimates one to a dozen production workers per site may be exposed to oil well chemicals; this estimate is consistent with figures provided by the U.S. Census (Industry, 2008). More specific industry data on worker exposure from 1983 estimated that 3-4 workers handle chemicals used as corrosion or scale inhibitors, 6-7 workers handle chemicals used for fracturing and acid treatment, and 5 workers handle chemicals used for enhanced oil recovery (EPA, 1983).			
Personal protective equipment:	One reference from 1983 indicates that workers may minimize exposure to oil well chemicals by wearing impervious gloves, clothing, safety glasses, masks or respirators (EPA, 1983). Recentindustry data also provides similar information. In cases where the Material Safety Data Sheet (MSDS) identifies specific hazards, full chemical suits with breathing apparatus may also be required(Clariant, 2008).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation but not specific to formaldehyde.	
	Metric 4: Temporal Representativeness	Medium	Most of the data are from more than 10 years back.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.	
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Formaldehyde

Occupational Exposure

HERO ID: 6387322 Table: 1 of 1

...continued from previous page			
Study Citation:	OECD, (2012). Emission scenario document on chemicals used in oil well production.		
HERO ID:	6387322		
Conditions of Use:	Processing: Petroleum Production		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Ohmichi, K., Komiyama, M., Matsuno, Y., Takanashi, Y., Miyamoto, H., Kadota, T., Maekawa, M., Toyama, Y., Tatsugi, Y., Kohno, T., Ohmichi, M., Mori, C. (2006). Formaldehyde exposure in a gross anatomy laboratory–personal exposure level is higher than indoor concentration. Environmental Science and Pollution Research 13(2):120-124.			
HERO ID:	1514215			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Gross anatomy laboratory work			
Physical form:	Liquid			
Personal sampling data:	average 0.45-1.08 (ppm) for students and instructors			
Area sampling data:	average 0.38-0.68 (ppm)			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2006)
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling during multiple laboratory sessions but uncertainty is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 2078408 Table: 1 of 1

Study Citation:	Olin Corp, (1987). Industrial hygiene survey - Olin Chemicals - and material safety data sheet for formaldehyde. 870000854:#86-870000854.			
HERO ID:	2078408			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Outside operator, operator, DNT supervisor, plt. 65 operator, Howe-Baker operator			
Area sampling data:	0.001-0.05 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1987)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by testing multiple areas of the facility but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	Organisation for Economic Co-operation and Development (OECD) (2015). Emission scenario document (ESD) on chemical vapour deposition in the semiconductor industry.			
HERO ID:	5184986			
Conditions of Use:	Use: Semiconductors (Chemical Vapor Deposition)			
EXTRACTION				
Parameter	Data			
Exposure route:	dermal and inhalation. ESD states exposures not expected.			
Personal protective equipment:	clean room suits (fitted cap, face cover, gloves, and boots)			
Engineering control:	equipment adhering to SEMI S-2 guidelines			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	N/A - only qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	OSHA (1992). Occupational exposure to formaldehyde. Federal Register 57(102):22290-22328.		
HERO ID:	1314358		
Conditions of Use:	Multiple		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation, dermal exposure, ingestions		
Physical form:	Vapor or liquid		
Number of workers:	OSHA estimates that approximately 2.2 million workers are exposed to formaldehyde at levels of 0.1 ppm or greater. An estimated 83,818 workers are exposed at levels between 0.75 ppm and 1.0 ppm. The balance of about 2.1 million workers are estimated to be exposed at levels between 0.1 and 0.75 ppm. The largest number of exposures currently is in the apparel industry, with an estimated 941,300 exposed workers, 58,831 of which have exposures between 0.75 and 1.0 ppm. Table 1 (page 22300) provides details concerning the number of exposed employees for different levels of exposure for 35 different industrial sectors		
Personal protective equipment:	page 22311 provides a summary of minimum PPE for different exposure levels.		
Comments:	This is the notice that sets the most recent PEL		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	As an FRN the information provided is based on high-quality data, techniques, and sound methods that are from frequently used sources and are generally accepted by the scientific community, and associated information though dated, does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The assessment is for all occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The data are more than 20 years old.
	Metric 5: Sample Size	N/A	No samples
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	The FRN clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	No statistics
Overall Quality Determination		High	

Study Citation:	Parsons Engineering Science, (1997). Allied Signal Aerospace Greenwood, South Carolina indoor air sampling and air quality investigation.		
HERO ID:	6321748		
Conditions of Use:	Adhesives and Sealants; Paint and coatings		
EXTRACTION			
Parameter	Data		
Worker activity description:	spray painting and curing to filter paper folding and strobe assembly. The majority of the air contaminants of concern stem from the coatings, paints, and finishes applied to the parts at the facility		
Exposure route:	inhalation		
Physical form:	liquid, vapor mist		
Personal sampling data:	<0.044 to 0.012 mg/m3		
Area sampling data:	<0.089 to 0.013		
Number of workers:	6		
Engineering control:	Ventilation resulting in positive pressure for paint booths		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old. The assessment captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		High	

Study Citation:	Persoons, R., Maitre, A., Bicout, D.J. (2011). Modelling the time profiles of organic solvent concentrations for occupational exposure assessment purposes. Annals of Occupational Hygiene 55(4):421-435.		
HERO ID:	1513134		
Conditions of Use:	Laboratory Use		
EXTRACTION			
Parameter	Data		
Worker activity description:	Activities included gross examination of surgical specimens, tissue processing, embedding, sectioning, staining, and microscopic examination.		
Exposure route:	Inhalation		
Physical form:	Liquid		
Personal sampling data:	1.15 (mg/m^3)		
Area sampling data:	8.9 (mg/m^3)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3: Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2010)
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by area and personal breathing zone sampling but uncertainty is not addressed.
Overall Quality Determination		Medium	

Study Citation:	Pierce, J.S., Abelmann, A., Lotter, J.T., Ruestow, P.S., Unice, K.M., Beckett, E.M., Fritz, H.A., Bare, J.L., Finley, B.L. (2016). An assessment of formaldehyde emissions from laminate flooring manufactured in China. Regulatory Toxicology and Pharmacology 81:20-32.			
HERO ID:	4264341			
Conditions of Use:	Building/construction materials not covered elsewhere			
EXTRACTION				
Parameter	Data			
Worker activity description:	Installation of laminate flooring			
Exposure route:	Inhalation			
Physical form:	Solid			
Area sampling data:	0.006 - 0.063 (ppm)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2016)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple days at multiple buildings but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Preuss, P.W., Dailey, R.L., Lehman, E.S. (1985). Exposure to formaldehyde. Advances in Chemistry Series Vol. 210 :247-259.			
HERO ID:	5946647			
Conditions of Use:	Domestic manufacturing, Processing, Use			
EXTRACTION				
Parameter	Data			
Personal sampling data:	School biology labs with formalin use range between 120-1360ppb in breathing zone; mean and max exposure levels given for various occupations in Table 2 (such as chemical manufacture, textile and wood product manufacture, embalming, etc)			
Area sampling data:	School biology labs where formalin is used range between 20-360ppb			
Number of workers:	Table 2 contains estimated number of workers exposed for each occupational exposure source (such as chemical manufacture, textile and wood product manufacture, embalming, etc)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for various scenarios such as domestic manufacturing and use in textile manufacturing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean and max, range) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by various industries and effect of treatment on biology lab exposure, but uncertainty is not addressed.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1319863 Table: 1 of 1

Study Citation:	Priha, E., Pennanen, S., Rantio, T., Uitti, J., Liesivuori, J. (2004). Exposure to and acute effects of medium-density fiber board dust. Journal of Occupational and Environmental Hygiene 1(11):738-744.			
HERO ID:	1319863			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Personal sampling data:	MDF board: 0.17 (mg/m^3); Wood: 0.10 (mg/m^3)			
Particle size characterization:	MDF dust containing formaldehyde: >10 um in diameter			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data are for furniture and furnishings not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2004)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at 3 different sites but uncertainty is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 4213948 Table: 1 of 1

Study Citation:	Radian Corp, (1991). Air toxic hot spots - AB 2588 health risk assessment Douglas Aircraft Company Long Beach Facility volume I with cover letter dated 081291.			
HERO ID:	4213948			
Conditions of Use:	Plastic material and resin manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	370 (ug/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1991)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Raymond, L. W., Williford, L. S., Burke, W. A. (1998). Eruptive cherry angiomas and irritant symptoms after one acute exposure to the glycol ether solvent 2-butoxyethanol. Journal of Occupational and Environmental Medicine 40(12):1059-1064.			
HERO ID:	100193			
Conditions of Use:	Unknown			
EXTRACTION				
Parameter	Data			
Worker activity description:	Clerical workers			
Exposure route:	Inhalation			
Area sampling data:	0.14-0.19 (ppm)			
Number of workers:	seven			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	Assessment does not specify the methods or techniques used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Condition of use is unknown.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1998)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	Reisen, F., Hansen, D., Meyer, C.P. (2011). Exposure to bushfire smoke during prescribed burns and wildfires: firefighters’ exposure risks and options. Environment International 37(2):314-321.			
HERO ID:	1075819			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter		Data		
Worker activity description:		Firefighters putting out bushfires and prescribed burns		
Exposure route:		Inhalation		
Physical form:		Vapor		
Area sampling data:		Fuel reduction burns: <0.112 (ppm); Experimental burns: 0.172 (ppm); Slash or heap burns: <0.042 (ppm); Prescribed burns: <0.161 (ppm); Victorian wildfires: 0.042 (ppm)		
Exposure duration:		10-14 hour shifts		
Personal protective equipment:		personal protective clothing		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	Data are from Australia, an OECD country.
		Metric 3: Applicability	Medium	Data are for bush fires (firefighters), which is similar to the in-scope occupational scenario agriculture, forestry, hunting and fishing.
		Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
		Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Medium	Variability addressed by sampling multiple types of fires but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	RHS, (1990). Air monitoring of freshly painted interior rooms with cover letter.			
HERO ID:	1332993			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Worker activity description:	Painting using solvent based paint			
Exposure route:	Inhalation			
Area sampling data:	0.06-0.2 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for paint additive and coating additive used in paint and coating manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1986)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1317191 Table: 1 of 1

Study Citation:	Riala, R.E., Riihimaki, H.A. (1991). Solvent and formaldehyde exposure in parquet and carpet work. Applied Occupational and Environmental Hygiene 6(4):301-308.			
HERO ID:	1317191			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Worker activity description:	flooring worker (varnishing)			
Physical form:	vapor			
Area sampling data:	mean (4.3) range (2.55-6.06) ppm			
Personal protective equipment:	half-mask respirator			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Finland, an OECD country.	
	Metric 3: Applicability	High	Data are for solvents in paint and coating manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by area sampling different parts of the process but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Rodriguez, M., West, C., Brueck, S. E. (2012). Air contaminant, noise, and dermal hazards during aluminum beverage can manufacturing – Texas.			
HERO ID:	8684526			
Conditions of Use:	Use of printing ink, toner and colorant products containing formaldehyde			
EXTRACTION				
Parameter	Data			
Worker activity description:	Printer operators; chemical press operators; forklift operators.			
Exposure route:	Inhalation			
Physical form:	Vapor			
Personal sampling data:	Front end: 0.044 (ppm); 0.023-0.090 (ppm)Printer: 0.098 (ppm); 0.071-0.13 (ppm)Chemical process operator: 0.026 (ppm); 0.020-0.031 (ppm)Millwright: 0.040 (ppm)Forklift operator: 0.080 (ppm)Lacquer spray: 0.042 (ppm)			
Area sampling data:	Conference Room: 0.040 (ppm)			
Exposure duration:	Production employees work 12-hour shifts and non-production employees work 8-hour shifts.			
Number of workers:	At the time of the evaluation the plant had 148 production employees working 12-hour shifts and 19 non-production employees working 8-hour shifts.			
Personal protective equipment:	All employees were required to wear safety glasses, safety shoes, and hearing protection. The company provided work uniforms (short or long sleeve shirts and pants), which some employees wore.Some employees voluntarily wore nitrile gloves (Flexshield®) while changing tools on the ironer/trimmers or when handling chemicals. A concern noted by employees was the limited selection of glove sizes. The employees maintaining the can washers wore polyvinyl chloride gloves, a Tychem® suit, and steel-toe rubber boots because they could contact hydrofluoric and sulfuric acid. Employees adding chemicals to the water treatment tank or adding biocide to the MWF sump wore a rubber apron and rubber or nitrile gloves. Durapro® barrier cream was available for employees at their workstations and from the storage room.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for use of printing ink, toner and colorant products containing formaldehyde, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2012)	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by sampling multiple workers and taking an area sample.	
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 8684526 Table: 1 of 1

...continued from previous page

Study Citation:	Rodriguez, M., West, C., Brueck, S. E. (2012). Air contaminant, noise, and dermal hazards during aluminum beverage can manufacturing – Texas.		
HERO ID:	8684526		
Conditions of Use:	Use of printing ink, toner and colorant products containing formaldehyde		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Rodriguez, Manuel, M., Aristeguieta, C. (2009). Evaluation of employees’ chemical exposures while blending and repackaging glass beads for road markings.
HERO ID:	8684530
Conditions of Use:	Paints and coatings

EXTRACTION	
Parameter	Data
Worker activity description:	Employees blend and repackage the beads in smaller paper sacks or boxes for distribution to state transportation departments and other customers.
Exposure route:	Inhalation.
Physical form:	Colorless gas.
Personal sampling data:	Packer/forklift operator: 0.0073 (ppm)Warehouseman: 0.0090 (ppm)Bagger/forklift operator: trace amountsManager: 0.0065 (ppm)Lab technician: 0.0073 (ppm)Packer: trace amounts
Area sampling data:	Outside: not detectedConference room: 0.0098 (ppm)Bagging Machine: trace amountsLaboratory: trace amounts
Exposure duration:	Employees work an 8-hour shift.
Number of workers:	Six employees worked at the time of the evaluation.
Personal protective equipment:	Weissker management provided employees safety glasses, foot protection, leather gloves, and a NIOSH-approved 3M model 8210 N95 filtering-facepiece respirator. Weissker required employees to wear respirators because of potential dust exposure from handling the glass beads. During this evaluation we observed all employees (with the exception of the supervisor) wearing filtering-facepiece respirators. None of the employees wore safety glasses or gloves.

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	Data are from the U.S.
		Metric 3: Applicability	High	Data are for paints and coatings, an in-scope occupational scenario.
		Metric 4: Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
		Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by sampling multiple workers and areas.

Overall Quality Determination	High

Formaldehyde

Occupational Exposure

HERO ID: 1515723 Table: 1 of 1

Study Citation:	Rosén, G., Andersson, I.M., Juringe, L. (1990). Reduction of exposure to solvents and formaldehyde in surface-coating operations in the woodworking industry. Annals of Occupational Hygiene 34(3):293-303.			
HERO ID:	1515723			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Worker activity description:	Surface coating using surface coating machines and spray booths			
Exposure route:	Inhalation			
Area sampling data:	1986: 0.24-0.57 (ppm); 1987: 0.31-0.49 (ppm)			
Exposure duration:	8 hour shifts			
Engineering control:	windows and hatches at strategic points; Adjustment of the damper in ventilation ducts; building a completely new workshop			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data are for solvent in paint and coating manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1987)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing multiple worker activities but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	RTI, (1984). A preliminary assessment of the benefits of reducing formaldehyde exposures (draft).			
HERO ID:	5901060			
Conditions of Use:	Various			
EXTRACTION				
Parameter	Data			
Area sampling data:	See Table 3-2, pg 98/233			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for multiple in scope occupational scenarios.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by data from multiple studies but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	Ruhe, R. L., Arnold, S. J., Anastas, M. (1986). Health Hazard Evaluation Report HETA-1984-379-495-1687 Metal Container Corporation, Columbus, Ohio.			
HERO ID:	8684538			
Conditions of Use:	Metal products not covered elsewhere			
EXTRACTION				
Parameter	Data			
Worker activity description:	Operating the printer oven and bander.			
Exposure route:	Dermal and inhalation.			
Physical form:	Gas, liquid.			
Area sampling data:	Line three inside spray DESPATCH oven: 0.07 (mg/m^3)Line four inside spray DESPATCH oven: 0.05 (mg/m^3)Line one inside spray DESPATCH oven: 0.10 (mg/m^3)Line four inside spray operator station: 0.12 (mg/m^3)Between line three and four inspection table: 0.17 (mg/m^3)Line one printer oven: 0.11 (mg/m^3)			
Exposure duration:	12 hours/day (12 hour shifts)			
Number of workers:	33-34 printer oven employees11-12 automatic bander employees			
Engineering control:	A general ventilation system is used to provide air to the production and other areas of the plant. Local exhaust systems have been installed to control VOCs. NISH recommends the installation of portable hoods for each oven attached to a distribution plenum by "elephant trunk" to control leaks.			
Comments:	Table 1.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for metal products not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by given sampling method. Variability addressed by testing multiple areas of the plant.
Overall Quality Determination			High	

Study Citation:	Salisbury, S. (1996). Health Hazard Evaluation Report 96-0091-2597 Photoart (Stannard Associates, Inc.) Fredricksburg, Virginia September 1996.			
HERO ID:	8049728			
Conditions of Use:	Commercial use-Chemical substances in packaging, paper-Photographic supplies			
EXTRACTION				
Parameter	Data			
Exposure route:	dermal			
Area sampling data:	Non-detect			
Personal protective equipment:	Protective clothing, gloves			
Engineering control:	Fans pulling 40 and 43 cfm above photo processing lab. Suggested replacement with units pulling 250 cfm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (NIOSH HHEs) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old. The assessment captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.	
Overall Quality Determination		High		

Study Citation:	Scarselli, A., Corfiati, M., Marzio, D.D., Iavicoli, S. (2017). National Estimates of Exposure to Formaldehyde in Italian Workplaces. Annals of Work Exposures and Health 61(1):33-43.			
HERO ID:	4453124			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Medical doctors, chemical and physical science technicians			
Personal sampling data:	Arithmetic Mean: 0.14-0.79 (mg/m^3)			
Number of workers:	131			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2016)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by samples for multiple worker activities but uncertainty is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 4453124 Table: 2 of 4

Study Citation: Scarselli, A., Corfiati, M., Marzio, D.D., Iavicoli, S. (2017). National Estimates of Exposure to Formaldehyde in Italian Workplaces. Annals of Work Exposures and Health 61(1):33-43.	
HERO ID: 4453124	
Conditions of Use: Plastic material and resin manufacturing	
EXTRACTION	
Parameter	Data
Personal sampling data:	0.15-0.16 (mg/m^3) arithmetic mean
Number of workers:	276
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1: Methodology	Medium
	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	
Metric 2: Geographic Scope	Medium
Metric 3: Applicability	High
Metric 4: Temporal Representativeness	High
	Assessment is based on current industry conditions and data no more than 10 years old. (2016)
Metric 5: Sample Size	Medium
	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	
Metric 6: Metadata Completeness	Medium
	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	
Metric 7: Metadata Completeness	Low
	Variability and uncertainty are not addressed.
Overall Quality Determination	Medium

Formaldehyde

Occupational Exposure

HERO ID: 4453124 Table: 3 of 4

Study Citation: Scarselli, A., Corfiati, M., Marzio, D.D., Iavicoli, S. (2017). National Estimates of Exposure to Formaldehyde in Italian Workplaces. Annals of Work Exposures and Health 61(1):33-43.	
HERO ID:	4453124
Conditions of Use:	All other basic chemical manufacturing
EXTRACTION	
Parameter	Data
Personal sampling data:	0.02-0.05 (mg/m ³) arithmetic mean
Number of workers:	964
EVALUATION	
Domain	Metric
Domain 1: Reliability	
Metric 1:	Methodology
	Medium
	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Metric 3:	Applicability
Metric 4:	Temporal Representativeness
	High
	Assessment is based on current industry conditions and data no more than 10 years old. (2016)
Metric 5:	Sample Size
	Medium
	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	Medium
	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	Low
	Variability and uncertainty are not addressed.
Overall Quality Determination	Medium

Study Citation:	Scarselli, A., Corfiati, M., Marzio, D.D., Iavicoli, S. (2017). National Estimates of Exposure to Formaldehyde in Italian Workplaces. Annals of Work Exposures and Health 61(1):33-43.			
HERO ID:	4453124			
Conditions of Use:	Building/construction materials - wood and wood engineered products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Woodworking machine setters and setter-operators, wood-processing plant operator, wood-products machine operator, wood treater, wood-processing-plant operator			
Personal sampling data:	0.08-0.25 (mg/m^3) Jay’s Note (this should be 0.14 to 0.15)			
Number of workers:	1,086			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3:	Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2016)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by samples for multiple worker activities but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1986791 Table: 1 of 6

Study Citation:	Siegel, D.M., Frankos, V.H., Schneiderman, M.A. (1983). Formaldehyde risk assessment for occupationally exposed workers. Regulatory Toxicology and Pharmacology 3(4):355-371.			
HERO ID:	1986791			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Personal sampling data:	1.2 (ppm)			
Number of workers:	Full time - 271-913Part time - 145-487			
Comments:	Per Table 4 footnote, "Mean of values reported in NIOSH evaluation (reported by USEPA, 1981) and TWA derived from SOCMA (1979) survey."			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	Assessment uses mean values reported in a NIOSH evaluation, unclear if samples are area or personal
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Siegel, D.M., Frankos, V.H., Schneiderman, M.A. (1983). Formaldehyde risk assessment for occupationally exposed workers. Regulatory Toxicology and Pharmacology 3(4):355-371.			
HERO ID:	1986791			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Personal sampling data:	0.50 (ppm)			
Number of workers:	Full time - 7,480Part time - 29,920			
Comments:	Per the footnote from Table 4, "Value derived from SOCMA (1979) survey results; no information on sampling methodology or analytical techniques provided."			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for paints and coatings, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1986791 Table: 3 of 6

Study Citation:	Siegel, D.M., Frankos, V.H., Schneiderman, M.A. (1983). Formaldehyde risk assessment for occupationally exposed workers. Regulatory Toxicology and Pharmacology 3(4):355-371.		
HERO ID:	1986791		
Conditions of Use:	Use of Adhesives and Sealants		
EXTRACTION			
Parameter	Data		
Personal sampling data:	0.50 (ppm)		
Number of workers:	Full time - 2,380Part time - 420		
Comments:	Per footnote of Table 4, "The data, data sources, and/or techniques or methods used in the assessment or report are not specified."		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for adhesives and sealants, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1986791 Table: 4 of 6

Study Citation:	Siegel, D.M., Frankos, V.H., Schneiderman, M.A. (1983). Formaldehyde risk assessment for occupationally exposed workers. Regulatory Toxicology and Pharmacology 3(4):355-371.		
HERO ID:	1986791		
Conditions of Use:	”Use in agriculture, forestry, fishing, and hunting”		
EXTRACTION			
Parameter	Data		
Personal sampling data:	0.9* (ppm)		
Area sampling data:	0.9* (ppm)		
Number of workers:	Full time - 500-900		
Comments:	*Per footnote of Table 4, ”Mean of 11 observations (personal and area samples) reported in NIOSH (1979, as reported by USEPA, 1981).”		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Uninformative	Data are for Pesticide, fertilizer, and other agricultural chemical manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Uninformative	

Formaldehyde

Occupational Exposure

HERO ID: 1986791 Table: 5 of 6

Study Citation: Siegel, D.M., Frankos, V.H., Schneiderman, M.A. (1983). Formaldehyde risk assessment for occupationally exposed workers. Regulatory Toxicology and Pharmacology 3(4):355-371.	
HERO ID: 1986791	
Conditions of Use: Plastic Manufacturing	
EXTRACTION	
Parameter	Data
Personal sampling data:	0.70 (ppm)
Number of workers:	full time - 4,728Part time - 1,272
Comments:	Per footnote from Table 4, "Mean of two means from NIOSH personal sampling (reported by USEPA, 1981) plus TWA derived from SOCMA (1979) survey."
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Methodology
Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
High	Data are from the U.S.
Metric 3:	Applicability
High	Data are for plastic material and resin manufacture, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness
Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
Metric 5:	Sample Size
Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
Low	Variability and uncertainty are not addressed.
Overall Quality Determination	Medium

Formaldehyde

Occupational Exposure

HERO ID: 1986791 Table: 6 of 6

Study Citation: Siegel, D.M., Frankos, V.H., Schneiderman, M.A. (1983). Formaldehyde risk assessment for occupationally exposed workers. Regulatory Toxicology and Pharmacology 3(4):355-371.	
HERO ID: 1986791	
Conditions of Use: Textile Finishing	
EXTRACTION	
Parameter	Data
Personal sampling data:	0.56 (ppm)
Number of workers:	Full time - 17,800Part time - 2,200
Comments:	Per footnote on Table 4, "Mean of 84 personal and area samples plus TWA derived from SOCMA (1979) survey"
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Methodology
Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
High	Data are from the U.S.
Metric 3:	Applicability
High	Data are for fabric, textile and leather manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness
Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
Metric 5:	Sample Size
Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
Low	Variability and uncertainty are not addressed.
Overall Quality Determination	Medium

Formaldehyde

Occupational Exposure

HERO ID: 1318472 Table: 1 of 1

Study Citation:	Skisak, C.M. (1983). Formaldehyde vapor exposures in anatomy laboratories. American Industrial Hygiene Association Journal 44(12):948-950.			
HERO ID:	1318472			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	gross anatomy labs			
Physical form:	vapor			
Personal sampling data:	range 0.3-2.63 (ppm)			
Engineering control:	Local exhaust ventilation providing 17.5 air changes/hour			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (min, max, mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling 8 laboratories within the same building but uncertainty is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1317705 Table: 1 of 1

Study Citation:	Stern, F.B., Beaumont, J.J., Halperin, W.E., Murthy, L.I., Hills, B.W., Fajen, J.M. (1987). Mortality of chrome leather tannery workers and chemical exposures in tanneries. Scandinavian Journal of Work, Environment and Health 13(2):108-117.			
HERO ID:	1317705			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Worker activity description:	leather and leather manufacturing products industry- Worker activities given in table 1.			
Area sampling data:	mean 2.45 (ppm)			
Number of workers:	~8895			
Comments:	95% of the 9,365 were successfully traced			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for fabric, leather and textile manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1987)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Stewart, P.A., Schairer, C., Blair, A. (1990). Comparison of jobs, exposures, and mortality risks for short-term and long-term workers. Journal of Occupational Medicine 32(8):703-708.			
HERO ID:	1515720			
Conditions of Use:	Building/construction materials - wood and wood engineered products			
EXTRACTION				
Parameter	Data			
Area sampling data:	Short-term workers: 0.1 (ppm); Long-term workers: 0.1 (ppm) - these are median values. - These are median values. Not clear if these are area or personal samples.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1990)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (median) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at multiple plants but uncertainty is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1515720 Table: 2 of 4

Study Citation:	Stewart, P.A., Schairer, C., Blair, A. (1990). Comparison of jobs, exposures, and mortality risks for short-term and long-term workers. Journal of Occupational Medicine 32(8):703-708.			
HERO ID:	1515720			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Area sampling data:	Short-term workers: 0.1, 0.5, 3.5 (ppm); Long-term workers: 0.1, 0.4, 3.3 (ppm)- These are median values. Not clear if these are area or personal samples.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for manufacture, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1990)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (median) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling at multiple plants but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1515720 Table: 3 of 4

Study Citation:	Stewart, P.A., Schairer, C., Blair, A. (1990). Comparison of jobs, exposures, and mortality risks for short-term and long-term workers. Journal of Occupational Medicine 32(8):703-708.			
HERO ID:	1515720			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Area sampling data:	Short-term workers: 1.1, 3.5, 0.2, 0.1, 0.3, 0.4, 0.5 (ppm); Long-term workers: 1.1, 3.3, 0.3, 0.1, 0.7, 0.4, 0.4 (ppm)- These are median values. Not clear if these are area or personal samples.			
Comments:	it is not clear if the values in Table 3 are personal samples or area samples.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1990)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (median) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at multiple plants but uncertainty is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1515720 Table: 4 of 4

Study Citation:	Stewart, P.A., Schairer, C., Blair, A. (1990). Comparison of jobs, exposures, and mortality risks for short-term and long-term workers. Journal of Occupational Medicine 32(8):703-708.			
HERO ID:	1515720			
Conditions of Use:	Use of photographic supplies			
EXTRACTION				
Parameter	Data			
Area sampling data:	Short-term workers: 0.2 (ppm); Long-term workers: 0.3 (ppm) - These are median values. Not clear if these are area or personal samples.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for photographic supplies, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1990)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (median) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling at multiple plants but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 4454858 Table: 1 of 1

Study Citation:	Su, M., Sun, R., Zhang, X., Wang, S., Zhang, P., Yuan, Z., Liu, C., Wang, Q. (2018). Assessment of the inhalation risks associated with working in printing rooms: a study on the staff of eight printing rooms in Beijing, China. Environmental Science and Pollution Research 25(17):17137-17143.			
HERO ID:	4454858			
Conditions of Use:	Ink, toner, and colorant products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Printing center staff			
Exposure route:	Inhalation			
Physical form:	Liquid/vapor			
Area sampling data:	0.05-0.18 (mg/m^3)			
Exposure duration:	8-13.75hr/day See table 1			
Exposure frequency:	260-360 days See table 1			
Number of workers:	27			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for ink, toner, and colorant products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2018)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at multiple printing facilities but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Sylvain, D. C. (1999). Health hazard evaluation report 97-0113-2720, U. S. Fish and Wildlife Service, Hadley, Massachusetts, January 1999.			
HERO ID:	8016870			
Conditions of Use:	Disinfectants			
EXTRACTION				
Parameter	Data			
Worker activity description:	Employees prepare and administer prophylactic salmon egg treatments. (9/20)			
Exposure route:	inhalation, dermal (10/20)			
Physical form:	solution (6/20)			
Personal sampling data:	For manual treatment, full shift samples revealed TWA concentrations ranging from approximately 0.6 ppm to >3.8 ppm during 21 to 33-minute sampling periods. For automated treatment, formaldehyde concentrations, determined by PBZ sampling , ranged from <0.07 ppm during a 9-minute period at Craig Brook, to 0.3 ppm during a 44-minute period at Green Lake. (12/20)			
Area sampling data:	Area samples were collected in egg incubation rooms during the actual treatment of the eggs, and for an additional 40-70 minutes thereafter. Formaldehyde concentrations in incubation rooms ranged from 0.08 to 0.59 ppm.. (11/20)			
Exposure duration:	up to 10 hours/day (9/20)			
Personal protective equipment:	Full-face respirators, latex gloves, rubber boots, full rain gear, and Viton gloves. (13/20)			
Engineering control:	Automated egg treatment systems reduce routine employee exposure by eliminating manual handling of formalin, and by containing formalin within an enclosed system during transfer and dilution. (13/20)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	Medium	The assessment is for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		Medium		

Study Citation:	Tan, Y.M., Diberardinis, L., Smith, T. (1999). Exposure assessment of laboratory students. Applied Occupational and Environmental Hygiene 14(8):530-538.			
HERO ID:	1233020			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Students in laboratories			
Number of workers:	132			
Personal protective equipment:	Lab coat, goggles, mask, gloves			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1999)	
	Metric 5: Sample Size	N/A	Not applicable - no sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - no sample data.	
Overall Quality Determination		High		

Study Citation:	Todhunter, J.A. (1985). Formaldehyde: Refining the risk assessment. Advances in Chemistry, Vol. 210 :357-373.			
HERO ID:	3260630			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	Formaldehyde producers, resin producers, plywood-particle board producers, urea-formaldehyde foam producers, foam isntallers, textile producers, paper-paper products producers, fertilizer producers/applicators, embalmers/funeral workers, pathologists, biology college and high school instructors; rubber-plastic workers, biology students, foundry workers, mobile home residents, urea-formaldehyde home residents (3 samples), US population by ambient air			
Area sampling data:	Mean ambient exposure based on worker activities provided in Table II (follows order in worker activity description tab): 1.35 ppm, 0.9 ppm, 1.75, 0.85, 0.02, 0.48, 0.06, 0.9, 0.52, NA, NA, NA, 0.03, NA, 0.43, 0.4. 0.72, 0.03, 0.03, 0.005			
Comments:	Predominantly an animal study and identifying ways to extrapolate animal data to humans. Exposure durations used in risk assessment are in Table III.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Refinement of previous exposure study by American Chemical Society.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is primarily scaling up from animal study but it does contain sampling data appli- cable to COUs
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1985)
	Metric 5:	Sample Size	Low	Not characterized by statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Provides results, methods and assumptions. Sources generally described.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by showing sampling data across multiple professions. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Tsigonia, A., Lagoudi, A., Chandrinou, S., Linos, A., Evlogias, N., Alexopoulos, E.C. (2010). Indoor air in beauty salons and occupational health exposure of cosmetologists to chemical substances. International Journal of Environmental Research and Public Health 7(1):314-324.		
HERO ID:	1320818		
Conditions of Use:	Use of personal care products		
EXTRACTION			
Parameter	Data		
Worker activity description:	Facial cleansing, skin, nails and body hydrotherapy and care, anti-wrinkle, pigmentation and acne treatment, make up, depilation, body and face massage, reflexology, aromatherapy, face and body hair removal, etc.		
Exposure route:	Dermal, inhalation		
Physical form:	Liquid, vapor		
Area sampling data:	<0.05 (ppm)		
Exposure duration:	7-9 hours		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Greece, an OECD country.
	Metric 3: Applicability	High	Data are for personal care products, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2009)
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by testing 4 nail salons but uncertainty is not addressed.
Overall Quality Determination		Medium	

Study Citation:	U.S. EPA, (2002). Flexographic ink options: A cleaner technologies substitutes assessment. Volume 1.		
HERO ID:	10293388		
Conditions of Use:	Ink, toner, and colorant products		
EXTRACTION			
Parameter	Data		
Worker activity description:	Pumping ink from a 55-gallon drum into 5-gallon cans, operating the printing press, adjusting inks in the five-gallon cans.		
Exposure route:	Inhalation and dermal.		
Physical form:	Liquid		
Exposure duration:	Ink pumping lasts 48-minutes per formulation shift. Operating the printing press occurs for 7.5 hours/day. Adjusting inks in the 5-gallon cans lasts 1-2.5 hours/day.		
Exposure frequency:	250 days/year.		
Number of workers:	14,000 workers.		
Personal protective equipment:	For many chemicals, appropriate equipment includes goggles, aprons or other impervious clothing, and gloves. In some printing facilities with loud presses, hearing protection may be recommended or required.		
Engineering control:	Pre-PressUse Computers for Proofs and Plates: By using computers to generate all proofs and plates, printers can skip photographic development and eliminate the use of darkroom chemicals.Switch from Rubber to Photopolymer Plates: Use of traditional nitric acid baths to etch designs into metal plates may generate wastewater that is low in pH and high in metal content, requiring regulation under the Clean Water Act. Photopolymer plates eliminate this waste stream as well as the metal engravingsand wastes generated from the production of conventional molded rubber plates.PrintingInstall Enclosed Doctor Blade Chambers: Enclosed doctor blade chambers reduce ink evaporation, which results in better control of ink usage, more consistent color, and improved performance of the inks on press.Use Higher Linecount Anilox Rolls: This enables printers to apply smaller ink droplets closer together, to achieve much finer ink distribution, easier drying, and potentially faster press speeds.Use Computerized Ink Blending: Software and specialized equipment help printers blend ink, reduce surplus ink, and reuse press return ink.		
Comments:	Area and dermal sampling are included in Appendix 3-F which is not in the documents (ends after chapter 8).		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for ink, toner, and colorant products, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2002)
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 10293388 Table: 1 of 1

...continued from previous page

Study Citation:		U.S. EPA, (2002). Flexographic ink options: A cleaner technologies substitutes assessment. Volume 1.		
HERO ID:		10293388		
Conditions of Use:		Ink, toner, and colorant products		
Domain	Metric	EVALUATION		Comments
		Rating		
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2022). Commercial use of automotive detailing products - Generic scenario for estimating occupational exposures and environmental releases (Methodology review draft).			
HERO ID:	10480464			
Conditions of Use:	Automotive detailing products			
EXTRACTION				
Parameter	Data			
Number of sites:	Provides method to calculate - 147,152 total establishments.			
Worker activity description:	Container unloading (liquids and solids), application and use of automotive detailing products.			
Exposure route:	Dermal, Inhalation			
Physical form:	liquids, pastes, or clays/waxes			
Area sampling data:	Inhalation: Provides methods for modeling exposures to non-volatile and volatile liquids and solids.			
Dermal exposure data:	nan			
Exposure duration:	8 hr/day.			
Exposure frequency:	260 days/yr.			
Number of workers:	3-4 workers/detailing facility.			
Personal protective equipment:	Particle respirators, ear plugs, safety glasses, aprons, knee pads, nitrile gloves, cooling towels, and face masks (page 37).			
Engineering control:	Miscellaneous control technologies include performing vehicle detailing in areas where there are no floor drains, keeping container lids closed, avoiding the use of detergents, using sloping pavement around drains, using high-pressure and low-volume sprays, and labeling all containers. Industrial and commercial facilities often collect dust emissions in ventilation filters.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality information/data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data.	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2023). Use of laboratory chemicals - Generic scenario for estimating occupational exposures and environmental releases (Revised draft generic scenario).			
HERO ID:	10480466			
Conditions of Use:	Use - Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Worker activity description:	Container unloading (liquids and solids), container cleaning, equipment cleaning, laboratory analyses, disposal of laboratory chemicals			
Exposure route:	Dermal, Inhalation; dermal: Provides methods for modeling exposures to non-volatile and volatile liquids and solidsInhalation: Provides methods for modeling exposures to non-volatile and volatile liquids and solids			
Physical form:	Liquid or solid			
Exposure duration:	8-12 hr/day			
Exposure frequency:	250 days/yr			
Number of workers:	3 workers/facility and 3 ONUs/facility			
Personal protective equipment:	Basic PPE includes wearing long sleeves (lab coats), long pants, closed-toe shoes, safety glasses or goggles, and gloves during the use of laboratory chemicals. Additional PPE may be worn depending on the level of hazard or specifics of the process.			
Engineering control:	Fume hood			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2022). Chemical repackaging - Generic scenario for estimating occupational exposures and environmental releases (revised draft).			
HERO ID:	11182966			
Conditions of Use:	Repackaging			
EXTRACTION				
Parameter	Data			
Worker activity description:	Unloading transport containers, container cleaning, equipment cleaning, loading of transport containers.			
Exposure route:	Dermal, Inhalation			
Physical form:	Liquid or solid			
Personal sampling data:	”dermal: Provides methods for modeling exposures to non-volatile and volatile liquids and solidsInhalation: Provides methods for modeling exposures to non-volatile and volatile liquids and solids”			
Dermal exposure data:	Dermal exposure data			
Exposure duration:	8-12 hr/day			
Exposure frequency:	The number of operating days is given in a range of 174-260 days/yr with an EPA default of 260 days/yr.			
Number of workers:	3 workers/facility and 1 ONUs/facility (total number of employees and facilities given in Table 5-3)			
Personal protective equipment:	Commonly used PPE includes safety glasses, face shields, aprons, and gloves.			
Engineering control:	Local exhaust ventilation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality information/data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data are for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete use amounts provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple worker activities.	
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2021). Use of chemicals in fuels and related products - Generic scenario for estimating occupational exposures and environmental releases (Methodology review draft).			
HERO ID:	11203977			
Conditions of Use:	Fuels and Fuel Additives			
EXTRACTION				
Parameter	Data			
Worker activity description:	Unloading transport containers, cleaning transport containers, equipment cleaning, fuel combustion exposures			
Exposure route:	Dermal, Inhalation			
Physical form:	Liquid			
Personal sampling data:	”Dermal: Provides methods for modeling exposures to volatile and non-volatile liquids.Inhalation: Provides methods for modeling exposures to volatile liquids. Also provides PBZ data reported in literature.”			
Dermal exposure data:	Dermal exposure data			
Exposure duration:	8 hr/day			
Exposure frequency:	250 days/yr			
Number of workers:	1 worker/site			
Personal protective equipment:	Respiratory protection			
Engineering control:	Routine maintenance, engine filters, avoiding idling, exhaust vents			
Comments:	41 PBZ samples (none FA-specific)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality information/data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	High	Statistical distribution of samples related to spray application is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering exposure to multiple fuel and additive types, and considering different worker activities.	
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Formaldehyde

Occupational Exposure

HERO ID: 11203977 Table: 1 of 1

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Study Citation:		U.S. EPA, (2021). Use of chemicals in fuels and related products - Generic scenario for estimating occupational exposures and environmental releases (Methodology review draft).		
HERO ID:		11203977		
Conditions of Use:		Fuels and Fuel Additives		
Domain		Metric	EVALUATION Rating	Comments
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (2014). Generic scenario draft on the use of additives in plastic compounding.			
HERO ID:	3827195			
Conditions of Use:	Reactant-Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Unloading and charging additives to process, container cleaning, equipment cleaning, and compounding processes (pdf pg 23)			
Exposure route:	dermal and inhalation (pdf pg 22)			
Personal sampling data:	Inhalation: Provides methods for modeling exposures to both solids and volatile liquids (pdf pg 50)			
Exposure frequency:	'148-264 days/yr (pdf pg 63)			
Number of workers:	24 workers/site (pdf pg 52)			
Engineering control:	forced ventilation (pdf pg 51)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Low	Model results characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple plastic types, additive types, and worker activities.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2014). Formulation of waterborne coatings - Generic scenario for estimating occupational exposures and environmental releases -Draft.			
HERO ID:	3827197			
Conditions of Use:	Formulation of Coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Unloading, container cleaning, sampling, equipment cleaning, filter media changeout, packaging			
Exposure route:	dermal and inhalation			
Personal sampling data:	”dermal: Provides methods for modeling exposures to non-volatile liquids and solidsInhalation: Provides methods for modeling exposures to volatile liquids and solids”			
Exposure frequency:	235-350 days/yr			
Number of workers:	25-40 workers/site			
Personal protective equipment:	PPE depends on the type of potential exposure. Typically, PPE used in the workplace include safety glasses and gloves. Face shields and a particulate respirator may also be required in cases where there is a potential for dust exposure			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple coating applications, and multiple chemical functions	
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 5908860 Table: 1 of 6

Study Citation:	U.S. EPA, (1984). Occupational exposures to formaldehyde from schweer G to hefter R with tabular enclosure (4). 13:1.			
HERO ID:	5908860			
Conditions of Use:	Metal products not covered elsewhere			
EXTRACTION				
Parameter	Data			
Personal sampling data:	[ppm] arithmetic mean:0.33; geometric mean for 3 plants: 1.2			
Area sampling data:	1.55 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Methods used in the assessment or reportare not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for metal products not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1982)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at multiple facilities but uncertainty is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 5908860 Table: 2 of 6

Study Citation:	U.S. EPA, (1984). Occupational exposures to formaldehyde from schweer G to hefter R with tabular enclosure (4). 13:1.			
HERO ID:	5908860			
Conditions of Use:	Plastic material and resin manufacturing			
EXTRACTION				
Parameter	Data			
Personal sampling data:	geometric means: 0.01-1.44 (ppm)			
Area sampling data:	arith. mean: 0.26 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Methods used in the assessment or reportare not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1982)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	All data sources, methods, results, and assumptions are clearly documented but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling at multiple facilities but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5908860 Table: 3 of 6

Study Citation:	U.S. EPA, (1984). Occupational exposures to formaldehyde from schweer G to hefter R with tabular enclosure (4). 13:1.			
HERO ID:	5908860			
Conditions of Use:	Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Personal sampling data:	means: 0.25-0.7 (ppm)			
Area sampling data:	means: 0.27-0.66 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	methods used in the assessment or reportare not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for finishing agents in textiles, apparel, and leather manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1982)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	All data sources, methods, results, and assumptions are clearly documented but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling at multiple facilities but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5908860 Table: 4 of 6

Study Citation:	U.S. EPA, (1984). Occupational exposures to formaldehyde from schweer G to hefter R with tabular enclosure (4). 13:1.			
HERO ID:	5908860			
Conditions of Use:	Building/construction materials - wood and wood engineered products			
EXTRACTION				
Parameter	Data			
Personal sampling data:	short term 0.39 (ppm); long term 0.2 ppm [geometric mean]			
Area sampling data:	short term 0.3 ppm; long term 1.28 (ppm)[geometric mean]			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Methods used in the assessment or reportare not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1982)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	All data sources, methods, results, and assumptions are clearly documented but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling at multiple facilities but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1984). Occupational exposures to formaldehyde from schweer G to hefter R with tabular enclosure (4). 13:1.			
HERO ID:	5908860			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	Manufacturers of formaldehyde and non-resin derivatives			
Personal sampling data:	[ppm] Arithmetic mean: 1.4 for urea and phenolic resins, 0.01-.2 for acetal resins; Geometric means: 0.01 to 0.12 for 1,4- butanediol, 0.71 for paraformaldehyde manufacture, 0.3 for acetal resins, 0.2 for phenolic resins , 0.8 for melamine resins			
Area sampling data:	Arithmetic mean: 0.24 (ppm) for melamine and phenolic resin			
Comments:	May not be primary source.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	methods used in the assessment or reportare not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for manufacture, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1982)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	All data sources, methods, results, and assumptions are clearly documented but not fully transparent	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling at multiple facilities but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5908860 Table: 6 of 6

Study Citation:	U.S. EPA, (1984). Occupational exposures to formaldehyde from schweer G to hefter R with tabular enclosure (4). 13:1.			
HERO ID:	5908860			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	Manufacturers of formaldehyde and non-resin derivatives			
Personal sampling data:	[ppm] Arithmetic mean: 0.46; Geometric means: 0.5 (ranged from 0.02 to 1.2 from 5 plants); 0.02 to 0.8 from 6 or less sites; 0.23 and 0.39 for shipping (celanese).			
Area sampling data:	Arithmetic mean: 0.41 (ppm)			
Comments:	May not be primary source.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	methods used in the assessment or reportare not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1982)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	All data sources, methods, results, and assumptions are clearly documented but not fully transparent
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at multiple facilities but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2004). Use of additives in foamed plastics – Generic scenario for estimating occupational exposures and environmental releases – Draft.			
HERO ID:	6304171			
Conditions of Use:	Flexible and Rigid Polyurethane Foam Manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	transfer from shipping containers, operation/supervision of the foam mix head/dispenser, foam production, transfer/handling of foamed articles			
Exposure route:	dermal and inhalation			
Exposure duration:	8 hr/day			
Exposure frequency:	250 days/yr			
Number of workers:	<50 workers/site			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Low	Number of workers characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple foam types.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2000). Leather dyeing - Generic scenario for estimating occupational exposures and environmental releases (draft).			
HERO ID:	6311220			
Conditions of Use:	Leather dyeing			
EXTRACTION				
Parameter	Data			
Number of sites:	315 tanneries in the United States, and 80% perform dyeing operations. Number of sites calculated based on PV and should not exceed 252 tanneries.			
Worker activity description:	Worker activities include weighing, mixing, dyeing, drying, and buffing.			
Exposure route:	Dermal, Inhalation			
Physical form:	Liquid or solid			
Personal sampling data:	”Inhalation: Exposures estimated in weighing, mixing, and buffing; exposure during dyeing and drying considered negligible. Inhalation exposures based on dye concentration in mixture and concentration of mixture in air. Dermal: If a solid, estimated dermal exposure in mg/day from weighing the dye is 3,100*concentration of chemical. If a liquid, estimated dermal exposure in mg/day from mixing and filling operations is 1,800*concentration of chemical.”			
Exposure duration:	Exposure duration ranges between 1.5-8 hrs/day based on worker activity.			
Exposure frequency:	Calculation for days of operation			
Number of workers:	<7 workers exposed per site			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations and some state statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering both liquid and solid physical forms and different worker activities.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2001). Manufacture and use of printing ink - Generic scenario for estimating occupational exposures and environmental releases (revised draft).			
HERO ID:	6311221			
Conditions of Use:	Formulation and Use of Printing Ink			
EXTRACTION				
Parameter	Data			
Worker activity description:	PROC: unloading, cleaning, packagingUSE: Printing operations, unloading			
Exposure route:	Inhalation, Dermal			
Physical form:	Vapor, Particulate, Liquid, Solid			
Personal sampling data:	Model equations to estimate inhalation exposure are provided on pg. 31-32(formulation), 39-40 (use)			
Dermal exposure data:	Dermal exposure data			
Exposure frequency:	250 days (pdf pg. 31, 39)			
Number of workers:	PROC: 13-22 workers/siteUSE: 16-43 workers/site (pdf pg. 30, 38)			
Comments:	Model uses measured monitoring data(not specific to formaldehyde) from NIOSH, which is explained in the Appendix.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses sound methods from a frequently used source, EPA, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation but is not specific to chemical.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old (2001). The assessment captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty not addressed. Variability is addressed in different ink classes and types of additives considered.
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (2003). Transportation equipment cleaning - Generic scenario for estimating occupational exposures and environmental releases (draft).			
HERO ID:	6385708			
Conditions of Use:	All			
EXTRACTION				
Parameter	Data			
Worker activity description:	The greatest potential for worker exposure to materials last transported occurs during heel removal.			
Personal protective equipment:	Facility personnel typically wear coveralls, safety shoes, protective glasses, and gloves during tank cleaning			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	only qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2010). Manufacture and use of printing inks - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385710			
Conditions of Use:	Ink, toner, and colorant products			
EXTRACTION				
Parameter	Data			
Worker activity description:	USE: Printing operations, unloading			
Exposure route:	Dermal and inhalation.			
Personal sampling data:	Inhalation: Provides methods for modeling exposures to volatile liquids and solids.			
Dermal exposure data:	Dermal exposure data			
Number of workers:	USE: 16-43 workers/site			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data.
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple printing applications, and multiple chemical functions.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2001). Leather tanning - Generic scenario for estimating occupational exposures and environmental releases (draft).		
HERO ID:	6385717		
Conditions of Use:	Leather Tanning		
EXTRACTION			
Parameter	Data		
Exposure route:	Dermal		
Personal sampling data:	"Dermal: 900 mg/day * concentration of chemical in original formulationInhalation: negligible vapor inhalation; provides equations and methods for determining inhalation exposure from particulates for chemicals in solid form"		
Exposure frequency:	up to 350 operating days/year		
Number of workers:	"Total of approximately 13,400, with 80% of the tanneries employing less than 50 employees. Average of 42 employees per site, and assumed that 75% of tannery employees areproduction workers."		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality information/data/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old
	Metric 5: Sample Size	Medium	Sample distributions characterized by ranges/estimations with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by considering different types of tanning (chromium and tannins), but uncertainty is not addressed.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 6385718 Table: 1 of 1

Study Citation:	U.S. EPA, (2004). Photographic industry - generic scenario for estimating occupational exposures environmental releases: Draft.			
HERO ID:	6385718			
Conditions of Use:	Coating of photographic film or paper			
EXTRACTION				
Parameter	Data			
Worker activity description:	Worker exposure to any chemicals during the coating application is limited to transferring chemicals to the emulsion formulation vessel as the coating is applied in a closed system			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old
	Metric 5:	Sample Size	N/A	only qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2004). Spray coatings in the furniture industry - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385719			
Conditions of Use:	Furniture Coating Application			
EXTRACTION				
Parameter	Data			
Worker activity description:	unloading, spray application, equipment cleaning			
Exposure route:	dermal and inhalation			
Physical form:	liquid			
Personal sampling data:	”dermal: Provides methods for modeling exposures to non-volatile liquidsInhalation: Provides methods for modeling exposures to mists and volatile liquids”			
Exposure frequency:	250 days/yr			
Number of workers:	12-98 workers/site			
Personal protective equipment:	Air-supplied full face piece respirator; Disposable overalls and head covering; Gloves specific to the chemicals used; and boots and boot coverings			
Engineering control:	Spray booths			
Comments:	Type of measurement or method: inhalation: 8-hr TWA surrogate data			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples related to spray application is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and wood vs metal furniture uses
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 6385725 Table: 1 of 1

Study Citation:	U.S. EPA, (1994). Application of chemicals in enhanced oil recovery: steam stimulation, steam flooding, and polymer/surfactant flooding-generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385725			
Conditions of Use:	Enhanced Oil Recovery			
EXTRACTION				
Parameter	Data			
Worker activity description:	"Worker exposure generally is limited to the time involved with mixing the chemicals for the injection fluids."			
Exposure route:	dermal, inhalation			
Physical form:	Powder, microbeads, or liquid formulation			
Personal sampling data:	"Inhalation: exposure to powder calculated based on OSHA PEL of powder respirable portion, microbead exposure considered negligible, and liquid exposure based on vapor pressure of chemicalDermal: exposure for powders based on routine two-hand contact, microbead and liquid exposures expected to be lower than powder"			
Exposure frequency:	250 days/yr			
Number of workers:	Generally, up to 5 people mix solutions during several hours per shift, with two to three shifts per site (total of 15 workers per site exposed). Using number of sites, estimate 2,145 people exposed in the United States			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple physical forms of chemical.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1994). Application of waterborne wood preservatives using pressure treatment-generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385737			
Conditions of Use:	Application of Wood Treatment Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	treatment operations			
Exposure route:	dermal and inhalation			
Personal sampling data:	”dermal: negligibleInhalation: Provides methods for modeling exposures to volatile liquids”			
Exposure frequency:	260 days/yr			
Number of workers:	4-15 workers/site			
Personal protective equipment:	gloves, rubber aprons, and rubber boots			
Comments:	type of measurement or method: inhalation: surrogate OSHA PEL			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple facility sizes.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1991). Granular detergents manufacture - generic scenario for estimating occupational exposures environmental releases: Draft.			
HERO ID:	6385740			
Conditions of Use:	Granular Detergent Manufacture			
EXTRACTION				
Parameter	Data			
Worker activity description:	handling bags, connecting feed hose, sampling mixtures, equipment leaks, handling fines from dust collectors/cyclone, cleaning spray dryer, dumping fines back into system, packing, maintenance work			
Exposure route:	dermal and inhalation			
Physical form:	powder			
Personal sampling data:	”dermal: Provides methods for modeling exposures to non-volatile liquids and solidsInhalation: Provides methods for modeling exposures to volatile liquids and solids”			
Exposure frequency:	250 days/yr			
Number of workers:	”3 material handlers/site3 wet-end operators/site3 dry-end operators/site6-9 packers/site3-6 maintenance workers/site”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Low	Model results characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple job types.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1994). Fabric finishing - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385741			
Conditions of Use:	Manufacture of Textiles, Apparel, and Leather			
EXTRACTION				
Parameter	Data			
Worker activity description:	mixing			
Exposure route:	dermal and inhalation			
Personal sampling data:	"inhalation: negligibledermal: 1,300-3,900 mg/day"			
Number of workers:	3-6 workers/site			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	Low	Exposure results characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple finishing agent types	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1996). Electrodeposition - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385753			
Conditions of Use:	Electrodeposition of paints			
EXTRACTION				
Parameter	Data			
Worker activity description:	Dermal exposures during measuring and pouring operations			
Exposure route:	Dermal, Inhalation			
Physical form:	Solid and liquid components in electrodeposition formulation			
Personal sampling data:	"Inhalation: references ""CEB models"" for volatile chemicalsDermal: exposure based on model for two-hand contact, with surface area and quantity remaining on skin multiplied by bath concentration of chemical"			
Exposure frequency:	Assume 250 days/yr			
Number of workers:	Assume 10 workers/site			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality information/data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distributions characterized by ranges/estimations and some state statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1994). Water treatment disinfectants application - generic scenario for estimating occupational exposures and environmental releases.			
HERO ID:	6385754			
Conditions of Use:	Water Treatment Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	handling and transfer operations, gas-phase chemicals released during treatment			
Exposure route:	dermal and inhalation			
Personal sampling data:	”dermal: Provides methods for modeling exposures to non-volatile liquids and solidsInhalation: Provides methods for modeling exposures to volatile liquids and solids”			
Number of workers:	”4-14 workers/site for water treatment facilities2 worker for every 1 MGD of wastewater treated”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	Low	Model results characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple facility sizes.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1994). Water treatment coagulants application - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385760			
Conditions of Use:	Use of Water Treatment Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Opening transport containers, during transfers of the chemical (pdf pg. 4)			
Exposure route:	Inhalation, Dermal			
Physical form:	Dry coagulents- fine powder, granules, flakes, pellets, rocks, and crystals. Liquid coagulents. (pdf pg. 3)			
Personal sampling data:	Source contains model for inhalation from powder handling (pdf pg. 6)			
Dermal exposure data:	Dermal exposure data			
Number of workers:	<10 MGD: Average of 9 staff workers, of which 4 are operators20-50 MGD: Average of 40 staff workers, of which 14 are operators.			
Comments:	Report is specific coagulents used in water treatment. The function of formaldehyde in the COU- Water Treatment Products, is unknown. Therefore, general information on coagulents is extracted and evaluated.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses sound methods that are from frequently used sources, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The assessment is for an occupational scenario (use of water treatment products) within the scope of the risk evaluation but is not data specific to formaldehyde.
	Metric 4:	Temporal Representativeness	Low	More than 20 years old.
	Metric 5:	Sample Size	Medium	characterized by uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is not addressed. Variability is considered with different physical forms of the coagulents considered and different sizes of operation.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2004). Additives in plastics processing (converting) - Generic scenario for estimating occupational exposures and environmental releases - Draft.			
HERO ID:	6549571			
Conditions of Use:	Additives in Plastics Processing (Converting into Finished Products)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Receipt of compounded resin, Forming (Heating), Molding/Shaping, Trimming, Finishing (including coating)			
Exposure route:	Inhalation and Dermal			
Physical form:	Exposure to solids during unloading of compounded resin from transport containers and charging to forming operation; Exposure to dusts generated from converting processes; Exposure to liquids during equipment cleaning of equipment; Exposure to solids during trimming activities.			
Personal sampling data:	Exposure from Unloading and Charging Compounded Resin; Exposure from Converting Processes; Exposure from Trimming Processes: Inhalation exposure = OSHA PEL x breathing rate x hours x fraction of additive in resin x fraction of chemical in additive (if applicable)Exposure from Converting Equipment Cleaning: Not expected, particles are expected to be contained in water.			
Dermal exposure data:	Dermal exposure data			
Exposure duration:	8 hours/day assumed for inhalation calculations			
Exposure frequency:	CEB standard assumption, 250 days per year based on 5 day work week and two weeks per year of operation shut down.			
Number of workers:	Overall, there were 736,698 workers employed in the Plastic Product Manufacturing industry in 2001. Table 1 provides Number of Workers for subcategories of NAICS 3261 Plastic Product Manufacturing.			
Engineering control:	Water: According to the Development Document for Effluent Limitation Guidelines for the Plastics Molding and Forming Point Source Category (1984), approximately 31% of surveyed sites that use process water directly discharged their process water; 44% indirectly discharged (POTW); and 25% had a zero discharge. Zero discharge methods include recycling, evaporation pond, septic tank with leach field, evaporation from equipment, land application, and contract haul. Types of on-site treatment include settling, pH adjustment, activated sludge, activated carbon adsorption, filtration, and vacuum filtration.Air: The Emissions Scenario Document on Plastic Additives suggests that bag filters used to collect particulate emissions are 99% efficient. However, the prevalence of bag filter use was not available.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment uses high quality data that are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation. However, data are not chemical specific.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	N/A	Sample size criteria are not applicable to data extracted.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 6549571 Table: 1 of 1

...continued from previous page			
Study Citation:	U.S. EPA, (2004). Additives in plastics processing (converting) - Generic scenario for estimating occupational exposures and environmental releases - Draft.		
HERO ID:	6549571		
Conditions of Use:	Additives in Plastics Processing (Converting into Finished Products)		
		EVALUATION	
Domain	Metric	Rating	Comments
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability in worker activities is captured through identification of various NAICS codes associated with plastic additive use, but uncertainty associated with number of workers is not characterized.
Overall Quality Determination		Medium	

Study Citation:	U.S. EPA, (2021). Application of spray polyurethane foam insulation - Generic scenario for estimating occupational exposures and environmental releases			
HERO ID:	- Final. 8674805			
Conditions of Use:	Spray Polyurethane Foam Application			
EXTRACTION				
Parameter	Data			
Worker activity description:	foam application, trimming, cleanup, chemical transfers, maintenance, distrubing foam during renovation and end-of-life activities			
Exposure route:	dermal and inhalation			
Personal sampling data:	Inhalation: Provides MDI, amine catalyst, blowing agent, and inhalable/respirable particulate exposure data			
Number of workers:	253,700 total workers in industry			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a mean with no other statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering different chemical components and particle sizes
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (1992). Generic scenario document for lube oil additives.		
HERO ID:	8726954		
Conditions of Use:	Lubricants		
EXTRACTION			
Parameter	Data		
Worker activity description:	Manufacture of additive - Chemical workerBlending - Chemical workerEnd use - changing and disposing of used oil.		
Exposure route:	dermal, inhalation (assumed to be negl. due to low VP)		
Physical form:	liquid		
Dermal exposure data:	Dermal exposure data		
Exposure frequency:	250 - 300 days per year		
Number of workers:	Lube oil manufacture 45Blending 30End usepure lube 20,000 employees 190 exposedGeneral automotive 222,720 employees 1851 exposed		
Personal protective equipment:	gloves		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods thatare from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, andassociated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	Medium	The data are for an occupational scenario (manufacture, blending and use of Lube additive) within the scope of the risk evaluation but data is general, not specific to formaldehyde.
	Metric 4: Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5: Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. The assessment provides only limited discussion of the variability.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1065662 Table: 1 of 6

Study Citation:	Ulsamer, A.G., Beall, J.R., Kang, H.K., Frazier, J.A. (1984). Overview of health effects of formaldehyde. 3:337–400.			
HERO ID:	1065662			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Area sampling data:	1.34 (ppm)			
Exposure duration:	Duration is presented as 40 hours per week (assume 8 hours per day).			
Number of workers:	420			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1065662 Table: 2 of 6

Study Citation: Ulsamer, A.G., Beall, J.R., Kang, H.K., Frazier, J.A. (1984). Overview of health effects of formaldehyde. 3:337–400.	
HERO ID: 1065662	
Conditions of Use: Plastic Manufacturing	
EXTRACTION	
Parameter	Data
Area sampling data:	0.31 (ppm)
Exposure duration:	Exposure duration is presented as 40 hours per week (assume 8 hours per day).
Number of workers:	2,000–45,000
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Methodology
Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
High	Data are from the U.S.
Metric 3:	Applicability
High	Data are for plastic and resin manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness
Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984)
Metric 5:	Sample Size
Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
Low	Variability and uncertainty are not addressed.
Overall Quality Determination	Medium

Formaldehyde

Occupational Exposure

HERO ID: 1065662 Table: 3 of 6

Study Citation:	Ulsamer, A.G., Beall, J.R., Kang, H.K., Frazier, J.A. (1984). Overview of health effects of formaldehyde. 3:337–400.			
HERO ID:	1065662			
Conditions of Use:	Use of Furniture and Furnishings			
EXTRACTION				
Parameter		Data		
Area sampling data:		0.92 (ppm)		
Exposure duration:		Exposure duration is presented as 40 hours per week (assume 8 hours per day).		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for furniture and furnishings, not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1065662 Table: 4 of 6

Study Citation: Ulsamer, A.G., Beall, J.R., Kang, H.K., Frazier, J.A. (1984). Overview of health effects of formaldehyde. 3:337–400.	
HERO ID: 1065662	
Conditions of Use: Use of fabric, textile and leather products	
EXTRACTION	
Parameter	Data
Area sampling data:	0.28-0.54 (ppm)
Exposure duration:	Exposure duration is presented as 40 hours per week (assume 8 hours per day).
Number of workers:	360-6,000
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Methodology
Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
High	Data are from the U.S.
Metric 3:	Applicability
High	Data are for Fabric, textile and leather products, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness
Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984)
Metric 5:	Sample Size
Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
Low	Variability and uncertainty are not addressed.
Overall Quality Determination	Medium

Formaldehyde

Occupational Exposure

HERO ID: 1065662 Table: 5 of 6

Study Citation: Ulsamer, A.G., Beall, J.R., Kang, H.K., Frazier, J.A. (1984). Overview of health effects of formaldehyde. 3:337–400.	
HERO ID: 1065662	
Conditions of Use: "Use in agriculture, forestry, fishing, and hunting"	
EXTRACTION	
Parameter	Data
Area sampling data:	0.82 (ppm)
Exposure duration:	Exposure duration is presented as 30 hours per week.
Number of workers:	500-900
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Methodology
Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
High	Data are from the U.S.
Metric 3:	Applicability
High	Data are for pesticide, fertilizer, and other agricultural chemical manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness
Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984)
Metric 5:	Sample Size
Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
Low	Variability and uncertainty are not addressed.
Overall Quality Determination	Medium

Formaldehyde

Occupational Exposure

HERO ID: 1065662 Table: 6 of 6

Study Citation: Ulsamer, A.G., Beall, J.R., Kang, H.K., Frazier, J.A. (1984). Overview of health effects of formaldehyde. 3:337–400.	
HERO ID: 1065662	
Conditions of Use: Laboratory Use	
EXTRACTION	
Parameter	Data
Area sampling data:	0.32-2.79 (ppm)
Exposure duration:	Exposure duration is presented as 1-20 hours per week.
Number of workers:	35,000-1,200,000
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1: Methodology	Medium
	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	
Metric 2: Geographic Scope	High
Metric 3: Applicability	High
Metric 4: Temporal Representativeness	Low
	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984)
Metric 5: Sample Size	Low
	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	
Metric 6: Metadata Completeness	Medium
	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 4: Variability and Uncertainty	
Metric 7: Metadata Completeness	Low
	Variability and uncertainty are not addressed.
Overall Quality Determination	Medium

Study Citation:	University of Milan, (1984). Mortality study testing a possible association between occupational exposure to formaldehyde and cancer.			
HERO ID:	1787226			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter		Data		
Area sampling data:		16-30 (ppm)		
Number of workers:		1,379 (one thousand three hundred and. thirty-two male and sixty-five female workers)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1986)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1477715 Table: 1 of 1

Study Citation:	Unwin, J., Coldwell, M.R., Keen, C., Mcalinden, J.J. (2013). Airborne emissions of carcinogens and respiratory sensitizers during thermal processing of plastics. Annals of Occupational Hygiene 57(3):399-406.			
HERO ID:	1477715			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Area sampling data:	<0.01 (mg/m^3)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from the United Kingdom, an OECD country.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2012)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (max) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Virji, M. A., Liang, X., Su, F. C., Lebouf, R. F., Stefaniak, A. B., Stanton, M. L., Henneberger, P. K., Houseman, E. A. (2019). Peaks, Means, and Determinants of Real-Time TVOC Exposures Associated with Cleaning and Disinfecting Tasks in Healthcare Settings. Annals of Work Exposures and Health 63(7):759-772.		
HERO ID:	5981264		
Conditions of Use:	Laboratory Chemicals (e.g., specimen preservation, medical samples, mortuary science)		
EXTRACTION			
Parameter	Data		
Worker activity description:	cleaning surfaces, sterilizing instruments, using products on patients, and using cleaning and disinfecting products such as general-purpose cleaners (e.g. bleach), high-level disinfectants (HLD, e.g. glutaraldehyde), and spray products		
Exposure route:	inhalation		
Area sampling data:	387 ppb		
Comments:	Measurement is for total VOC, not specifically formaldehyde.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors may impact exposures or releases relative to the U.S.
	Metric 3: Applicability	Low	The assessment is for an occupational scenario within the scope of the risk evaluation but the measurement is in total VOC not specific to formaldehyde.
	Metric 4: Temporal Representativeness	High	The assessment captures operations, equipment, and worker activities expected to be representative of current conditions. EPA has no reason to believe exposures have changed.The completed exposure or risk assessment is generally no more than 10 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Associated meta-data are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination		Medium	

Study Citation:	Ward, J.B., Hokanson, J.A., Smith, E.R., Chang, L.W., Pereira, M.A., Whorton, E.B., Legator, M.S. (1984). Sperm count, morphology and fluorescent body frequency in autopsy service workers exposed to formaldehyde. Mutation Research: Environmental Mutagenesis and Related Subjects 130(6):417-424.			
HERO ID:	1548606			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Personal sampling data:	TWA 0.61-1.32 (ppm)			
Area sampling data:	min and max: 0.1-5.8 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984)	
	Metric 5: Sample Size	Low	Sample distribution characterized by a range with no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1514882 Table: 1 of 1

Study Citation:	Wu, J.D., Milton, D.K., Hammond, S.K., Spear, R.C. (1999). Hierarchical cluster analysis applied to workers’ exposures in fiberglass insulation manufacturing. Annals of Occupational Hygiene 43(1):43-55.			
HERO ID:	1514882			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Worker activity description:	fiberglass wool manufacturing plant			
Exposure route:	inhalation			
Personal sampling data:	24.91-75.65 (ug/m^3)			
Number of workers:	37			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesive in construction, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1998)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing different work groups but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Wu, P.C., Li, Y.Y., Lee, C.C., Chiang, C.M., Su, H.J. (2003). Risk assessment of formaldehyde in typical office buildings in Taiwan. Indoor Air 13(4):359-363.			
HERO ID:	1513921			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Area sampling data:	0.13-0.89 (ppm)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Taiwan, a non-OECD country.
	Metric 3:	Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2001)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing multiple buildings but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Zhitkovich, A., Lukanova, A., Popov, T., Taioli, E., Cohen, H., Costa, M., Toniolo, P. (1996). DNA-protein crosslinks in peripheral lymphocytes of individuals exposed to hexavalent chromium compounds. Biomarkers 1(2):86-93.			
HERO ID:	1510695			
Conditions of Use:	Processing aid			
EXTRACTION				
Parameter	Data			
Area sampling data:	0.009-0.327 (mg/m^3)			
Exposure duration:	8 hours			
Exposure frequency:	1.5 - 15 years			
Number of workers:	14			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from Bulgaria, a non-OECD country.	
	Metric 3: Applicability	High	Data are for plating agents and surface treating agents in all other chemical product and preparation manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1996)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5956331 Table: 1 of 1

Study Citation:	[Anonymous] (1985). OSHA moves to toughen formaldehyde standard. Wood & Wood Products 90(6):12-12.			
HERO ID:	5956331			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Number of workers:	About 1.3 million workers might be exposed to formaldehyde according to OSHA. (2/3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources. (OSHA)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for general occupational work under OSHA rules, not one specific sector.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	[Redacted] (2013). [Redacted] Exposure screening assessment for XXX (formaldehyde, epichlorohydrin).		
HERO ID:	10605379		
Conditions of Use:	Textile/Fabric Finishing		
EXTRACTION			
Parameter	Data		
Worker activity description:	Workers during: (i) production of dipped fiber, (ii) production of transmission belts, (iii) inside sales worker in motorcycle shop in CA.		
Personal sampling data:	Processing(dipping process): CONSEXPO inhalation exposure estimate = 0.01 mg/m3 Above scenario is dependent on the containment system being at least 99.9% effective.Downstream processing (dipped fiber is then mixed with rubber for the final processing) CONSEXPO inhalation exposure estimate = 0.04 mg/m3 (pg 10-11 of 14)		
Area sampling data:	Formaldehyde was detected in the compounding and curing areas in Korea of the plant with levels in the range 0.01 – 0.04 mg/m3 indicating that tire manufacturers have adequate containment for such processes. In Japan, 0.05 mg/m3 was measured at redacted site(pg 9 of 14). All results are not in English.		
Personal protective equipment:	”During the preparation of dipping solution, operators must use gas musk and protective globe.” (pg 9 of 14)		
Engineering control:	Ventilation (pg 9 of 14)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country(Japan and South Korea) other than the U.S.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5: Sample Size	Low	Distribution of samples is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Report provides results and assumptions, but the underlying methods, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium	

Study Citation:	ACA, (2019). Comment submitted by Raleigh Davis, Assistant Director and Riaz Zaman, Counsel, Government Affairs, American Coatings Association (ACA) regarding the proposed 20 high priority candidates for chemical risk evaluation.			
HERO ID:	10369850			
Conditions of Use:	non-TSCA			
EXTRACTION				
Parameter	Data			
Personal protective equipment:	Formaldehyde may also be present in biocides used in paint and coatings products. When handling biocides, airborne formaldehyde concentrations would be greater than background levels during application. Handling neat biocides is hazardous. Workers must exercise precautions against corrosivity. Workers use safety glasses, smocks and butyl rubber gloves when handling (page 5 of 7)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	From the knowledge of the American Coatings Association
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	From USA
	Metric 3:	Applicability	Uninformative	Non-TSCA (biocides)
	Metric 4:	Temporal Representativeness	High	From 2019
	Metric 5:	Sample Size	Medium	The Association’s membership represents 90% of the paint and coatings industry, including downstream users (or processors) of chemicals, as well as chemical manufacturers (information was assumedly gathered from this large membership pool)
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination		Uninformative		

Formaldehyde

Occupational Exposure

HERO ID: 1314424 Table: 1 of 1

Study Citation:	Ahman, M., Alexandersson, R., Ekholm, U., Bergström, B., Dahlqvist, M., Ulfvarson, U. (1991). Impeded lung function in moulders and coremakers handling furan resin sand. International Archives of Occupational and Environmental Health 63(3):175-180.			
HERO ID:	1314424			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Worker activity description:	filling of big boxes, hand moulding of big boxes, cleaning of the mixer, and handling of warm recovered sand			
Personal sampling data:	0.1 (mg/m^3) (TWA over entire shift) See also Fig 2 for complete data set.			
Number of workers:	200 moulders and coremakers correspond to the 1000 tons used.			
Comments:	There are 4 different core and moulding methods, all of which use organic binders with formaldehyde resin (cold-setting furan, cold-box, shell moulding, and hot-box). This data source is associated with cold-setting furan resin.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Journal article
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data pertain to a COU
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1991)
	Metric 5:	Sample Size	Medium	A figure that is difficult to read contains TWA data for all sampled workers.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple facilities but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Ahuja, Y.R., Goud, K.I., Rao, K.P., Shankarappa, K., Vijayashree, B. (2001). DNA damage and repair studies in individuals working with photocopying machines. International Journal of Human Genetics 1(2):139-143.		
HERO ID:	6034881		
Conditions of Use:	Ink, toner, and colorant products; photographic supplies (photocopying machines)		
EXTRACTION			
Parameter	Data		
Worker activity description:	photocopying machines		
Exposure route:	inhalation		
Physical form:	vapor		
Exposure duration:	Duration: 8-10 hr/day (pg 3)		
Number of workers:	29 in study		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from India, a non-OECD country
	Metric 3: Applicability	High	Data are for Ink, toner, and colorant products; photographic supplies, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	N/A	no monitoring data
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	no monitoring data
Overall Quality Determination		Medium	

Study Citation:	Almgren, G., Bruze, M. (1988). Dermatositis in workers exposed to resins based on phenol and formaldehyde. :18-26.			
HERO ID:	1317040			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	1) Cleaning of equipment used prior to curing, including the the varnishing machines, the dryers, and cutters. Workers are possibly dermally exposed during cleaning or if the paper roll accidently broke. 2) Manually stacking impregnated paper for curing. Workers are exposed to uncured P-F-R 3) sawing, cutting and inspection of the products. This resulted in exposure to dust from the laminate.			
Exposure route:	demal			
Physical form:	component of liquid resin.			
Number of workers:	238 employees at one plant (site)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden - an OECD member	
	Metric 3: Applicability	High	The data are for formaldehyde resin products which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The data were published in 1987, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 1317054 Table: 1 of 1

Study Citation:	American Cyanamid, (1984). Letter from American Cyanamide Co to USEPA regarding comments pursuant to ANPR with attachments.			
HERO ID:	1317054			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Number of workers:	50 workers/site (American Cynamid)			
Comments:	Section for chemical compositions but does not provide data. Just states that it is described extensively in textbooks, monographs, chemical encyclopedias and the patent literature. Source is monitoring data for toxicological effects on humans using patch testing.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Source is a TSCA submission so it likely meets criteria for acceptable methodology but lack of information about specific sampling.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is for manufacturing of formaldehyde resins.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1984)
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1986670 Table: 1 of 1

Study Citation:	Anonymous (1983). Guidelines on handling of formaldehyde. RCN Nursing Standard 306:6.			
HERO ID:	1986670			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Nurses working in renal units where formaldehyde is used for disinfecting dialysers.			
Personal protective equipment:	Plastic aprons and eye shields			
Engineering control:	Closed transfer system using pumps.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	More than 20 years old.
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			Low	

Study Citation:	Anonymous, (1991). Update: Formaldehyde. Healthcare Hazardous Materials Management 4(6):7-9.			
HERO ID:	6115002			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Worker activity description:	”Morgue staff, anatomy laboratory staff, dialysis clinic staff, pathology laboratory staff, and possibly staff from other laboratories who are also at risk. There is also a risk of exposure to maintenance personnel who handle bulk shipments and wastes, as well as those who might use formaldehyde-containing products in enclosed spaces. ”			
Exposure route:	inhalation, dermal			
Personal protective equipment:	Employers must provide protection against contact with any solution containing more than 1 % formaldehyde. The equipment must be maintained free of formaldehyde contamination. At concentrations that would be immediately threatening to life and health, whole-body protection is required. Butyl and nitrile gloves provide the greatest protection. Thicker gloves of other materials (rubber, PVC, etc.) are satisfactory only for short-term exposure.			
Engineering control:	”Employers must provide quick-drench showers for employees who become splashed with solutions of 1 % or more formaldehyde. The showers must be provided even for employees who wear protective clothing. Eyewash facilities within the immediate work area must also be provided for use by any employee whose eyes are splashed by solutions containing 0.1 % formaldehyde or more. Any employee who must wear a respirator to avoid formaldehyde exposure must fill out a medical disease questionnaire that is administered by a licensed physician. All persons exposed to formaldehyde at concentrations between the action level (0.5 ppm) and the PEL (1 ppm) must be given the opportunity to participate in an annual medical surveillance program by filling out a medical disease questionnaire. ”			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	he assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	More than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by mentioning how different procedures should be followed at different exposure levels. Uncertainty isn’t addressed.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1222840 Table: 1 of 1

Study Citation: Armstrong, R.W., Imrey, P.B., Lye, M.S., Armstrong, M.J., Yu, M.C., Sani, S. (2000). Nasopharyngeal carcinoma in Malaysian Chinese: occupational exposures to particles, formaldehyde and heat. International Journal of Epidemiology 29(6):991-998.	
HERO ID:	1222840
Conditions of Use:	Use of Metalworking fluid
EXTRACTION	
Parameter	Data
Worker activity description:	Workers in the metal working industry
Exposure route:	inhalation
Physical form:	dust, smoke, gases
Area sampling data:	0.16-0.35 (mg/m^3)
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Methodology
Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Low	Data are from China, a non-OECD country.
Metric 3:	Applicability
High	Data are for Chemical substances in construction, paint, electrical, and metal products, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness
Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
Metric 5:	Sample Size
Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
Low	Variability and uncertainty are not addressed.
Overall Quality Determination	Medium

Study Citation:	Asphalt Roofing Manufacturers Association (ARMA), (2019). Comment submitted by Reed B. Hitchcock, Executive Vice President, Asphalt Roofing Manufacturers Association (ARMA) regarding initiation of prioritization of formaldehyde under the Toxic Substances Control Act.			
HERO ID:	10369851			
Conditions of Use:	Building/construction materials not covered elsewhere			
EXTRACTION				
Parameter	Data			
Worker activity description: Exposure route:	Working near the coater, storage tanks supplying the coater, and other process steps in the asphalt roofing line. [PDF Pg. 4] Inhalation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data not from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	N/A	N/A - Worker activity and exposure route.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - Worker activity and exposure route.	
Overall Quality Determination		High		

Study Citation:	Athanassiadis, B., George, G.A., Abbott, P.V., Wash, L.J. (2015). A review of the effects of formaldehyde release from endodontic materials. International Endodontic Journal 48(9):829-838.			
HERO ID:	2520140			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Exposure route:	Dermal, inhalation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2014)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			High	

Study Citation:	Austin, C.C., Wang, D., Ecobichon, D.J., Dussault, G. (2001). Characterization of volatile organic compounds in smoke at municipal structural fires. Journal of Toxicology and Environmental Health, Part A: Current Issues 63(6):437-458.			
HERO ID:	666418			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Worker activity description:	Firefighter			
Area sampling data:	ND-8.3 (ppm)			
Comments:	Firefighter exposure from structure fires (combustion of articles). Note that COU table in the scope document does not include firefighting. Further discussion may be needed.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from the United Kingdom, an OECD country.
	Metric 3:	Applicability	Medium	Data are for combustion of products during a structure fire, which is similar to the in-scope occupational scenario building and construction materials.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2001)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by analyzing exposures during certain types of fires but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Bahauddin, A., Prihatmanti, R. (2014). Indoor air quality in adaptively reused heritage buildings at a UNESCO world heritage site, Penang, Malaysia. 19(1):69.			
HERO ID:	6031964			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Area sampling data:	Air concentrations (ppm) of formaldehyde at the following locations: City Hall – 0, JHEAIPP – 0, Fire Brigade and Rescue – 0.01, Penang Immigration Department – 0.06, GTWHI – 0.01This chemical is widely used in indoor environments and is a common irritant of the eyes, nose, throat and sinuses at a low concentration of only 0.03 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	data are from a non-OECD country	
	Metric 3: Applicability	High	report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The report is generally no more than 10 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 1171856 Table: 1 of 1

Study Citation:	Barry, A., Corneau, D., Lovell, R. (2000). Press volatile organic compound emissions as a function of wood particleboard processing parameters. Forest Products Journal 50(10):35-42.			
HERO ID:	1171856			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
Physical form:	Vapor			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1997907 Table: 1 of 1

Study Citation:	Bauer, A. (2013). Contact dermatitis in the cleaning industry. Current Opinion in Allergy and Clinical Immunology 13(5):521-524.			
HERO ID:	1997907			
Conditions of Use:	Use of Cleaning and Furniture Care Products			
EXTRACTION				
Parameter	Data			
Personal protective equipment:	Gloves worn in contact with formaldehyde, glyoxal, glutaraldehyde, quaternary ammonium compounds and polymethylurea derivates containing disinfectants must reach a material thickness of at least 0.4mm for nitrile, 0.5mm for chloroprene, 0.7mm for fluorinated rubber and 0.5mm for butyl rubber gloves to provide relevant protection.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.	
	Metric 3: Applicability	High	Data are for cleaning and furniture care products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2013)	
	Metric 5: Sample Size	N/A	Not applicable - no sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - no sample data.	
Overall Quality Determination		High		

Study Citation:	Bello, A., Xue, Y., Gore, R., Woskie, S., Bello, D. (2019). Assessment and control of exposures to polymeric methylene diphenyl diisocyanate (pMDI) in spray polyurethane foam applicators. International Journal of Hygiene and Environmental Health 222(5):804-815.
HERO ID:	6134670
Conditions of Use:	Spray polyurethane foam

EXTRACTION

Parameter	Data
Worker activity description:	The main SPF insulation tasks consisted of site preparation (establishing a tarp containment, sealing windows, doors, establishing active space ventilation, setting up the compressed air lines for SARs and SPF hoses, assembling spray guns), spraying of SPF, shaving/cutting of excess foam, and site cleanup, including removal of foam debris. Sprayers performed spraying of the product using spray guns, often stopping to re-position the hoses or unclog and clean the gun. Helpers were responsible for cutting the excess foam flat against the studs using saw blades and assisting the sprayer in a variety of ways (checking drums of raw materials, relocating supply foam lines and supplied air hoses, repositioning the ladder, etc.).
Number of workers:	Insulation at each site was performed mostly by a crew of 2 workers (a sprayer and a helper). Bigger spray jobs sometimes involved a second crew. 54 study participants, 41 of whom were sprayers, 9 helpers, and 4 bystanders
Personal protective equipment:	Supplied air respirator, 3mil thin nitrile gloves, Disposable coveralls, full face organic vapor cartridge without particulate filters, nitrile covered in cotton, latex gloves. Field observation data summarized in Table 1 indicate that during spraying insulation tasks 53% of SPF applicators (the large contractors) wore air purifying supplied air respirators (SARs); 45% (the small contractors) wore full-face and half-face OVC respirators without particulate filters. The bystanders, including on site safety engineers and EHS personnel, would occasionally wear an OVC respirator without particulate filters when entering the site. All workers removed the respirators during lunch breaks and at the end of spraying, while still inside the spray space. Among all participants, 82% wore disposable thin blue nitrile gloves, 12% wore nitrile coated cotton gloves and 4% used latex gloves. One helper did not wear a respirator and another one did not wear gloves at the retrofitting sites. All but one wore disposable coveralls and all wore goggles to protect against SPF overspray particles and dust.
Comments:	Study does not mention formaldehyde but has information on the condition of use for spray polyurethane foam application.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5: Sample Size	N/A	Information is qualitative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 6134670 Table: 1 of 1

...continued from previous page

Study Citation:	Bello, A., Xue, Y., Gore, R., Woskie, S., Bello, D. (2019). Assessment and control of exposures to polymeric methylene diphenyl diisocyanate (pMDI) in spray polyurethane foam applicators. International Journal of Hygiene and Environmental Health 222(5):804-815.			
HERO ID:	6134670			
Conditions of Use:	Spray polyurethane foam			
		EVALUATION		
Domain		Metric	Rating	Comments
	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			High	

Study Citation:	Bender, J. (2002). The use of noncancer endpoints as a basis for establishing a reference concentration for formaldehyde. Regulatory Toxicology and Pharmacology 35(1):23-31.			
HERO ID:	1222846			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	cabinet manufacture			
Exposure route:	Inhalation			
Physical form:	airborne substances (dust)			
Area sampling data:	0.3-0.4 (ppm)			
Number of workers:	47			
Comments:	see page 25			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Sweden, an OECD country.	
	Metric 3: Applicability	High	Data are for construction/building materials - wood and wood engineered products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1989)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Low		

Study Citation:	Binding, N., Witting, U. (1990). Exposure to formaldehyde and glutardialdehyde in operating theatres. International Archives of Occupational and Environmental Health 62(3):233-238.			
HERO ID:	1222786			
Conditions of Use:	Use of Cleaning and Furniture Care Products			
EXTRACTION				
Parameter	Data			
Area sampling data:	5% cleaning solution: Peak concentrations: 0.43 (ppm); whole cleaning time: 0.23 (ppm); During the whole 8-h shift, mean values were 0.18 pm formaldehyde; See also similar data for 3% cleaning solution on page 3/6 of PDF.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	jounal article
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	data pertain to a COU
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1990)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by giving peak concentration and full work time concentration but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Breum, N.O., Orhede, E. (1994). Dilution versus displacement ventilation: Environmental conditions in a garment sewing plant. American Industrial Hygiene Association Journal 55(2):140-148.			
HERO ID:	1317514			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Number of workers:	40			
Engineering control:	Dilution ventilation (DILVENT) and Displacement ventilation (DISPVENT). Air exchange efficiency of DILVENT came to 49%. DISPVENT improved the efficiency to a level of 57%.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for fabric, textile and leather products not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1994)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			High	

Study Citation:	Breyse, P. A. (1980). Small plants and their medical problems – the furniture industry: The environmental problems of urea-formaldehyde structures – formaldehyde exposure in mobile homes. NIOSH(NIOSH):56-64.			
HERO ID:	1322359			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Formaldehyde emissions from UF-bonded chipboard and particle board stem from unreacted formaldehyde that remains in the product after manufacture, as well as from the subsequent breakdown of the urea-formaldehyde resin by their reaction withmoisture and heat (7). Some gaseous formaldehyde escapes from plywood during itspressing; small amounts are, however, given off afterwards during subsequent storage, sanding, trimming, etc, of the material (8). The extent of emissions and degree of concentration build-up of formaldehyde from both particle board and plywood dependupon a number of factors; for example,the amount of free formaldehyde remaining in the panels,the volume of panels in an enclosed space relative to the volume of that space,the area of exposed surface of the panels,the temperature and humidity and rate of diffusion of formaldehyde from the panel andthe amount of ventilation available to the enclosed space.			
Exposure route:	inhalation			
Physical form:	off-gas from particleboard and plywood			
Comments:	Note: Report contains monitoring data but that data is not extracted as the data is air monitoring inside mobile homes, a consumer/general population exposure data need.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data published by NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment,and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative information
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1222793 Table: 1 of 1

Study Citation:	Bruze, M., Almgren, G. (1988). Occupational dermatoses in workers exposed to resins based on phenol and formaldehyde. Contact Dermatitis 19(4):272-277.			
HERO ID:	1222793			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Cleaning equipment, handling sheets impregnated with uncured resin, sawing, cutting and inspection of cured product.			
Exposure route:	Dermal			
Physical form:	Liquid, dust			
Number of workers:	238 potentially exposed workers at the facility that is the subject of the data source.			
Comments:	This data source pertains to the industrial use of resol resins based on phenol and formaldehyde (P-F-R) for the manufacture of decorative equipment by the impregnation of paper sheets with these resins.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	scientific journal article
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1988)
	Metric 5:	Sample Size	N/A	sampling data was not included
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Methods, results, and assumptions are clearly documented
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		High		

Formaldehyde

Occupational Exposure

HERO ID: 1267867 Table: 1 of 1

Study Citation:	Burgess, W. A. (1991). Potential exposures in the manufacturing industry—Their recognition and control. :595-674.			
HERO ID:	1267867			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Exposure route:	dermal			
Area sampling data:	A study was cited, and this involved short period air sampling conducted for periods of 20 min. at 15 work sites to define worker exposure. The concentration of formaldehyde was in the range of 0.25 to 1.0 of the occupational exposure limits.			
Dermal exposure data:	Dermal exposure data			
Engineering control:	Redesigning water-based paint formulations to reduce formaldehyde			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	Medium	The report is for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	Low	characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	underlying methods, data sources, and assumptions are not fully transparent	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	CalEPA, (2012). Air Toxics Hot Spots Program Risk Assessment Guidelines: Technical support document for exposure assessment and stochastic analysis.			
HERO ID:	10217809			
Conditions of Use:	General			
EXTRACTION				
Parameter	Data			
Comments:	This data source is about exposure of people who are located near sites at which chemicals are emitted. This data source contains information pertaining to the exposure of "offsite workers" to various chemicals including formaldehyde. Offsite workers are all workers who work near a site that emits a specified chemical. The exposure routes discussed are inhalation and dermal exposure as a result of contact with soil. This data source contains information about assessment methods for assessing such exposures. Offsite workers are not ONUs because they are not located within a site associated with a COU of the RE, and, instead, they are a part of the general population. Therefore, this data source is not relevant to the assessment of occupational exposure to formaldehyde (although it may be relevant in the case of general population exposure.)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report provides general information, not specific to any COU, that may be useful for occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old
	Metric 5:	Sample Size	N/A	no sampling data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	Carteret, M., Pauwels, J.F., Hanoune, B. (2012). Emission factors of gaseous pollutants from recent kerosene space heaters and fuels available in France in 2010. Indoor Air 22(4):299-308.			
HERO ID:	1290538			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Exposure duration:	Some people use the heaters continuously for several hours, and steady state is probably reached. (page 8/10.)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2010)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1314633 Table: 1 of 1

Study Citation:	Casteel, S. W., Vernon, R. J., Bailey, E. M. (1987). Formaldehyde: Toxicology and hazards. Veterinary and Human Toxicology 29(1):31-33.			
HERO ID:	1314633			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Area sampling data:	Urea-formaldehyde concentration from 0 to 4 ppm in homes with UF foam insulation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is applicable to production of FA and exposure to FA in homes.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1987).
	Metric 5:	Sample Size	Low	Primarily qualitative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Only contains PV data, life cycle, and some area sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Celanese Corp, (2020). Comment submitted by Stephanie Daigle, Vice President, Government Affairs, Celanese Corporation regarding the draft scope of the risk evaluation for formaldehyde.			
HERO ID:	10370219			
Conditions of Use:	Multiple: Manufacture, Processing as a formulation, mixture, or reaction product- Plastic Compounding			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation, dermal			
Physical form:	pellets, flakes			
Number of workers:	typically only 3 or 4 operators per unit at any given time (pdf pg. 6)			
Personal protective equipment:	Site-wide required personal protective equipment includes hard hats, fire-retardant clothing, gloves, goggles or eye shields, safety shoes, and, where appropriate, hearing protection. Respiratory protection- generally full-face respirators with an assigned protection factor of 50 for any tasks with potential exposure above the OSHA limits are required. Additionally, employees performing short-term tasks in conditions potentially exceeding 20 ppm of formaldehyde must wear either a self-contained breathing apparatus or pressure demand supply air with egress bottle, which offer 10,000 and 1,000 APF respectively. (pdf pg. 6)			
Engineering control:	Typical processing set-ups include ventilation systems that include collection hoods above process discharge points such as extrusion line dies and injection molding machine nozzles. The chemical units are located outside, the site is highly automated.(pdf pg. 6)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A- qualitative information.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Site-specific PPE and EC information is not applicable for variability or uncertainty. For the information on customers, the report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Chin, J. Y. (2011). Characterization of biofuels blends: Emissions, permeation and apportionment of volatile organic compounds.			
HERO ID:	6026451			
Conditions of Use:	Use of fuels			
EXTRACTION				
Parameter	Data			
Worker activity description:	Fuel delivery represents an individual who loads, drives and delivers fuel to retail gasoline stations. Dermal exposure may occur during refueling events due to contact with wet or leaky fuel caps, nozzles, fuel splashes, etc. a full-time technician analyzes fuel properties in the laboratory.			
Exposure route:	Dermal and inhalation			
Personal protective equipment:	measured breakthrough times (BTs), permeation rates(PRs), and the VOC composition of permeants for four fuels (gasoline, E85, ULSD and B20) through three types of gloves (neoprene, nitrile Sol-Vex and Viton) commonly usedas PPE, three types of gloves (latex, nitrile and vinyl) used in laboratory settings, and a reference material (neoprene sheet). Gasoline tended to have the highest PR among the four fuels, and only the Viton glove gave excellent protection (BT > 8 hr). Diesel and B20 had low PRs, and both Viton and nitrile Sol-Vex materials gave good protection; neoprene also could give acceptable protection.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., ATSM) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu- ated.
	Metric 3:	Applicability	High	The data relates to an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be repre- sentative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	Data is qualitative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well char- acterized.
Overall Quality Determination			High	

Study Citation:	Cleary, W. M. (1970). Thermoplastic resins decomposition. Industrial Medicine and Surgery 39(3):129-131.
HERO ID:	1321064
Conditions of Use:	Other Byproduct

EXTRACTION	
Parameter	Data
Worker activity description:	Manufacturing establishments where thermal decomposition of resin occurs, such as a plastic molding plant, injection molding company.
Exposure route:	inhalation
Personal protective equipment:	Compressed air supply under emergency condition
Engineering control:	The following controls are: 1) All feed screws must be of the vented type. 2) Heat regulation must be automatically controlled and overtemperature conditions monitored by an audible alarm or warning device in direct view of the operator. 3) All employees involved in handling or processing of these resins should be instructed as to the potential hazards involved. 4) A standby cooling water source must be available which is not dependent upon the main electrical system. Where municipal water is not available, a gravity cooling arrangement is acceptable providing adequate flow can be maintained for approximately a ten minute period. 5) Should decomposition of the resin occur while a machine is in operation, as a result of overheating or other machine failure, the gassing action can be stopped by immediately disconnecting the electrical or steam heating source from the feed cylinder and air ejecting and/or purging (with polyethylene) the hot material into water. Following this the area should be cleared of personnel and fully ventilated to remove all traces of decomposition gases. 6) All machines using Delrin or similar thermoplastic resins must be so identified, and emergency shutdown instructions posted in a location readily available to operating personnel. A variety of metal and decal type signs are available through most major resin suppliers. General ventilation is extremely important as a means of emergency control for molding operations. In addition, a properly designed system will prevent the accumulation of toxic combustion products from lift trucks as well as minimizing solvent exposure which may arise from component assembly operations.

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	high quality data and/or information
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	more than 20 years old
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination	High

Formaldehyde

Occupational Exposure

HERO ID: 627553 Table: 1 of 4

Study Citation:	Collins, J.J., Esmen, N.A., Hall, T.A. (2001). A review and meta-analysis of formaldehyde exposure and pancreatic cancer. American Journal of Industrial Medicine 39(3):336-345.			
HERO ID:	627553			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Resin production, plastic molding			
Exposure route:	Inhalation			
Area sampling data:	ND-49 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for plastic and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1987)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by examining both plastic and resin manufacturing but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 627553 Table: 2 of 4

Study Citation:	Collins, J.J., Esmen, N.A., Hall, T.A. (2001). A review and meta-analysis of formaldehyde exposure and pancreatic cancer. American Journal of Industrial Medicine 39(3):336-345.			
HERO ID:	627553			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	Plywood manufacturing			
Exposure route:	Inhalation			
Area sampling data:	ND-6.8 (ppm)			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for construction materials-wood and engineered wood products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1987)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by data from two different studies but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation: Collins, J.J., Esmen, N.A., Hall, T.A. (2001). A review and meta-analysis of formaldehyde exposure and pancreatic cancer. American Journal of Industrial Medicine 39(3):336-345.	
HERO ID: 627553	
Conditions of Use: Furniture Manufacturing	
EXTRACTION	
Parameter	Data
Worker activity description:	Furniture manufacturing
Exposure route:	Inhalation
Area sampling data:	1.1 (ppm)
EVALUATION	
Domain	Metric
Domain 1: Reliability	
Metric 1:	Methodology
	Medium
	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Metric 3:	Applicability
Metric 4:	Temporal Representativeness
	High
	High
	Low
	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1986)
Metric 5:	Sample Size
	Medium
	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	Medium
	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	Low
	Variability and uncertainty are not addressed.
Overall Quality Determination	Medium

Formaldehyde

Occupational Exposure

HERO ID: 627553 Table: 4 of 4

Study Citation:	Collins, J.J., Esmen, N.A., Hall, T.A. (2001). A review and meta-analysis of formaldehyde exposure and pancreatic cancer. American Journal of Industrial Medicine 39(3):336-345.			
HERO ID:	627553			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Anatomist, autopsy, undertaker			
Exposure route:	Inhalation			
Area sampling data:	0.92-2.6 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2001)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by getting exposure ranges from multiple studies but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Conner, R. (2000). Head lice; formaldehyde storage; chewing gum in the OR; building design. AORN Journal 71(3):688-694.			
HERO ID:	6211799			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation, dermal (2/4)			
Physical form:	aqueous solution, formalin (2/4)			
Personal protective equipment:	The OSHA standard requires that employers provide protective clothing and equipment, including goggles, face shields, and gloves. (3/4)			
Engineering control:	Formalin should be stored and dispensed carefully in a centralized location. Individual specimen containers can be filled under controlled conditions and stored at the central location, close to eye wash, cleanup, and decontamination facilities in the event of an accidental spill or injury. The OSHA standard requires that employers provide emergency showers; provide eye wash facilities in the immediate work area (bottle-type eye washes are not acceptable); label all containers of formalin; and provide employee education and training.(2/4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses OSHA standards and federal regulations, which are frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Cox, J. E. (1985). OSHA reconsidering formaldehyde. ASHRAE Journal 27(9):10.			
HERO ID:	5936914			
Conditions of Use:	All			
EXTRACTION				
Parameter	Data			
Worker activity description:	Industries most likely to have higher exposures to formaldehyde are: 1) producers of formaldehyde; 2) manufacturers of plywood and particle board; 3) plastics manufacturers; 4) high school and university instructors; 5) hospital laboratory technicians. Other industries: photographic processing, building construction and manufacturers of end and specialty chemicals, textiles, paper and paperboard, abrasive products, and mobile homes.			
Number of workers:	up to 1.5 million workers (assumed for total U.S. in 1985)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for multiple in-scope occupational scenarios.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	number of workers data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	number of workers data	
Overall Quality Determination		High		

Study Citation:	Cox, J. E., Miro, C. R. (1991). OSHA to lower formaldehyde exposure level. ASHRAE Journal 33(11):14.			
HERO ID:	5936923			
Conditions of Use:	All			
EXTRACTION				
Parameter	Data			
Number of workers:	OSHA has estimated that some 84,000 workers are currently exposed to formaldehyde levels between 0.75 and 1.0 ppm (with 59,000 of these being in the apparel industry).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	D’Ettorre, G., Criscuolo, M., Mazzotta, M. (2017). Managing formaldehyde indoor pollution in anatomy pathology departments. Work 56(3):397-402.		
HERO ID:	4571619		
Conditions of Use:	Laboratory Uses		
EXTRACTION			
Parameter	Data		
Worker activity description:	During the dissection of cadavers, FA vapors are emitted, exposing the workers; “sampling” step where workers handle the anatomic piece from the container filled with formalin and, before slicing, rinse it under running water for 10–15 minutes.		
Personal sampling data:	Five papers showed personal exposures to FA and indoor concentrations lower than the ACGIH TLV ceiling level. In gross anatomy laboratories, the personal exposure levels are frequently 2–3-fold higher than the mean indoor FA level.		
Personal protective equipment:	Aprons, lab coats, gloves, protective eyewear and face masks, and respirators		
Engineering control:	Local exhaust ventilation systems; ventilation systems demonstrated the consequent reduction of FA air pollution in gross anatomy laboratories below the ceiling standard of 0.3 ppm; FA indoor levels were successfully decreased by using a dissection table equipped with a photocatalyst device that reduced FA concentrations by about 80%; vacuum sealing systems		
Comments:	Source has some qualitative exposure information (such as how exposure compares to PELs).		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5: Sample Size	N/A	Information is generally qualitative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Information is generally qualitative.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 1315142 Table: 1 of 1

Study Citation: Dahlquist, I., Fregert, S. (1970). Occupational dermatoses in hospital personnel. Berufs Dermatosen 18(5):261-268.	
HERO ID: 1315142	
Conditions of Use: Laboratory Use	
EXTRACTION	
Parameter	Data
Dermal exposure data:	nan
Number of workers:	3500 employees: 260 physicians, 560 nurses, 300 assistant nurses, 730 other persons to care for sick, 300 full-time cleaning women. About 1400 employees have nothing to do with nursing the sick.
Comments:	Article identified workers who developed hand eczema and traced it back to certain chemicals.
EVALUATION	
Domain	Metric
Domain 1: Reliability	Rating
Metric 1:	Methodology
	Medium
	Source is not peer reviewed by likely contains high quality data.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
	Medium
	Data is for Sweden.
Metric 3:	Applicability
	Medium
	Data is for hospital exposure but does not provide quantifiable data.
Metric 4:	Temporal Representativeness
	Low
	Data is from 1970s, so over 20 years old.
Metric 5:	Sample Size
	Low
	Data is qualitative.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	Low
	Report provides results but no quantifiable data is provided.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	Low
	Does not address variability or uncertainty.
Overall Quality Determination	
Low	

Study Citation:	Dow Chemical, (2016). [Redacted] Industrial hygiene assessment of employee exposures to formaldehyde during manufacturing of Dow Corning® MB40-006 Masterbatch on Line 7 at the Copley, OH Multibase Site.
HERO ID:	10602470
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product: Paint additives and coating additives not described by other categories in: paint and coating manufacturing and plastic material and resin manufacturing

EXTRACTION

Parameter	Data
Exposure route:	inhalation (p. 4)
Physical form:	vapor (p.4)
Personal sampling data:	Two personal samples were collected for formaldehyde. The two personal samples ranged from 0.064 to 0.16 ppm. (p.5)
Area sampling data:	The area sample collected was 0.042 ppm. (p.6)
Exposure frequency:	This masterbatch material is produced only a few times each year.
Personal protective equipment:	However it is recommended operators on line 7 continue to wear full face elastomeric respirators with multigas cartridges during production of the Dow Corning® MB40-006 MASTERBATCH product until the second sampling event is completed. (p. 5)
Engineering control:	The line 7 extruder portion has two local exhaust ventilation units. One is a repositionable arm, located along the water bath, which has been certified for employee exposure control under the provisions of pd.std.00121. The other unit is a canopy hood located above the line 7 extruder which, due to inadequate flow, has not been certified for employee exposure control but serves to provide heat and odor control. Both ventilation units were running during the time of the survey and the repositionable arm unit was working within established performance specifications. (p.5)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (OSHA FA Standard 1910.1048)
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5: Sample Size	Medium	Statistical distribution of samples is fully characterized. However, samples size is small.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.

Continued on next page ...

Formaldehyde

Occupational Exposure

HERO ID: 10602470 Table: 1 of 1

...continued from previous page

Study Citation:	Dow Chemical, (2016). [Redacted] Industrial hygiene assessment of employee exposures to formaldehyde during manufacturing of Dow Corning® MB40-006 Masterbatch on Line 7 at the Copley, OH Multibase Site.		
HERO ID:	10602470		
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product: Paint additives and coating additives not described by other categories in:paint and coating manufacturingand plastic material and resin manufacturing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 3076814 Table: 1 of 1

Study Citation:	Driscoll, T.R., Carey, R.N., Peters, S., Glass, D.C., Benke, G., Reid, A., Fritschi, L. (2016). The Australian Work Exposures Study: Prevalence of Occupational Exposure to Formaldehyde. Annals of Occupational Hygiene 60(1):132-138.			
HERO ID:	3076814			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	working with particle board or plywood typically through carpentry work, building maintenance, or sanding prior to painting. See table 1			
Personal protective equipment:	half-face respirators; half face paper dust mask			
Engineering control:	local exhaust ventilation			
Comments:	59% of respondents reported using PPE or area or local exhaust ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	Uninformative	Data are for particle board which is not in-scope or similar to an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	data collection
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by surveying a large cohort of workers but uncertainty is not addressed.
Overall Quality Determination		Uninformative		

Study Citation:	Dugheri, S., Bonari, A., Pompilio, I., Colpo, M., Mucci, N., Arcangeli, G. (2018). An integrated air monitoring approach for assessment of formaldehyde in the workplace. Safety and Health at Work 9(4):479-485.			
HERO ID:	6072310			
Conditions of Use:	Processing, Manufacturing, Use			
EXTRACTION				
Parameter		Data		
Number of workers:		The number of North American employees directly involved in sectors where FA is used is estimated at 700,000		
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report provides a citation for the data presented
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data refer to the United States and all of North America, and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Eastman Kodak, (2009). Material Safety Data Sheet (MSDS): Kodak Flexicolor Stabilizer III and Replenisher/C-41.			
HERO ID:	11328020			
Conditions of Use:	Chemical substances in packaging, paper, plastic, and hobby products: Photographic supplies			
EXTRACTION				
Parameter	Data			
Physical form:	Physical form: liquid (pg. 3)			
Personal protective equipment:	Respiratory protection: If formaldehyde is emitted at levels requiring respiratory protection, the following respirator type should be worn: full facepiece with cartridges or canisters specifically approved by NIOSH for protection against formaldehyde or a TypeC air-supplied respirator demand type, with full facepiece, hood, or helmet. If respirators are used, a program should be instituted to assure compliance with applicable federal, state, commonwealth, provincial, or local laws and regulations.Eye protection: Wear safety glasses with side shields (or goggles) and a face shield.Hand protection: All skin contact with liquids containing 0.1 percent or more formaldehyde should be prevented by use of chemical protective clothing made of material impervious to formaldehyde and the use of other personal protective equipment. Wear impervious gloves and protective clothing appropriatefor the risk of exposure. (pg. 3)			
Engineering control:	Use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. Controls should be sufficient so that applicable occupational exposure limits are not exceeded. (pg. 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Source is from manufacturer.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report captures formulations that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A-Qual.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	N/A	N/A-Recommended PPE
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A-Recommended PPE
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1988111 Table: 1 of 1

Study Citation:	Ehdaivand, S., Chapin, K.C., Andrea, S., Gnepp, D.R. (2013). Are biosafety practices in anatomical laboratories sufficient? A survey of practices and review of current guidelines. Human Pathology 44(6):951-958.				
HERO ID:	1988111				
Conditions of Use:	Laboratory Use				
EXTRACTION					
Parameter	Data				
Exposure route:	dermal				
Personal protective equipment:	Morgue/autopsy suite: Caps/hoods, Face shield, N-95 respirator, Fluid-resistant clothing, Double gloves, Cut-resistant gloves, Foot covers or protective boots. Surgical pathology suite: Gowns, Apron, Gloves, Face shield for bloody specimens, Double gloves for fresh specimens. Frozen section area: Gloves, N-95 respirator				
Engineering control:	Negative pressure with air exhausted to outside at 12 air exchanges per hour or recirculation through HEPA filters or UV irradiation; Biohazard sign; Easily accessible sharps container; Hands-free sink at the exit for washing, eye wash station and shower				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data	
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	High	data less than 10 years old	
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination			High		

Study Citation:	ENSR, (1991). Acute ISC input data-full grid & AB 2588 health risk assessments: Corrected & alternative emissions cases for the Cymric area oil fields McKittrick, California with letter 090591.			
HERO ID:	1481763			
Conditions of Use:	”Processing aids, specific to petroleum production in: oil and gas drilling, extraction, and support activities and all other basic inorganic chemical manufacturing”			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for petroleum manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1991)
	Metric 5:	Sample Size	N/A	Not applicable - exposure route.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - exposure route.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1356128 Table: 1 of 1

Study Citation:	Environ & Ecol Engin, (1992). Health risk assessment in fulfillment of requirements under the AB2588 Air Toxics Information and Assessment Act of 1987 (final report) with attachments and letter dated 021492.			
HERO ID:	1356128			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter		Data		
Exposure route:		Inhalation, dermal		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1986)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 1317568 Table: 1 of 1

Study Citation:	Estlander, T., Jolanki, R., Kanerva, L., Plosila, M. (1990). An artist’s allergy to reactive dyes and formaldehyde. Contact Dermatitis 23(4):271.			
HERO ID:	1317568			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Hand printing textiles using reactive dyes.			
Exposure route:	Dermal			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for fabric, textiles and leather products not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1990)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 200024 Table: 1 of 1

Study Citation: Fishbein, L. (1992). Exposure from occupational versus other sources. Scandinavian Journal of Work, Environment and Health 18(S1):5-16.
HERO ID: 200024
Conditions of Use: Additional Clarification Needed

EXTRACTION

Parameter	Data
Exposure route:	inhalation
Physical form:	vapor
Area sampling data:	ambient air 0.02 mg/d; indoor Home conventional 0.5-2.0 mg/day; prefabricated 1.0-10.0 mg/d; Workplace w/o occupational exposure 0.2-0.8 mg/d; w/1 mg/m3 occupational exposure 5 mg/d; environmental tobacco smoke 0.1-1.0 mg/d; smoking 20 cigarettes/day = 1.0 mg/day
Exposure duration:	Outdoor air: 10% of time; Indoor Air Home: 65% of time; Workplace: 25% of time

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Low	nothing was specified
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	Medium	Exposure at home and at work
	Metric 4: Temporal Representativeness	Low	Published 1989
	Metric 5: Sample Size	Low	no statistics were included
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	no documentation was provided
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination

Uninformative

Formaldehyde

Occupational Exposure

HERO ID: 1508862 Table: 1 of 1

Study Citation:	Fondelli, M.C., Costantini, A.S., Ercolanelli, M., Pizzo, A.M., Maltoni, S.A., Quinn, M.M. (2007). [Exposure to carcinogens and mortality in a cohort of restoration workers of water-damaged library materials following the River Arno flooding in Florence, 4 November 1966]. La Medicina del Lavoro 98(5):422-431.		
HERO ID:	1508862		
Conditions of Use:	Use of Water Treatment Products		
EXTRACTION			
Parameter	Data		
Worker activity description:	Restoration of books recovered from a flood using a variety of chemicals including formaldehyde.		
Exposure route:	Inhalation, dermal		
Physical form:	Liquid		
Number of workers:	159		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3: Applicability	High	Data are for water treatment products, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination		Medium	

Study Citation:	Forintek Canada Corp, (1983). The report of the technical mission on formaldehyde release control measures from particleboard in selected Scandinavian and European countries with cover letter 010986.			
HERO ID:	5901048			
Conditions of Use:	Particleboard mfg			
EXTRACTION				
Parameter	Data			
Number of workers: 100 employees in the Wirus-Werke W. Ruhenstroth complex are in particleboard production.				
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data is more than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Occupational Exposure

HERO ID: 6574573 Table: 1 of 1

Study Citation:	Formaldehyde Institute, (1984). Letter from Formaldehyde Institute to USEPA regarding comments on ANPR for urea-formaldehyde resins.			
HERO ID:	6574573			
Conditions of Use:	Commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers involved in resin manufacturing, manufacturers of wood products (particleboard, veneer, hardwood plywood), wood furniture, paints and coatings.			
Exposure route:	Inhalation and dermal			
Number of workers:	There are more than 10 estimates of the number of workers exposed and they attempt to break it down into subcategories like dermal exposure vs inhalation exposure, manufacture of particle board vs plywood vs wood furniture vs uf resin, etc.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The data sources used in the report are not specified	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1317355 Table: 1 of 1

Study Citation:	Fregert, S. (1980). Irritant dermatitis from phenol formaldehyde resin powder. Contact Dermatitis 6(7):493-493.			
HERO ID:	1317355			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Number of workers:	60 workers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data are for plastic material and resin production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1980)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			Medium	

Study Citation:	Gerberich, H. R., Seaman, G. C. (2013). Formaldehyde. 11:929-951.		
HERO ID:	626378		
Conditions of Use:	Combustion Byproduct		
EXTRACTION			
Parameter	Data		
Worker activity description:	Workers exposed to engine exhaust, tobacco smoke, natural gas, fossil fuels, waste incineration, and oil refineries.		
Exposure route:	inhalation		
Physical form:	At ordinary temperatures, pure formaldehyde is a colorless gas with a pungent, suffocating odor.		
Area sampling data:	Facilities that manufacture or consume formaldehyde must control workers’ exposure in accordance with the following workplace exposure limits in ppm: action level, 0.5; TWA, 0.75; STEL, 2. In other environments such as residences, offices, and schools, levels may reach 0.1 ppm HCHO due to use of particle board and urea-formaldehyde foam insulation in construction.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 6247876 Table: 1 of 1

Study Citation:	Griffin, V. (1990). Formaldehyde: hazard alert on a possible human carcinogen. Queensland Nurse 9(2):14-15.		
HERO ID:	6247876		
Conditions of Use:	Laboratory chemicals		
EXTRACTION			
Parameter	Data		
Worker activity description:	Nurses working with and sterilizing a renal dialysis machine. (1/2)		
Exposure route:	inhalation, ingestion, dermal, eye contact (1/2)		
Physical form:	Gaseous, and aqueous solution (1/2)		
Exposure duration:	8 hours		
Personal protective equipment:	Goggles, face shields, aprons, positive-pressure air supplied respirators, neoprene gloves, and boots should be worn. (2/2)		
Engineering control:	Local exhaust ventilation, small quantities should be purchased in plastic containers, traps should be placed in floor drains, spill absorbent bags should be available for emergencies. In dialysis, the main system should be isolated from personnel or patients in case of a spill, and the dialyzers should be disconnected before sterilization. The air should be regularly monitored, and staff should be educated on the effects of formaldehyde. (2/2)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3: Applicability	Medium	The report is for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4: Temporal Representativeness	Low	More than 20 years old.
	Metric 5: Sample Size	N/A	Qualitative data.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Qualitative data.
Overall Quality Determination		Medium	

Formaldehyde

Occupational Exposure

HERO ID: 5954949 Table: 1 of 1

Study Citation:	Gu, J., Kirsch, I., Schripp, T., Froning-Ponndorf, F., Berthold, D., Salthammer, T. (2018). Human exposure to airborne particles during wood processing. Atmospheric Environment 193:101-108.			
HERO ID:	5954949			
Conditions of Use:	Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Physical form:	Inhalable wood dust			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used source.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Medium	The article contains information that is relevant to a condition of use in the scope but does not contain any information specific to formaldehyde.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	Contains general information on dust particles from wood processing, but not specific to formaldehyde.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Contains general information on dust particles from wood processing, but not specific to formaldehyde.
Overall Quality Determination			High	

Study Citation:	Halm, P. E. (1989). Controlling indoor air quality. Consulting Specifying Engineer 5(1):42.			
HERO ID:	6024376			
Conditions of Use:	emission			
EXTRACTION				
Parameter	Data			
Engineering control:	The following engineering controls are recommended during designing new buildings or rehabilitating existing buildings: provide adequate controlled ventilation (outdoor air); provide adequate and easily maintainable filtration systems; be balanced to ensure proper operation in all areas; control operational costs by storing energy, rather than by reducing ventilation rates. In particular, designers must allow sufficient space around the HVAC systems to facilitate preventive maintenance programs. NASA’s environmental specialists also found that house plants such as philodendrons, chrysanthemums and aloe vera are quite effective in removing harmful gases such as formaldehyde from indoor air. However, while house plants may be effective in reducing indoor air pollution in small, completely enclosed spaces they are likely to be less effective in larger, ventilated spaces such as offices.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	report uses high quality data and/or techniques or sound methods that are not from a frequently used source
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	report does not address variability or uncertainty
Overall Quality Determination		Medium		

Study Citation:	Hampl, V., Johnston, O. E., Watkins, D. S. (1988). Application of an air curtain-exhaust system at a multiple opening veneering press. Applied Industrial Hygiene 3(10):291-298.			
HERO ID:	6111758			
Conditions of Use:	Building and construction materials (wood panel manufacturing)			
EXTRACTION				
Parameter	Data			
Worker activity description:	Multiple opening veneering press			
Exposure route:	inhalation			
Physical form:	vapor			
Engineering control:	Air curtain-exhaust system; tested with sulfur hexafluoride as a tracer gas simulating FA emissions, 94% reduction (abstract); Table VI (page 8) presents % reduction for various control tech parameters/sulfur hexafluoride discharge locations			
Comments:	GC used for analysis of sulfur hexafluoride (pg 7)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for building/construction materials, an in-scope occupational scenario; however, formaldehyde exposure reduction via controls is based on surrogate chemical data.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples (for % exposure reduction via control) is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by evaluating different flow rates/position/orientation for the control technology. Uncertainty is not addressed
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 10176929 Table: 1 of 1

Study Citation:	Haz-Map, (n.d.). Haz-Map: Hazardous Agents: Formaldehyde.			
HERO ID:	10176929			
Conditions of Use:	All conditions of use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Industrial Processes with risk of exposure:Dressing Hair; Electroplating; Fur Dressing and Dyeing; Leather Tanning and Processing; Metal Machining; Molding and Core Making; Painting (Pigments, Binders, and Biocides); Photographic Processing; Plastic Composites Manufacturing; Pulp and Paper Processing; Semi-conductor Manufacturing; Sterilizing EquipmentTextiles (Printing, Dyeing, or Finishing); Using Disinfectants or Biocides; Working with Glues and Adhesives			
Exposure route:	inhalation			
Physical form:	Colorless gas.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for all conditions of use.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	N/A	N/A - physical form.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - physical form.	
Overall Quality Determination		High		

Study Citation:	Heiden Associates, (1984). A survey of occupational exposure to uncured UF resins in seven industries.			
HERO ID:	6574574			
Conditions of Use:	Processing/Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Workers related to UF resin production and use. Workers performed the following operations: (a) handling; (b) resin manufacture; (c) resin mixing; (d) resin application or use;(e) equipment cleaning and washdown; (f) product recycling; (g) testing and quality control sampling; and (h) other.			
Exposure route:	Dermal exposure was the most significant type of exposure for three of seven industries surveyed-UF resin manufacturers, fertilizers, and wood furniture. An average of 23.24, 40, and 6.23 workers per plant respectively were reported as experiencing dermal exposure (unadjusted basis). Inhalation exposure tended to be more significant for two industries-particleboard and glass mats with 17.36 and 26.50 workers exposed (unadjusted) respectively. Dermal and inhalation exposure tended to be about equally significant as actual exposure sources for the remaining two industries-averaging about 10.1 workers for hardwood plywood and 3.33 workers for corrugated converters (both unadjusted).			
Physical form:	All seven industries reported that the liquid form of uncured UF resin was used more frequently than any other form. Only a minority of plants in four industries reported regular use of the powdered form.			
Exposure duration:	40-hour per week			
Number of workers:	The total number of workers actually exposed (unadjusted for the number of hours per week that such exposure occurred) in all seven industries ranged between 13,040 and 14,076. The percent of total employees (per average plant) who were actually exposed ranges from 2% for wood furniture to 26% for glass mats. Those potentially exposed range from 3% of total employees (wood furniture) to 30% (glass mats and particleboard). On the average, over all seven industries, 75% of workers who were reported to be in the path of potential exposure experienced actual exposure.			
Personal protective equipment:	Five of seven industries reported that over 50 percent of their workers wore some form of protective clothing or used some kind of protective equipment. Reported use ranged from 100 percent in the fertilizer industry (two plants) to 26 percent for the particle board industry.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	Report is for an occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Report is more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Heitbrink, W., Cooper, T., Edmonds, M., Bryant, C., Ruch, W. (1993). In-depth survey report: control technology for autobody repair and painting shops at Valley Paint and Body Shop, Amelia, Ohio.		
HERO ID:	6558536		
Conditions of Use:	Autobody repair and painting		
EXTRACTION			
Parameter	Data		
Worker activity description:	During repair activities, the workers may be exposed to aerosols from sanding, grinding, and welding. Workers who paint cars can be exposed to organic solvents, hardeners that may contain isocyanate resins, and pigments that may contain toxic components.		
Number of workers:	This autobody shop employs seven technicians, five of which repair cars, and two of which paint cars.		
Personal protective equipment:	Three types of respirators were used in this autobody shop. Half-facepiece, air purifying respirators that were equipped with organic vapor cartridges and spray painting prefilters were issued to all of the workers. This respirator was used for some primer painting, sanding, and welding. During abrasive blasting, a constant flow air line respirator with a half-facepiece was used. The air was supplied to this respirator through an oil-less pump equipped with a HEPA cartridge. In the spray painting area, an air-supplied hood was used to control worker exposure to paint overspray. The air for this respirator was supplied by the shop air compressor. This compressor did not have a high temperature alarm or a carbon monoxide alarm. Before flowing into the respirator, the air passes through filters and absorbent. According to shop personnel, this absorbent removes carbon monoxide, oil mist, and particulate. In addition, the air passes through a refrigeration unit. Respirator fit testing results in Table 7. Respirator defects in Table 8.		
Engineering control:	Each vehicle preparation bay exhausts air through three filters in the back of the vehicle preparation station. Bays have 5000 cfm of air exhausted from each bay. // The paint booth has a downdraft ventilation system to remove the paint vapors. During the painting cycle, outside air is passed through a series of filters. The final set of filters cover the entire ceiling of the spray painting booth. A nominal 12,000 cubic feet per minute of air flows out of the ceiling around the car or object being painted and out of the booth through exhaust grates located in the floor of the booth. // During drying, airflow in the booth is reduced about 80% of the air flow during spraying. Airflows listed in Table 2. Static pressures listed in Table 3. Air velocities in Table 6.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
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Study Citation:	Heitbrink, W., Cooper, T., Edmonds, M., Bryant, C., Ruch, W. (1993). In-depth survey report: control technology for autobody repair and painting shops at Valley Paint and Body Shop, Amelia, Ohio.		
HERO ID:	6558536		
Conditions of Use:	Autobody repair and painting		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination		High	

Study Citation:	Hovding, G. (1961). Contact eczema due to formaldehyde in resin finished textiles. Acta Dermato-Venereologica 41:194-200.			
HERO ID:	6117731			
Conditions of Use:	Processing: Finishing agents in textiles			
EXTRACTION				
Parameter	Data			
Exposure route:	dermal (2/7)			
Physical form:	4% aqueous formaldehyde solution (3/7)			
Comments:	Article is about contact eczema due to formaldehyde in resin finished textiles.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Norway, an OECD country.
	Metric 3:	Applicability	High	Data are for textile finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by discussing possibilities of false positives in the study, but variability is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Huang, L., Anastas, N., Egeghy, P., Vallero, D.A., Jolliet, O., Bare, J. (2019). Integrating exposure to chemicals in building materials during use stage. International Journal of Life Cycle Assessment 24(6):1009-1026.			
HERO ID:	5964979			
Conditions of Use:	Use as chemical substance in wood products in Homes			
EXTRACTION				
Parameter	Data			
Exposure route:	Table 3 provides proportion of exposure in homes due to each route: inhalation, dermal contact, gaseous dermal, ingestion			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	Low	The article applies to exposure in homes, which may be similar to exposure at commercial places.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	ICFI, (1985). Production and use of formaldehyde containing resins and options for controlling formaldehyde release from durable-press fabrics.			
HERO ID:	5901058			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Engineering control:	Several control options are available to reduce the level of formaldehyde release from fabrics treated with resins that impart durable properties: using a different resin; changing the catalyst or the time and temperature of the reaction which cures the resin in place on the fabric; altering the concentration of the resin and impurities therein; introducing other additive during the "padding" step in which the fabric is impregnated with resin; altering fabric condition; changing the method of storage; and afterwashing and aftertreating the fabric.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	data are from the United States	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	ICFI, (1984). Formaldehyde emissions from building products: cost-effectiveness of reduction strategies. Chapter II: formaldehyde-emitting wood products and alternatives for controlling emissions.			
HERO ID:	5901065			
Conditions of Use:	Surface coatings using resins			
EXTRACTION				
Parameter	Data			
Worker activity description:	workers involved in surface coatings using resins			
Area sampling data:	Formaldehyde concentrations can range from 1.2 to 13.2 ppm			
Engineering control:	Controlling formaldehyde emissions from urea-formaldehyde wood products can be done by: reducing the formaldehyde content in UF resins; use of coatings or scavengers; use of phenol-formaldehyde or other lower emitting formaldehyde resins; use of ammonia treatment; and having longer storage times before sales. Another option is ventilation. Though this does not reduce formaldehyde emission, it will decrease formaldehyde concentration within an area.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	data are from the United States	
	Metric 3: Applicability	High	report is for an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	report is more than 20 years old	
	Metric 5: Sample Size	Low	characterized by no statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	report does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Jenkins, M. F. (1980). Reducing occupational exposure to formaldehyde in the dialysis laboratory. Dialysis & Transplantation 9(11):1049-1050.		
HERO ID:	5944900		
Conditions of Use:	Laboratory chemical		
EXTRACTION			
Parameter	Data		
Worker activity description:	sterilizing instruments and exterior of dialyzer, packing dialyzer (pg 2)		
Exposure route:	inhalation		
Physical form:	vapor		
Personal protective equipment:	Gown, mask, cap, chemical safety goggles, heavy-duty waterproof gloves, face shields for pouring or mixing FA solutions. Full face respirators with appropriate cartridges available for emergency use. (pg 1)		
Engineering control:	trapped floor drains and adequate ventilation in case of spills (pg 1); exhaust ducting/fan, exhaust hood (pg 2)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	no sampling data
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	no sampling data
Overall Quality Determination		Medium	

Study Citation:	Jr, M.V. (1981). Walk-Through Survey Report: Monsanto Plastics and Resins Company, Phenolormaldehyde Resin Facility, Port Plastics Plant, River Road, Addyston, Ohio, Report No. CT-108-11a. NIOSH(CT-108-11a):108-111.			
HERO ID:	1320858			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Worker activity description:	charging and monitoring reactors (2/4)			
Exposure route:	inhalation			
Physical form:	vapor			
Exposure duration:	Employees involved in the production of P/F resins are scheduled in four shifts to cover a 24 hour/day. (2/4)			
Exposure frequency:	operates 7 days per week (2/4)			
Number of workers:	Two or three workers per shift are responsible for charging and monitoring reactors.(2/4)			
Personal protective equipment:	wearing respiratorssafety glassesshard hatsapronsgloveshearing protection			
Engineering control:	Reactors are sealed and operate below atmospheric pressure. when one is open for charging or cleaning a local exhaust collar-hood can ne placed around the opening to reduce escaping vapors			
Comments:	Report notes that there are no contract housekeeping on production floors.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data and/or techniques or sound methods that are from frequently used sources (NIOSH study)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 - More than 20 years old
	Metric 5:	Sample Size	N/A	Not applicable for extracted data (e.g., exposure duration)
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative, site specific information provided
Overall Quality Determination			High	

Study Citation:	Kim, E.A., Lee, H.E., Ryu, H.W., Park, S.H., Kang, S.K. (2011). Cases series of malignant lymphohematopoietic disorder in Korean semiconductor industry. Safety and Health at Work 2(2):122-134.			
HERO ID:	1508886			
Conditions of Use:	Use of Ink, Toner, and Colorant Products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Operator, process engineer			
Personal protective equipment:	A protective suit known as a ‘bunny suit’ which is composed of all-in-one clothing, including a mask, safety glasses, gloves, and boots			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Korea, an OECD country.	
	Metric 3: Applicability	High	Data are for ink, toner and colorant products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Report is based on current industry conditions and data no more than 10 years old. (2007-2010)	
	Metric 5: Sample Size	N/A	Not applicable - no sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - no sample data.	
Overall Quality Determination		Medium		

Study Citation:	Lawryk, N. J. (1994). Automobile commuter exposures to volatile organic compounds: Emissions, malfunctions, and policy.			
HERO ID:	6025389			
Conditions of Use:	In-vehicle exposure			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	gas			
Area sampling data:	Table 12 shows in-vehicle concentrations of VOCs (ug/m^3): FA - 0.4 +/- 0.2; 0.3 +/- 0.2; 0.1 +/- 0.1; 0.1 +/- 0.04; 0.3 +/- 0.2; Table 26 with median (and 90th percentile) conc. of in-vehicle VOCs (ug/m^3): 0.3 (0.6); 0.2 (0.4); Table 40 compares mean in-vehicle VOC conc. (ug/^3) for this study and previous ones: Previous studies - 5.1, 13.7, and 16.5			
Comments:	Source evaluates in-vehicle exposure not actual emissions coming out of the vehicle			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Source is a dissertation and uses EPA and OSHA guidance in determining exposure and relevant data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Low	Data is for standard gen pop vehicle emissions which is not an occupational exposure.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	Medium	Range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes description of release source, physical form, exposure route, area sampling data, pollution control.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses uncertainty by referencing other studies that have in-vehicle VOCs of a larger magnitude which cannot be explained. Does not address variability.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1314457 Table: 1 of 1

Study Citation:	Letz, G.A. (1990). Sick building syndrome: Acute illness among office workers—the role of building ventilation, airborne contaminants and work stress. Allergy Proceedings 11(3):109-116.			
HERO ID:	1314457			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Worker activity description:	Office workers			
Area sampling data:	0.01-0.30 (ppm)			
Comments:	Reported levels ranged from 0.01 to 0.30 ppm			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1990)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Li, Y., Shao, S. X., Shi, K. Q., Jiang, L. (2006). Release of free formaldehyde in THP salts tannages. :94-99.				
HERO ID:	1963870				
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product				
EXTRACTION					
Parameter	Data				
Exposure route:	Inhalation				
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Non OECD country	
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Medium	Data between 10 and 20 years old	
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination			High		

Formaldehyde

Occupational Exposure

HERO ID: 1515532 Table: 1 of 1

Study Citation:	Lodén, M. (1986). The in vitro permeability of human skin to benzene, ethylene glycol, formaldehyde, and n-hexane. Acta Pharmacologica et Toxicologica 58(5):382-389.			
HERO ID:	1515532			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Dermal exposure data:	Dermal exposure data			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1986)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by showing dermal absorption at different points in time but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Manning, C. R. (1990). Controlling chemical exposure in healthcare facilities. Journal of Clinical Engineering 15(2):119-124.			
HERO ID:	1621531			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Use of various cocktails to prepare tissue samples			
Exposure route:	Inhalation			
Engineering control:	Small fume hoods should be used in pathology areas			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1990)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			Medium	

Study Citation:	Martinsone, Z., Bake, M.A., Seile, A., Zellane, M., Sudmalis, P., Lakisa, S., Sprudza, D. (2012). Occupational risks and related health effects for office workers in Latvia. :91-94.			
HERO ID:	1828807			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter		Data		
Exposure route:		Inhalation		
Physical form:		Solid (dust)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Latvia, an OECD country.
	Metric 3:	Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2012)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 8724621 Table: 1 of 1

Study Citation:	Massachusetts OTA, (2013). A report on barriers to reducing the use of asthma-related chemicals.			
HERO ID:	8724621			
Conditions of Use:	All conditions of use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Exposures can occur in a wide range of workplaces, in transfer operations, reactor or vessel cleaning, and before curing, and particularly where heat and/or pressure is applied in the processing of products made from or including formaldehyde-bearing resins, such as pressing wood products, extrusion or injection molding of plastics, heat-setting of pleats on apparel, and mold casting at foundries.			
Exposure route:	Inhalation			
Physical form:	Gas.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for all conditions of use.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. [2013]	
	Metric 5: Sample Size	N/A	N/A - worker activity, physical form, and exposure route.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - worker activity, physical form, and exposure route.	
Overall Quality Determination		High		

Study Citation:	Mccammon, C. (1990). Hazard Evaluation and Technical Assistance Report No. HETA-90-170-L2053, Johnson Junior High School, Laramie County School District Number 1, Cheyenne, Wyoming. :90-170.			
HERO ID:	1317196			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Engineering control:	Ventilation			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building and construction products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - engineering controls.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - engineering controls.
Overall Quality Determination			High	

Study Citation:	McDonald, L. (1989). Blood exposure and protection in funeral homes. American Journal of Infection Control 17(4):193-195.			
HERO ID:	1320553			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Creating incisions, fusing embalming fluid, draining blood, and sewing incisions.			
Personal protective equipment:	Disposable scrub suit, plastic apron, double rubber gloves, hair covering and a face mask.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1989)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination		Medium		

Study Citation:	Mihlan, G.J. (1983). Preliminary control technology survey on Datel Intersil Corporation, Mansfield, Massachusetts.			
HERO ID:	5471613			
Conditions of Use:	Process Aid- Electroless Copper Plating			
EXTRACTION				
Parameter	Data			
Number of workers:	340 workers in production; 204 workers in administrative and technical support			
Personal protective equipment:	Workers in the area of electroless copper plating wear goggles, gloves, and aprons during handling and transfer of boards.			
Engineering control:	The ventilation system consists of air treatment and recirculation, and local exhaust ventilation. Monitoring of capture velocity and face velocity of local exhaust ventilation systems is not performed by the plant. Local exhaust ventilation from process operations is exhausted through stacks to the atmosphere.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data and/or techniques	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data	
	Metric 3: Applicability	High	report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	report is greater than 20 years old	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Mortimer, V. (1982). Preliminary survey report: Fiberboard Plant, Medford Corporation, Medford, Oregon.			
HERO ID:	6558530			
Conditions of Use:	Adhesives and sealant chemicals in: Plastic and resin manufacturing; Wood product manufacturing; All other basic organic chemical manufacturing			
EXTRACTION				
Parameter	Data			
Number of workers:	100, including 80 production workers			
Personal protective equipment:	All workers are required to wear hardhats except while in certain specific areas, such as the enclosed control rooms and the break room. Hearing protectors and safety glasses are required for some jobs. Respirators are not mandatory for any worker, except when working above the press. Both a Norton 7500-30M half-face mask and supplied-air resirators are available, but rarely required.			
Engineering control:	Local exhaust ventilation is used over the cooling wheel. A canopy hood covers the boards as they make a 1800 pass over a supply of air from a plenum on the lower left side. The unit is also enclosed on the sides, and air is extracted into a plenum on the right side as well as through the top of the hood. Four roof fans located above the press remove much of the heated air from the press, although there is not much air flow observable at floor level or on the platform which provides worker access to all points of the production line. Control rooms have been built for the operators who control the press and the layering of wood fibers. Now only a few workers involved in maintenance and clean-up regularly work outside this booth. An air conditioner has been installed for cooling during hot weather. The unit is a small, central-air type model which does have the provision to draw air from outside the building. It was not operating on the day of the survey, and it is not known what effect, if any, air-conditioning would have on formaldehyde levels in the control room. The area where the resin is pumped and blended into the wood fibers is ventilated by a 40,000 cubic-feet-per-minute exhaust fan. There is approximately 100,000 cfm of air pulled through the finish-shipping area and evacuated by the vacuum-cleaning fans of the sanding machine and the cut-up saw. No appreciable odor of formaldehyde was noticed in either location. The spray nozzles are cleaned by pressing a built-in rod through the orifice.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data directly from industry, and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 6558530 Table: 1 of 1

...continued from previous page			
Study Citation:	Mortimer, V. (1982). Preliminary survey report: Fiberboard Plant, Medford Corporation, Medford, Oregon.		
HERO ID:	6558530		
Conditions of Use:	Adhesives and sealant chemicals in: Plastic and resin manufacturing; Wood product manufacturing; All other basic organic chemical manufacturing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 1512946 Table: 1 of 1

Study Citation:	Mui, K.W., Wong, L.T., Hui, P.S. (2008). Policy Influence of Formaldehyde Exposure Risk in Air-conditioned Office Environment. Indoor and Built Environment 17(5):449-454.			
HERO ID:	1512946			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Area sampling data:	66 (ug/m^3) ranged from 22 to 273 ug /m^3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.	
	Metric 3: Applicability	High	Data are for building/construction material not covered elsewhere, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2008)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5947081 Table: 1 of 1

Study Citation:	Mäkelä, E. A., Vainiotalo, S., Peltonen, K. (2003). The permeability of surgical gloves to seven chemicals commonly used in hospitals. Annals of Occupational Hygiene 47(4):313-323.				
HERO ID:	5947081				
Conditions of Use:	Laboratory Chemical				
EXTRACTION					
Parameter	Data				
Dermal exposure data:	nan				
Personal protective equipment:	Gloves. Clear evidence of formaldehyde (37%) permeation was detected through single layered natural rubber gloves, where the ASTM breakthrough times were 17–67 min, but the permeation rates were not high enough for breakthrough to have occurred according to the EN standard.				
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.	
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.	
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report provides discussion of the variability (different gloves) and also addresses uncertainty in results (mentions even small changes in test conditions can cause major differences).	
Overall Quality Determination			High		

Formaldehyde

Occupational Exposure

HERO ID: 57058 Table: 1 of 1

Study Citation:	Nazaroff, W. W., Weschler, C. J. (2004). Cleaning products and air fresheners: exposure to primary and secondary air pollutants. Atmospheric Environment 38(18):2841-2865.			
HERO ID:	57058			
Conditions of Use:	Use of Cleaning and Furniture Care Products			
EXTRACTION				
Parameter	Data			
Number of workers:	3 million janitors and cleaners			
Comments:	This is an interesting article that considers the secondary formation of formaldehyde from chemicals from cleaning products and other indoor air contaminants such as OH and O3. But there are few specifics about formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (janitors and cleaners) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	2001 - 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Department of labor
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NFDA, (2020). Comments of the National Funeral Directors Association (NFDA) requesting that EPA remove funeral service, including embalming and mortuary science, as a condition of use from EPA’s proposed scope for its formaldehyde risk assessment (submitted by Lesley Witter).			
HERO ID:	10370214			
Conditions of Use:	Commercial Use - Embalming			
EXTRACTION				
Parameter	Data			
Worker activity description:	Formaldehyde-based products are the leading products used for embalming in the United States as there is no substitute for the dual preservative and antimicrobial properties that these products possess. (page 1 of 4)			
Exposure route:	inhalation and dermal exposure (page 3 of 4)			
Exposure duration:	A typical embalming lasts from 45 to 90 minutes with an average time of one hour. (page 3 of 4)			
Exposure frequency:	Funeral directors do not embalm daily and with the increase in the cremation rate, funeral directors may conduct embalmings only several times a week. (page 3 of 4)			
Engineering control:	room ventilation (page 3 of 4 and throughout. Only vaguely discussed, refers to OSHA guidelines as the controls and PPE they implement)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	From the National Funeral Directors Association, they do not site sources, but it can be assumed they are knowledgably about their practices
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	From USA
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	2020
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		Medium		

Study Citation:	NIOSH (2001). Controlling formaldehyde exposures during embalming. Applied Occupational and Environmental Hygiene 16(4):438-438.			
HERO ID:	1986847			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Engineering control:	The LEV system consists of a pair of six-foot long slot hoods placed on each side of the embalming table. These slot hoods capture formaldehyde by means of an exhaust fan, which is placed outside the embalming room. The exhaust fan maintains an optimum air flow of 700 cubic feet per minute. For a slot width of one inch, the slot velocity is 720 feet per minute. Embalming equipment manufacturers and distributors can provide LEV systems for existing tables, or a sheet metal contractor can custom build the LEV system (see Figure 1). General room (dilution) ventilation is another way to exhaust formaldehyde from the embalming room. Depending on how well the air in a room is mixed, 4 to 13 times more exhaust air is needed to achieve the same control as from the LEV system. Make-up air costs for heating or cooling are considerably less for the LEV system than for dilution ventilation. Therefore, NIOSH recommends that the primary control be the LEV system.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2001)	
	Metric 5: Sample Size	N/A	Not applicable - no sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - no sample data.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1975). Working with formaldehyde.			
HERO ID:	1316750			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Personal protective equipment:	recommend using goggles, gloves and protective clothing.For emergencies full-face respirators or canister type gas masks are recommended.			
Engineering control:	adequate ventilation			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	US Public Health Service/NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	does not focus on any specific COU
	Metric 4:	Temporal Representativeness	Low	1975 more than 20 years old
	Metric 5:	Sample Size	N/A	information provides is qualitative rather than quantitative
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Basis of the information provided is the US Public Health Service/CDC/ NIOSHA
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	information provides is qualitative rather than quantitative
Overall Quality Determination		High		

Study Citation:	NIOSH, (2007). NIOSH pocket guide to chemical hazards.			
HERO ID:	192177			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Exposure route:	Toxicologically important entry routs (i.e., not potential routes associated with an exposure scenario):inhalation, skin and/or eye contact.			
Physical form:	Nearly colorless gas with a pungent, suffocating odor. [Note: Often used in an aqueous solution] This is not the physical form in the case of a specific occupational exposure scenario of the risk evaluation.			
Personal protective equipment:	NIOSH recommends two types of respirators if the exposure concentration equals or exceeds the NIOSH REL and the APF of each of these types is 10,000. These two types are any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode and Any supplied-air respirator that has a full-facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode. A respirator is also recommended for escape (Pg. 178/454)Pg. 357 contains OSHA's respiratory protection standard pertaining to formaldehyde. This standard consist of specified respirators that must be used if exposure concentration exceeds certain limits. Three different limits are specified. Additionally, respirators are specified in the case of firefighting and escape.			
Comments:	Formaldehyde was found under other chemicals in 'incompatibilities and reactivities': bis-chloromethyl ether [CAS No. 542-88-1], chloromethyl methyl ether [CAS No. 107-30-2], rosin flux pyrolysis product [pg. 305]			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report is developed from frequently used sources (NIOSH) and is generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is more than 10 years old but not more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A- no sampling data extracted.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Formaldehyde

Occupational Exposure

HERO ID: 192177 Table: 2 of 2

Study Citation:	NIOSH, (2007). NIOSH pocket guide to chemical hazards.		
HERO ID:	192177		
Conditions of Use:	Firefighting		
EXTRACTION			
Parameter	Data		
Personal protective equipment:	Self-contained breathing apparatus with positive-pressure in full facepiece. (Under Appendix E-OSHA Respirator Requirements for Selected Chemicals)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report is developed from frequently used sources (NIOSH) and is generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Medium	Report is for firefighting, which is not a COU but may be an occupational scenario considered.
	Metric 4: Temporal Representativeness	Medium	Published in 2007, more than 10 years old but generally no more than 20 years old.
	Metric 5: Sample Size	N/A	N/A- no sampling related data extracted.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium	

Study Citation:	NIOSH, (1976). Criteria for a recommended standard: Occupational exposure to formaldehyde.		
HERO ID:	192344		
Conditions of Use:	Manufacture		
EXTRACTION			
Parameter	Data		
Exposure route:	inhalation and ingestion		
Physical form:	vapor and liquid		
Exposure duration:	up to 10 hours per day		
Exposure frequency:	40 hours per week		
Number of workers:	8,000 directly involved in production of formaldehyde monomer		
Personal protective equipment:	Protective Clothing(1) Employees shall wear gloves made of rubber or of other impervious material when working with formaldehyde and when contact with the hands is likely.(2) Employees shall wear protective sleeves, aprons, jackets, trousers, and caps as needed to protect them from skin contact with formaldehyde. Protective garments shall be made of a material impervious to formaldehyde. In emergencies or other circumstances involving exposure to formaldehyde at high concentrations of vapor, mists, or dusts in the air, full body protection shall be worn. Emergency garments shall be of an impervious material, and shall fit snugly about the wrists, neck, waist, and ankles.(3) Employees handling drums, cans, or other containers of formaldehyde shall wear leather or rubber safety shoes. Rubbers may be worn over leather safety shoes as protection from splashes or spills of formaldehyde.(4) Protective garments shall be cleaned inside and out and well ventilated after each use~ and particularly after contamination has occurred.(b) Eye and Face Protection(1) Cup-type or rubber-framed chemical safety goggles shall be worn by employees when there is any possibility of eye or facial contact with formaldehyde solutions. Goggles also protect eyes from contact with gas. In cases of excessive vapor concentrations, a full face mask respiratory protective device shall be required; this device may be substituted for cup-type or rubber-framed chemical safety goggles.(2) Full-length, plastic face shields shall be required in addition to safety goggles for face protection when the work process involves risks of exposure to splashes of formaldehyde. Chemical safety goggles are required in addition to the face shield when there is danger of formaldehyde entering underneath or around the sides of the shield.(3) The safety goggles, full-face masks, and shields shall be thoroughly decontaminated after each use.(4) Eye-protective measures and equipment shall conform with the provisions under 29 CFR 1910.133.(c) Respiratory ProtectionRespirators may be used for nonroutine operations, evacuation, or emergencies which may involve occasional brief exposures to formaldehyde at concentrations in excess of 1.2 mg/cum. Such exposures may occur during the period necessary to install or test required engineering controls, or to take protective actions.Appropriate respirators may only be used pursuant to the following requirements:(1) For the purpose of determining the type of respirator to be used, the employer shall measure the airborne formaldehyde concentration in the workplace initially, and thereafter whenever process, operations, worksite, climate, control, or other changes may occur which are likely to increase the airborne concentration of formaldehyde. This requirement does not apply when only positive pressure supplied-air respirators are used.(2) The respirator and cartridge or canister used shall be of the appropriate class, as determined on the basis of the airborne concentration of formaldehyde. The employer shall ensure that no employee is exposed to formaldehyde in excess of 1.2 mg/cu m for any 30-minute period because of improper respirator selection, fit, use, or maintenance.(3) A respiratory protective program meeting the requirements of 29 CFR 1910.134 shall be established and enforced by the employer.(4) The employer shall provide respirators and shall ensure that the employee uses the respirator properly.(5) Respiratory protective devices shall be approved under provisions of 30 CFR 11(6) Respirators specified for use at greater airborne concentrations of formaldehyde may be used in lesser airborne concentrations of formaldehyde.(7) Use of chemical cartridges and canisters more than once for a period greater than that indicated in Table I-1 shall be prohibited.(8) The employer shall ensure that respirators are adequately cleaned, maintained, and stored when not in use, and that employees are instructed on the use of respirators assigned to them and on how to test for leakage. Note table I-1 provides even more details about approved respirators.		
Engineering control:	Engineering controls shall be used to maintain the concentration of airborne formaldehyde at or below the ceiling concentration of 1.2 mg/m3.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH Study
Domain 2: Representativeness			
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 192344 Table: 1 of 1

...continued from previous page

Study Citation:		NIOSH, (1976). Criteria for a recommended standard: Occupational exposure to formaldehyde.			
HERO ID:		192344			
Conditions of Use:		Manufacture			
Domain		Metric	EVALUATION		Comments
	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	High	The data are for an occupational scenario (formaldehyde monomer manufacture) within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	1976- more than 20 years old	
	Metric 5:	Sample Size	N/A	Qualitative information provided	
Domain 3: Accessibility/ Clarity					
	Metric 6:	Metadata Completeness	High	NIOSH study with complete references	
Domain 4: Variability and Uncertainty					
	Metric 7:	Metadata Completeness	N/A	Qualitative information provided	
Overall Quality Determination			High		

Study Citation:	NIOSH, (1981). Current intelligence bulletin 34: Formaldehyde: evidence of carcinogenicity.			
HERO ID:	63806			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Number of workers:	”During a 1972-74 survey,... 1.6 million workers were exposed to formaldehyde in more than 60 industrial categories. Of these workers, about 57,000 were exposed to formaldehyde 4 hours or more per day”. 457,200 workers were involved in: chemicals and allied products, printing and publishing, paper and allied products, machinery (except electrical), retail general merchandise, automotive dealers, and service stations, eating and drinking places (i.e., busboys, cooks, dishwashers, etc.) and personal services (such as funeral services and crematories, photographic studios and dry cleaning plants).			
Personal protective equipment:	respirators, gloves, goggles			
Engineering control:	Product substitution; contaminant controls(enclosure of the operation or use of local exhaust ventilation); employee isolation			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The report was compiled by NIOSH, a frequently used source, and generally accepted by the scientific community.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	High	The report is for an occupational scenarios within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	1981 which is older than 20 years	
	Metric 5: Sample Size	N/A	Only quantitative data extracted are approximate number of workers from survey.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Report clearly documents its sources, methods, and results.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1988). Occupational safety and health guideline for formaldehyde potential human carcinogen.			
HERO ID:	8408529			
Conditions of Use:	Incorporation into an artilce textiles, apparel and Leather manufacture			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation and dermal			
Physical form:	vapor and liquid			
Personal protective equipment:	Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions. Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with formaldehyde.Respiratory ProtectionIt must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators are used to control exposure: when engineering and work practices controls are not technically feasible when engineering controls are in the process of being installed or during emergencies and certain maintenance operations, including those requiring confined-space entry.In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards, 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker’s ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, period environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including the selection of the correct respirators, requires that a knowledgeable person is in charge of the program and that the program be evaluated regularly. Only respirators that have been approved by the mine Safety and Health Administration and by NIOSH should be used.			
Engineering control:	During use in textile manufacturing or handling and tanning operations - process enclosure and local exhaust ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH release
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario that is similar to an occupational scenario (textile and leather manufacture)within the scope of the risk evaluation, in terms of the type of industry, operations, and workactivities.
	Metric 4:	Temporal Representativeness	Low	1988 - more than 20 years old
	Metric 5:	Sample Size	Low	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	NIOSH information release
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Qualitative information provided
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1988). Occupational safety and health guideline for formaldehyde potential human carcinogen.			
HERO ID:	8408529			
Conditions of Use:	Domestic manufacture of formaldehyde			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation and dermal			
Physical form:	vapor and liquid			
Personal protective equipment:	Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions. Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with formaldehyde.Respiratory ProtectionIt must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators are used to control exposure: when engineering and work practices controls are not technically feasible when engineering controls are in the process of being installed or during emergencies and certain maintenance operations, including those requiring confined-space entry.In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards, 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker’s ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, period environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including the selection of the correct respirators, requires that a knowledgeable person is in charge of the program and that the program be evaluated regularly. Only respirators that have been approved by the mine Safety and Health Administration and by NIOSH should be used.			
Engineering control:	During synthesis and handling of formaldehyde, chelating agents or dyes - process enclosure and local exhaust ventilation			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH release
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The report is for an occupational scenario that is similar to an occupational scenario (manufacture of formaldehde) within the scope of the risk evaluation, in terms of the type of industry, operations, and workactivities.
	Metric 4:	Temporal Representativeness	Low	1988 - more than 20 years old
	Metric 5:	Sample Size	Low	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	NIOSH, (1988). Occupational safety and health guideline for formaldehyde potential human carcinogen.			
HERO ID:	8408529			
Conditions of Use:	Chemical substances in building and construction materials			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation and dermal			
Physical form:	vapor and liquid			
Personal protective equipment:	Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions. Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with formaldehyde.Respiratory ProtectionIt must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators are used to control exposure: when engineering and work practices controls are not technically feasible when engineering controls are in the process of being installed or during emergencies and certain maintenance operations, including those requiring confined-space entry.In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards, 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, period environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including the selection of the correct respirators, requires that a knowledgeable person is in charge of the program and that the program be evaluated regularly. Only respirators that have been approved by the mine Safety and Health Administration and by NIOSH should be used.			
Engineering control:	During the manufacture of particleboard, plywood, sandpaper, and grinding wheels- process enclosure and local exhaust ventilation.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH release
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario that is similar to an occupational scenario (manufacture of building materials) within the scope of the risk evaluation, in terms of the type of industry, operations, and workactivities.
	Metric 4:	Temporal Representativeness	Low	1988 - more than 20 years old
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	NIOSH information release. Assessment or report clearly documents results, methods, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Qualitative information provided
Overall Quality Determination			Medium	

Study Citation:	NIOSH, (1988). Occupational safety and health guideline for formaldehyde potential human carcinogen.			
HERO ID:	8408529			
Conditions of Use:	Chemical substances in products not described by other codes: Laboratory Chemicals (mortuary science)			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation and dermal			
Physical form:	vapor and liquid			
Personal protective equipment:	Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions. Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with formaldehyde.Respiratory ProtectionIt must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators are used to control exposure: when engineering and work practices controls are not technically feasible when engineering controls are in the process of being installed or during emergencies and certain maintenance operations, including those requiring confined-space entry.In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards, 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, period environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including the selection of the correct respirators, requires that a knowledgeable person is in charge of the program and that the program be evaluated regularly. Only respirators that have been approved by the mine Safety and Health Administration and by NIOSH should be used.			
Engineering control:	During the use as an embalming fluid-process enclosure and local exhaust ventilation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH release
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The report is for an occupational scenario that is similar to an occupational scenario (embalming) within the scope of the risk evaluation, in terms of the type of industry, operations, and workactivities.
	Metric 4:	Temporal Representativeness	Low	1988 - more than 20 years old
	Metric 5:	Sample Size	Low	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	NIOSH information release. Assessment or report clearly documents results, methods, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Qualitative information provided
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 79-157-1212. Crane Company, Rogers, AR.			
HERO ID:	8632187			
Conditions of Use:	Medical products not covered elsewhere			
EXTRACTION				
Parameter	Data			
Worker activity description:	Metal pouring.			
Exposure route:	Dermal and inhalation.			
Number of workers:	100			
Personal protective equipment:	Use of gloves should be considered.			
Engineering control:	Pouring of of metal should be ventilated at both the furnaces and molds.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for metal products not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 82-239-1355. Allen Bradley Company, Milwaukee, WI.			
HERO ID:	8637925			
Conditions of Use:	Chemical substances in furnishing, treatment/care products-Cleaning and furniture care products			
EXTRACTION				
Parameter	Data			
Worker activity description:	Of the workers in Department 205 at the time of the survey, 13 were Machine Operators and 2 Machine Set Up, 14 Coil Molders and 2 Coil Molder Set up, 28 Assemblers, 1 coil impregnator (varnish), and 1 machine repair worker. There were four major subdivisions of Department 205; 9 employees working in the winding area, 17 in the molding area, 12 in the assembly area, and 23 in the finishing and testing area. (pdf pg 4)The nylon core coils are also wound in the winding area and soldered in the assembly area. These coils are then transported to the molding area. The 4 inch wide wire wrapped coils are placed in a press along with preheated epoxy powder in pill form. These epoxy pills are produced in the molding area by compression of powder. Under heat and pressure the epoxy pill is molded around the coil, with local ventilation in place. These presses are regularly cleaned with a formaldehyde based cleaner. (pdf pg 6)			
Exposure route:	inhalation, dermal			
Exposure duration:	These employees worked an 8 hour day, 5 day week. For the past two years, two (previously three) shifts have been operating in the molding area. There were 51 production employees on the 7-3:30 shift and 9 employees working 3:30 to 11:00. (pdf pg 4)			
Number of workers:	13 were Machine Operators and 2 Machine Set Up, 14 Coil Molders and 2 Coil Molder Set up, 28 Assemblers, 1 coil impregnator (varnish), and 1 machine repair worker. There were four major subdivisions of Department 205; 9 employees working in the winding area, 17 in the molding area, 12 in the assembly area, and 23 in the finishing and testing area. (pdf pg 4)			
Engineering control:	a combination of window, local exhaust and general exhaust ventilation. (pdf pg 4)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment uses NIOSH resources and methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Study was conducted in 1982 and is unlikely to capture current operations, equipment or activities.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources (NIOSH IH site visit)
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 8673771 Table: 1 of 1

Study Citation:	NIOSH, (1994). Table of Immediately Dangerous to Life or Health Concentrations (IDLH): Formaldehyde.			
HERO ID:	8673771			
Conditions of Use:	All conditions of use			
EXTRACTION				
Parameter	Data			
Exposure route:	Inhalation.			
Physical form:	Nearly colorless gas.			
Comments:	Immediately Dangerous to Life or Health Concentration (IDLH): 20 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for all conditions of use.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - physical form and exposure route.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - physical form and exposure route.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1993). HETA-1993-0282-2303: Manatee Memorial Hospital, Bradenton, Florida.			
HERO ID:	8724601			
Conditions of Use:	Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Worker activity description:	"The laboratory cultures most types of general bacterial, mycobacterial, and fungal microorganisms typically seen in community hospitals. A formaldehyde-containing product and ethyl acetate are used to prepare fecal ova parasitesamples. (3/15)"			
Exposure route:	inhalation (10/15)			
Physical form:	vapor (10/15)			
Exposure duration:	The sample preparation procedure takes less than five minutes for a single sample. (3/15)			
Number of workers:	5 employees work in the microbiology laboratory during the first shift, and one works part-time on second and third shifts. (3/15)			
Personal protective equipment:	Lab coats and gloves are required in the "non-clean" area of the lab. Faceshields are used when streaking culture plates. (3/15)			
Engineering control:	Preparation is conducted in a laboratory hood. (3/15)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	N/A	No sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	No scope to address variability and uncertainty.	
Overall Quality Determination		High		

Study Citation:	OECD, (2015). Emission scenario document on use of adhesives.		
HERO ID:	3833136		
Conditions of Use:	Use of Adhesives		
EXTRACTION			
Parameter	Data		
Worker activity description:	Equipment loading/container unloadingEquipment cleaningApplicationDrying/curing		
Exposure route:	inhalation or dermal		
Physical form:	vapor or liquid		
Area sampling data:	Equations are provided but the supporting values for Phenol-Formaldehyde resins are not included.		
Number of workers:	If we assume that phenol-formaldehyde adhesives are primary related to Automotive and Aerospace applications; the report suggests a potential exposure number for motor vehicle workers to be 90 per facility, but this may include exposure to other adhesives.		
Personal protective equipment:	EPA did not assess the effectiveness of personal protective equipment (PPE) in mitigating occupational exposures in this ESD. The exposure mitigation by PPE is affected by many factors including availability, cost, worker compliance, impact on job performance, chemical and physical properties of the substance and protective clothing, and the use, decontamination, maintenance, storage, and disposal practices applicable to the industrial operation (CEB, 1997b). Therefore, the conservative, screening-level occupational exposure estimates presented in this ESD do not account for PPE. Actual occupational exposure may be significantly less than the estimates presented in this ESD.Chemical PMN submissions recently submitted to EPA by adhesive chemical manufacturers show that, at a minimum, all manufacturers recommended the use of gloves and safety glasses with side shields or goggles. Approximately half of the submissions also recommended the use of some kind of ventilation and respirators if necessary.		
Engineering control:	ventilation		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	OECD report authored by EPA, this report is generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Medium	The report is for an occupational scenario (use of adhesives) within the scope of the risk evaluation, but information is general for the use scenario and not necessarily specific to formaldehyde.
	Metric 4: Temporal Representativeness	High	The report is generally no more than 10 years old (2015).
	Metric 5: Sample Size	N/A	No sample data were extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	The report aggregates all of the information such that it is not possible to differentiate what processes and application techniques apply to Formaldehyde.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results
Continued on next page ...			

Formaldehyde

Occupational Exposure

HERO ID: 3833136 Table: 1 of 1

...continued from previous page

Study Citation:	OECD, (2015). Emission scenario document on use of adhesives.		
HERO ID:	3833136		
Conditions of Use:	Use of Adhesives		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	OECD, (2018). Economic valuation in formaldehyde regulation.			
HERO ID:	7681892			
Conditions of Use:	All conditions of use			
EXTRACTION				
Parameter	Data			
Worker activity description:	While indoor sources include combustion processes, such as smoking, heating and cooking, the main non-combustion sources are building materials and consumer products, such as wooden products containing formaldehyde-based resins, textiles, paints, cleaning products, electronic equipment and insecticides (WHO, 2010[2]).			
Physical form:	Liquid			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for all conditions of use.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		High		

Study Citation:	Ogunnowo, B. E., Anunobi, C. C., Onajole, A. T., Odeyemi, K. A. (2010). Awareness of occupational health hazards and the practice of universal safety precautions among mortuary workers in South West Nigeria. Nigerian Quarterly Journal of Hospital Medicine 20(4):192-196.			
HERO ID:	5946180			
Conditions of Use:	Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Worker activity description:	Mortuary workers during embalming (1/5)			
Number of workers:	76 workers in the sampled teaching hospitals (1/5)			
Personal protective equipment:	Workers wear gloves, aprons, face masks, goggles, boots, and hand washing. (1/5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Nigeria, a non-OECD country,
	Metric 3:	Applicability	Medium	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5954043 Table: 1 of 1

Study Citation:	Pirila, V., Kilpio, O. (1949). On dermatitis caused by formaldehyde and its compounds. Annales medicinae internae Fenniae 38(1):38-51.			
HERO ID:	5954043			
Conditions of Use:	Processing/Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Worker categories include users of formalin (gluers of labels, cardboard boxes etc., bookbinders, lithographers, glue barrel washers, laboratory charwomen, pathologists, hairdressers) and users of formaldehyde resins (painters, plywood workers, bakelite workers), workers using formalin as insecticides, medicine.			
Exposure route:				
Physical form:				
Dermal exposure data:				
nan				
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 8252455 Table: 1 of 1

Study Citation:	Pryor, P. (1986). Health Hazard Evaluation Report HETA-1984-0535-1690 National Jewish Hospital, Denver, Colorado.		
HERO ID:	8252455		
Conditions of Use:	Laboratory chemical		
EXTRACTION			
Parameter	Data		
Worker activity description:	Technicians performing tissue fixing operations in small animal and electron microscopy laboratories.		
Exposure route:	Inhalation		
Physical form:	Liquid		
Personal protective equipment:	An organic vapor/formaldehyde cartridge respirator i s recommended for protection against glutaraldehyde. This type of respirator is specifically designed for organic vapors and formaldehyde, however, they are also suitable for other aldehydes, such as , glutaraldehyde.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for use as a laboratory chemical, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium	

Study Citation:	Pryor, P., Thoburn, T. W., Koons, R. K. (1985). Health hazard evaluation report: HETA-83-313-1534 - Municipal court section, City Of Englewood, Englewood, Colorado.				
HERO ID:	1316838				
Conditions of Use:	Use of photographic supplies				
EXTRACTION					
Parameter	Data				
Worker activity description:	In addition to the judge, this section consists of seven (7) employees whose job functions include: typing, answering phones, handling ticket payments and warrants, using a photocopier, and filing.				
Exposure route:	inhalation				
Physical form:	vapor				
Area sampling data:	Top shelf left side 0.04 mg/M3 (12/16/83) 0.042 mg/m3 (3/15/84) 0.046 (3/17/84)Third shelf left side 0.029 mg/M3 (12/16/83) 0.033 mg/m3 (3/15/84) 0.041 (3/17/84)Top shelf Rich side 0.029 mg/M3 (12/16/83) 0.036 mg/m3 (3/15/84) 0.046 (3/17/84)Third shelf left side 0.018 mg/M3 (12/16/83) 0.024 mg/m3 (3/15/84) Desk by shelves 0.0296mg/M3 (12/16/83) 0.0246 mg/m3 (3/15/84) 0.031 (3/17/84)Desk by computers 0.024 mg/m3 (3/15/84) Desk by window 0.031 (3/17/84)Jury room 0.020 mg/m3 (3/15/84)				
Dermal exposure data:	nan				
Number of workers:	8				
Personal protective equipment:	cotton gloves				
Engineering control:	Enhance HVAC ventilation and increase air flow in office				
Comments:	Results indicate some dependence on the formaldehyde exposure to the carbonless paper but it also was noted that there was plywood shelves and plastic laminated counter tops. The report also indicates sources could also be from cigarette smoke, glues in carpeting and fabricated materials.				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	High	The report is for an occupational scenario (public building - court house) within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	implemented in 1983 prior to the PEL (1992)	
	Metric 5:	Sample Size	N/A	Qualitative information	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	information obtained from NIOSH site visit	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information	
Overall Quality Determination			High		

Study Citation:	Radian Corp, (1991). General electric engine maintenance center AB 2588 air toxics ”hot spots” health risk assessment (final report) with attachments and cover letter dated 123191.			
HERO ID:	1481770			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Worker activity description:	Aircraft engine testing and maintenance			
Exposure route:	Inhalation			
Number of workers:	11,806 (page 45/470)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for paint and coating additives in transportation manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1992)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			Medium	

Study Citation:	Robinson, C. F., Fowler, D., Brown, D. P., Lemen, R. A. (1987). Plywood mill workers’ mortality patterns 1945 1977 (revised March 1987).			
HERO ID:	2453808			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	raw wood preparationVeneer cuttingpressing/drying of veneerGlue mixingveneer and panel gluingpanel patching of flaws, knotholes etc.Panel finishing, trimming and sandingutility, and maintenance			
Exposure route:	Inhalation: Plywood workers were potentially exposed to formaldehyde around the gluing operations in the mill.			
Physical form:	vapor			
Exposure duration:	provided in terms of person years of exposure (57,588 person years).			
Number of workers:	35,300 production workers employed in the US softwood veneer and plywood industry and 19,600 production workers employed in the hardwood veneer and plywood industry. For this study 2,283 employed for at least 1 year between 1945 and 1955.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario(plywood manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1987 - more than 20 years old
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination		High		

Study Citation:	Sancini, A., Rosati, M.V., Sio, S.D., Casale, T., Caciari, T., Samperi, I., Sacco, C., Fortunato, B.R., Pimpinella, B., Andreozzi, G., Tomei, G., Tomei, F. (2014). Exposure to formaldehyde in health care: an evaluation of the white blood count differential. Giornale Italiano di Medicina del Lavoro ed Ergonomia 36(3):153-159.			
HERO ID:	2820911			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Health workers in laboratories of Pathological Anatomy, Molecular Biology, Molecular Neurobiology, Parasitology and Experimental Oncology.			
Number of workers:	86			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Italy, an OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2014)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			High	

Study Citation:	Sandvik, A., Klingen, T.A., Langård, S. (2014). Sinonasal adenoid cystic carcinoma following formaldehyde exposure in the operating theatre. Journal of Occupational Medicine and Toxicology 9(1):43.			
HERO ID:	2993591			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Nurse exposed to formaldehyde during her work in the operating theatre. Her work tasks during this period had involved the handling of biopsies and she put the tissue samples in containers filled with formaldehyde. Her work tasks also included preparing the surgical patients by cleaning the skin with a solution of iodine in ethanol and assisting as a non-sterile-assistant at various surgeries. In addition, her work involved daily disinfection of the operating theatre after use using disinfectants which may contain formaldehyde .			
Exposure duration:	Several times per day			
Comments:	States that they do not have access to measurements of the levels of formaldehyde to the nurse. Article is a case report of a nurse developing cancer.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The report is from Norway - OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5:	Sample Size	N/A	Mainly worker activity information.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Mainly worker activity information.
Overall Quality Determination			High	

Study Citation:	Savitz, D. A., John, E. M. (1991). Adverse Pregnancy Outcomes among Cosmetologists. Final Report. School of Public Health(R03-OH-02548):169.			
HERO ID:	1976959			
Conditions of Use:	Use of personal care products			
EXTRACTION				
Parameter	Data			
Worker activity description:	haircutsBleachingDyesPermanentsChemical servicesManicureNail sculpting			
Exposure route:	inhalation and dermal			
Physical form:	vapors and as a component of cosmetology chemicals			
Exposure duration:	35 or more hours per week.			
Number of workers:	over half a million			
Personal protective equipment:	Nearly two thirds of the respondents always wore gloves during hair dyeing (64%) or bleaching (61%). For permanents, only16% of the respondents reported that they always wore gloves.Barbicide (91%) was most commonly used to sanitize implements and equipment, followed by formaldehyde (60%), and soap and hot water (59%).			
Engineering control:	ventilation			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Low	Salons may be covered by FDA regulations
	Metric 4:	Temporal Representativeness	Low	1991- more than 20 years old
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	data obtained from survey
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination		Medium		

Study Citation:	Schwensen, J. F., Friis, U. F., Menné, T., Flyvholm, M. A., Johansen, J. D. (2017). Contact allergy to preservatives in patients with occupational contact dermatitis and exposure analysis of preservatives in registered chemical products for occupational use. International Archives of Occupational and Environmental Health 90(4):319-333.		
HERO ID:	4454637		
Conditions of Use:	various		
EXTRACTION			
Parameter	Data		
Dermal exposure data:	nan		
Comments:	Table 4 (pg 11) has results of patch testing: 44/995 patch tested workers were positive for formaldehyde contact dermatitis, 22/994 positive for formaldehyde releaser chemicals. Formaldehyde contact allergy ~2% prevalence in Europe, secondary study referenced states 5% of cohort of 219 Danish painters with contact dermatitis had positive patch test reaction to formaldehyde (pg 13)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Denmark, an OECD country.
	Metric 3: Applicability	Low	Data are for a study population composed of contact dermatitis patients (including occupational), but exact occupations not specified.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	n/a - no quantified exposure data, just frequency of occurrence of contact dermatitis
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty addressed by comparing patch testing results to frequency of chemical occurrence in PROBAS database. Variability is not addressed
Overall Quality Determination		Medium	

Study Citation:	SIA, (2020). SIA comments on the draft scope of the risk evaluation for formaldehyde.			
HERO ID:	10384684			
Conditions of Use:	electroless copper plating			
EXTRACTION				
Parameter	Data			
Worker activity description:	Pg. 9 provides data on tasks where exposures could occur			
Exposure route:	dermal, inhalation			
Physical form:	part of liquid formulation(s) and vapor			
Engineering control:	”Use of Formaldehyde containing formulations in the semiconductor industry are subject to significant levels of control. Manufacturing tools are equipped with exhaust, interlocks to prevent an exposure during processing, a once-through closed path system, and pre-open cleaning procedures. Industrial Hygiene monitoring has been conducted showing exposures below the ACGIH threshold limit values (TLV) and OSHA permissible exposure limit (PEL).” pg. 8/20			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	Solomons, K., Cochrane, C., J.W. (1984). Formaldehyde toxicity. Part I. Occupational exposure and a report of 5 cases. South African Medical Journal 66(3):101-102.			
HERO ID:	1978905			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Worker activity description:	During 1979 between 1.4 and 1.7 million people in the USA wereexposed to formaldehyde in the workplace.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	The report is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984).
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	Springborn Laboratories, (1981). The formaldehyde industry and industries using formaldehyde (EPA contract #68-01-6075).			
HERO ID:	5901013			
Conditions of Use:	Multiple COUs - Adhesives, particleboard, plywood, textiles, embalming, mobile homes.			
EXTRACTION				
Parameter	Data			
Number of workers:	Typical FA plant employs 2 to 3 persons per shift to operate the system. Figuring 3 persons conservatively, approximately 504 men are employed on a 3 shift bases that are directly involved in producing FA. This is based on the 56 plant sites. FA bond resin industry has 3000-3500 employees with 2200-2500 production workers.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Data is high quality data as a TSCA submission to the EPA.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data is for US.	
	Metric 3: Applicability	High	Data is applicable to multiple COUs. Recommend making multiple sets of data review for each COU as it goes in depth for each one on process description, PVs, number of sites, number of workers, etc.	
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old.	
	Metric 5: Sample Size	Medium	Characterized by a large range of data over multiple years.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Provides production volume, process descriptions, number of workers, number of sites, life cycle description etc.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Addresses variability by looking at multiple COUs and data spanning multiple years.	
Overall Quality Determination		High		

Study Citation:	Srivastava, A.K., Gupta, B.N., Gaur, J.S., Bihari, V. (1992). Clinical evaluation of workers handling melamine formaldehyde resin. Journal of Toxicology. Clinical Toxicology 30(4):677-681.			
HERO ID:	1787036			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Worker activity description:	The work site was a room of 5 x 4.5 x 4.5 m. There was only one door and an exhaust fan for ventilation. Protective devices were provided but the workers did not use them, preferring to cover their faces with a piece of dry cotton cloth. The workers dissolved melamine formaldehyde powder in an open container of water and hydrochloric acid three times per shift with constant stirring for one to one and a half hour. In a single shift 150 kg of melamine formaldehyde powder is dissolved in water using 75 kg of hydrochloric acid. Formaldehyde is released during mixing and ageing. The workers are exposed to high concentrations of formaldehyde for about 30 min three times a day and to a relatively lower concentration for the rest of the time. They are also exposed to melamine resin through skin contact.			
Exposure route:	Inhalation, dermal			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from India, a non-OECD country.	
	Metric 3: Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1992)	
	Metric 5: Sample Size	N/A	Not applicable - no sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - no sample data.	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 1231209 Table: 1 of 1

Study Citation:	Sullivan, P. A., Bang, K. M., Hearl, F. J., Wagner, G. R. (1995). Respiratory disease risks in the construction industry. Occupational Medicine 10(2):313-334.				
HERO ID:	1231209				
Conditions of Use:	Installation/Demolition of Building Materials				
EXTRACTION					
Parameter	Data				
Worker activity description:	carpenters, cabinet makers				
Exposure route:	Inhalation				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	journal article	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.	
	Metric 3:	Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.	
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1995)	
	Metric 5:	Sample Size	N/A	Not applicable - no sample data	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.	
Overall Quality Determination			High		

Study Citation:	T-M, N.K. (1999). Occupational exposure to genotoxic agents. Mutation Research 437(2):175-194.			
HERO ID:	1267396			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Number of workers:	1.5 million (Table 2, combined total for multiple COU's)			
Comments:	There was no breakdown per industry, just a total number of workers across multiple industries.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of several industries being evaluated.	
	Metric 3: Applicability	High	The data are for multiple occupational scenarios within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old (Study was published in 1999)	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty	
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 5905893 Table: 1 of 1

Study Citation:	TOMA, (1988). Historical prospective mortality study of past and present employees of Celanese Chemical Plant located in Bishop, Texas with cover letter dated 05/02/88.			
HERO ID:	5905893			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Number of workers:	2084			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1982)
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	U.S. BLS, (2023). U.S. Census Bureau of Labor Statistics Data from 2021.			
HERO ID:	11138808			
Conditions of Use:	All sectors - Census employment values			
EXTRACTION				
Parameter	Data			
Number of workers:	9356 individual OCC codes by NAICS groupings are included in the spreadsheet for annual and hourly by percentile			
Comments:	These data are of limited value on their own but could be combined with exposure data provided by NAICS code to estimate exposed population			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Source is census data which is generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	USA	
	Metric 3: Applicability	High	Report covers all employment sectors, such that is applicable across the in-scope COUs.	
	Metric 4: Temporal Representativeness	High	The report is generally no more than 10 years old.	
	Metric 5: Sample Size	High	Hourly and annual data are provided by mean, median, and percentiles.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Hourly and annual data are provided by percentiles which could be used to estimate variance and uncertainty.	
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2020). 2020 CDR: Commercial and consumer use.		
HERO ID:	10366189		
Conditions of Use:	Manufacture and Import		
EXTRACTION			
Parameter	Data		
Number of workers:	Range of workers is provided for each recordConstruction and building materials covering large surface areas, including wood articles 100-499Solvent-based paint 50-99Textile finishing and impregnating/surface treatment products 50-99		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	EPA 2020 CDR requires manufacturers and importers to submit information to the best of their knowledge, and is generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	High	The data is directly applicable across COUs within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Submission in2020, data represents 2019.
	Metric 5: Sample Size	Medium	Individual records are provided to allow for the development of appropriate statistics but value provided in ranges.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Report clearly documents results, and datasources. Methods, and assumptions are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		High	

Formaldehyde

Occupational Exposure

HERO ID: 11224653 Table: 1 of 1

Study Citation:	U.S. EPA, (2013). Updating CEB’s method for screening-level estimates of dermal exposure.			
HERO ID:	11224653			
Conditions of Use:	All COUs - Dermal Exposure			
EXTRACTION				
Parameter	Data			
Exposure route:	dermal			
Physical form:	solids and liquids			
Dermal exposure data:	Dermal exposure data			
Comments:	Note: formaldehyde is not specifically mentioned in the report, but the provided data are relevant to account for process and operational assumptions.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	USEPA/CEB EPA Exposure Assessment Handbook for dermal exposure, generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	USA
	Metric 3:	Applicability	N/A	Applicable with most occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	2013, the report is generally no more than 10 years old.
	Metric 5:	Sample Size	Low	No statistics were provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	There is no discussion of uncertainty or variance
Overall Quality Determination		Medium		

Formaldehyde

Occupational Exposure

HERO ID: 4115766 Table: 1 of 1

Study Citation:	U.S. EPA, (1987). Occupational health evaluation of morgan, pa plant employees koppers company, inc organic materials group building materials division (final report) with attachments.				
HERO ID:	4115766				
Conditions of Use:	Incorporation into Article- Plastic and resin manufacturing- Foam Manufacturing				
EXTRACTION					
Parameter	Data				
Worker activity description:	Production of phenolic foam, product formed from phenolsulfonates and formaldehyde using a laminator. Workers can be exposed to vapor from unreacted starting material. temperature levels can reached 150F				
Exposure route:	inhalation				
Physical form:	gaseous				
Comments:	Report did not monitor for formaldehyde but completed a medical review which includes results of investigating health effects for workers at the plant.				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States	
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents the medical history survey and potential exposures to workers.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	The report does not address variability or uncertainty.	
Overall Quality Determination			High		

Study Citation:	U.S. EPA, (1999). Flexographic printing - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385709			
Conditions of Use:	commercial use: chemical substances in packaging, paper, plastics and hobby products.			
EXTRACTION				
Parameter	Data			
Worker activity description:	(i) Ink Preparation Room Inhalation Exposure:Prior to a production run, the potential exists for inhalation exposures for the workers transferring and mixing inks in the ink preparation room due to volatilization of PMN chemicals. (ii) Printing Room Inhalation Exposure:During the production runs, inhalation exposures occur when workers adjust the 5 gallon ink cans at the press and when workers operate the press.Inhalation exposures in the printing room are expected to be substantially higher than those in the ink prep room, primarily because of the higher generation rate (volatilization) associated with the process compared to simple diffusion from an open surface.			
Exposure route:	inhalation			
Physical form:	vapor			
Personal sampling data:	Contains models to estimate inhalation exposures			
Dermal exposure data:	Dermal exposure data			
Exposure duration:	(i) Ink Preparation Room Inhalation Exposure:One worker is exposed for four hours per shift.(ii) Printing Room Inhalation Exposure:Two workers are exposed per press for 7.5 hours per shift and there are typically four presses per site.			
Exposure frequency:	Facilities are expected to operate 300 days per year			
Number of workers:	Typically, one worker per shift will be required in the ink prep room and eight workers per shift will be required in the printing room (two workers per press, four presses per site). Facilities operate an average of three shifts per day; therefore, a typical facility will require a total of 27 workers.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses sound methods that are from frequently used sources (EPA) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	USA
	Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation, but no formaldehyde specific information.
	Metric 4:	Temporal Representativeness	Low	1999 (more than 20 years old)
	Metric 5:	Sample Size	Low	Data are characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Continued on next page ...				

Formaldehyde

Occupational Exposure

HERO ID: 6385709 Table: 1 of 1

...continued from previous page			
Study Citation:	U.S. EPA, (1999). Flexographic printing - generic scenario for estimating occupational exposures and environmental releases: Draft.		
HERO ID:	6385709		
Conditions of Use:	commercial use: chemical substances in packaging, paper, plastics and hobby products.		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	U.S. EPA, (2016). Chemical Data Reporting (CDR): Cyclotetrasiloxane, 2,2,4,4,6,6,8,8-octamethyl-; CAS Number 556-67-2.			
HERO ID:	7315471			
Conditions of Use:	industrial use			
EXTRACTION				
Parameter	Data			
Physical form:	Liquid			
Number of workers:	Number of sites varies with the industrial sector			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	High	Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Formaldehyde

Occupational Exposure

HERO ID: 1477715 Table: 1 of 1

Study Citation:	Unwin, J., Coldwell, M.R., Keen, C., Mcalinden, J.J. (2013). Airborne emissions of carcinogens and respiratory sensitizers during thermal processing of plastics. Annals of Occupational Hygiene 57(3):399-406.			
HERO ID:	1477715			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Area sampling data:	<0.01 (mg/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from the United Kingdom, an OECD country.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	Not applicable - process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - process description.
Overall Quality Determination			High	

Study Citation:	Uraz, A., Ramsay, A. (2013). Air purification: Dual filtration approach meets formaldehyde challenge. Filtration and Separation 50(1):38-40.		
HERO ID:	5973301		
Conditions of Use:	Disposal (via thermocatalytic air filtration)		
EXTRACTION			
Parameter	Data		
Engineering control:	In indoor workplaces, formaldehyde concentrations in the air can be reduced by photocatalytic oxidation. Titanium dioxide is the catalyst, and when exposed to UV light, it absorbs photons and excites its electrons. These electrons react with VOC’s trapped on a filter to convert them to CO2 and water. A second filter with manganese oxide then traps even more formaldehyde in thermocatalytic oxidation. After 160 days running there was a relative activity of 50-70% with exposure to formaldehyde and VOCs over time. Also, it is theorised that it may be possible to reduce outdoor air supply rates by 50% or more, while simultaneously maintaining indoor air quality and saving energy.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3: Applicability	Medium	Data are for ambient air, which is similar to the the in-scope occupational scenario of disposal of formaldehyde.
	Metric 4: Temporal Representativeness	High	Less than 10 years old
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium	

Study Citation:	Verma, T.N., Sahu, A.K., Sinha, S.L. (2018). Numerical Simulation of Air Pollution Control in Hospital. :185-206.			
HERO ID:	5953532			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Worker activity description:	Healthcare place			
Exposure route:	Inhalation			
Engineering control:	Ventilation			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2018)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			Medium	

Study Citation:	Wang, W.L., Gardner, D.J., Baumann, M.G. (2002). Volatile organic compound emissions during hot-pressing of southern pine particleboard: Panel size effects and trade-off between press time and temperature. Forest Products Journal 52(4):24-30.			
HERO ID:	2886898			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	adhesives → vapor during hot pressing			
Area sampling data:	[Emission factor information extracted under release data]			
Engineering control:	addition of formaldehyde scavengers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Unclear if data is peer reviewed but appears to contain high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is for use of formaldehyde containing wood adhesives.
	Metric 4:	Temporal Representativeness	Medium	Data is from 2002, over 10 years old.
	Metric 5:	Sample Size	N/A	qualitative
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at different adhesives/resins. Does not address uncertainty.
Overall Quality Determination			High	

Study Citation:	Wei, W., Boumier, J., Wyart, G., Ramalho, O., Mandin, C. (2016). Cleaning practices and cleaning products in nurseries and schools: to what extent can they impact indoor air quality?. Indoor Air 26(4):517-525.		
HERO ID:	3401413		
Conditions of Use:	Use of Cleaning and Furniture Care Products		
EXTRACTION			
Parameter	Data		
Number of sites:	Figure 1 shows the distribution of nurseries and schools in the survey (in France)		
Exposure duration:	Exposure duration and frequency varied among locations with some exposure being every day for cleaning of floors and furniture whereas beds and mattresses were cleaned once per week. Windows and toys cleaned in wide variety of frequencies once per week or once per year. Cleaning times in Table 2 which equates to exposure duration		
Exposure frequency:	Frequencies described in Table 1.		
Personal protective equipment:	No PPE stated but typical PPE used for cleaning are likely used (gloves, eyewear/goggles, masks)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data is for France, an OECD country.
	Metric 3: Applicability	Medium	Report is for use as cleaning products as commercial or consumer use but it is very general and could be applied to specific COUs.
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old (2016)
	Metric 5: Sample Size	Low	Data is qualitative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Includes exposure duration/frequencies, and assumed PPE.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Addresses variability by looking at different uses of cleaning products across various locations across France. Does not address uncertainty.
Overall Quality Determination		Medium	

Study Citation:	Wills, F. K. (1983). Fumigants and sanitation: update on formaldehyde. Poultry digest 42(499):452.			
HERO ID:	6016950			
Conditions of Use:	Manufacturing of formaldehyde			
EXTRACTION				
Parameter	Data			
Number of workers:	1.6 million workers were estimated to be exposed to formaldehyde in 1972-74 survey.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent. and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	Wingfors, H., Hägglund, L., Magnusson, R., Höjer, K. (2009). Development of air sampling strategies for monitoring common air pollutants in a mission area at Camp Victoria in Kosovo—stationary vs. personal monitoring. Journal of Occupational and Environmental Hygiene 6(6):332-340.
HERO ID:	900047
Conditions of Use:	Unknown

EXTRACTION	
Parameter	Data
Personal sampling data:	16-26 (ug/m^3)
Area sampling data:	11 (ug/m^3)

Domain		EVALUATION		Comments
	Metric	Rating		
Domain 1: Reliability	Metric 1: Methodology	High		Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium		Data are from Sweden, an OECD country.
	Metric 3: Applicability	Uninformative		Condition of use is unknown.
	Metric 4: Temporal Representativeness	Medium		Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2009)
	Metric 5: Sample Size	Medium		Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium		Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium		Variability addressed by area and personal sampling data but uncertainty is not addressed.

Overall Quality Determination	Uninformative

Study Citation:	Xu, B., Chen, X., Xiong, J. (2018). Air quality inside motor vehicles’ cabins: A review. Indoor and Built Environment 27(4):452-465.			
HERO ID:	4439411			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Worker activity description:	Drivers and occupants in motor vehicle cabin			
Exposure route:	Inhalation			
Physical form:	Vapor			
Area sampling data:	In one study, carbonyl concentrations in the cabin of a new Japanese estate car (station wagon in American English) were measured. On the day after the delivery (about two weeks after manufacture), the in-cabin concentrations of formaldehyde were 46.4 ug/m3. The in-cabin formaldehyde concentration was reported to decline from a higher concentration in summer to a lower concentration in winter and the concentration was reported to increase from winter to summer. Another study tested the pollutant concentrations in 50 new cars and observed that the in-cabin formaldehyde concentration was in the range of 17–67 ug/m3. Another study tested 12 taxis and mean concentration of in-cabin formaldehyde was 26 ug/m3. Another study examined the air pollution in the microenvironment of 802 parked new cars and found that the formaldehyde concentration was within 20-1110 ug/m3, with the average value of 80 ug/m3. Other references were cited also.			
Engineering control:	Ventilation with filtration unit is a most efficient method to avoid outside pollutants entering into vehicles’ cabins and capture air pollutants, emitted from combusted fuel and interior materials into the cabin air.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The report was from a non-OECD country
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	report is generally no more than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty
Overall Quality Determination		Medium		

Study Citation:	Zaatari, M., Nirlo, E., Jareemit, D., Crain, N., Srebric, J., Siegel, J. (2014). Ventilation and indoor air quality in retail stores: A critical review (RP-1596). HVAC & R Research 20(2):276-294.			
HERO ID:	2382442			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Area sampling data:	26 (ppb)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for building/construction materials - wood and wood engineering products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2014)	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Zervas, E., Montagne, X., Lahaye, J. (2001). Emission of specific pollutants from a compression ignition engine Influence of fuel hydrotreatment and fuel/air equivalence ratio. Atmospheric Environment 35(7):1301-1306.			
HERO ID:	14152			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Exposure route:	inhalation			
Physical form:	vapor			
Engineering control:	hydrotreated fuels			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	sampling and analytic methods not provided, but formaldehyde was collected using acidified DNPH solution and analyzed by HPLC/UV	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	France - OECD member	
	Metric 3: Applicability	Medium	The release data are for a diesel vehicle exhaust is an occupational scenario within the scope of the risk evaluation, but the engine and fuels used in twenty years ago may not be equivalent to current US vehicles and fuels.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 2000, after release of the most recent PEL (1992) and approximately 20 years old.	
	Metric 5: Sample Size	Medium	The distribution of samples is characterized by individual testing data points. Uncertain was discussed in terms of the reproducibility of results.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	supplemental metadata were not provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Uncertain was discussed in terms of reproducibility of results	
Overall Quality Determination		Low		

Study Citation:	3M, (1991). Letter from 3M Co to USEPA submitting enclosed report concerning modified results on two chemicals studies in the non-criteria air study with attachments. 910000779:#86-910000779.			
HERO ID:	1579713			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Release quantity:	0.1-1.3 (lb/hr) - maximum emission rates from various point sources (page 7 & 8 /14) Estimated total maximum emission rate for this facility is ~ 6.7 lb/hr (0.1x8 + 1.0x3 + 1.3x1 + 0.7x2 + 0.2x1)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesive and sealant chemical in adhesives, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old. (1991)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (max) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing waste treatment methods.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Abou-Elela, S.I., Haleem, H.A., Abou-Taleb, E., Lbrahim, H.S. (2007). Application of cleaner production technology in chemical industry: A near zero emission. Journal of Cleaner Production 15(18):1852-1858.
HERO ID:	5971179
Conditions of Use:	plastic material and resin manufacturing (plasticizer)

EXTRACTION

Parameter	Data
Description of release source:	reactor washing water; retained water from filter press; high-pressure pump used for spray drying of the product to change it from liquid to powder “option”; leakage of raw materials, product, and water; utilization of the retained product from the semi-solid waste
Release quantity:	40 m3 liquid waste/day, 15 ton solid waste/day (pg 1); 370 mg/l of FA in “end-off-pipe wastewater” (Table 1, pg 3)
Release or emission factors:	nan
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Egypt, a non-OECD country
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided (for some sources) but missing some metadata .
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by suggesting various control technologies, but uncertainty is not addressed.

Overall Quality Determination**Medium**

Study Citation:		Aldag, N., Gunschera, J.,an, Salthammer, T. (2017). Release and absorption of formaldehyde by textiles. Cellulose 24(10):4509-4518.			
HERO ID:		5955448			
Conditions of Use:		Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION					
Parameter		Data			
Description of release source:		Released to air from textiles			
Release or emission factors:		Release or emission factors			
EVALUATION					
Domain		Metric		Rating	Comments
Domain 1: Reliability		Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate but details release from a product rather than a site.
Domain 2: Representativeness		Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors may impact releases relative to the U.S.
		Metric 3:	Applicability	Medium	The release data are for a scenario that could occur in an occupational setting.
		Metric 4:	Temporal Representativeness	High	The release data were collected after the most recent federal regulatory action or update or are no more than 10 years old,whichever is shorter.
		Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.
Overall Quality Determination				High	

Study Citation:	American Cyanamid, (1984). Letter from American Cyanamide Co to USEPA regarding comments pursuant to ANPR with attachments.			
HERO ID:	1317054			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Description of release source:	Release is from manufacturing of urea-formaldehyde resins or due to process wastes going to POTWs or other disposal methods not specified.			
Release quantity:	No environmental releases due to the manufacturing operations. All process wastes are pre-treated and go to POTWs or are disposed as if they were RCRA hazardous wastes.			
Comments:	Section for chemical compositions but does not provide data. Just states that it is described extensively in textbooks, monographs, chemical encyclopedias and the patent literature. Source is monitoring data for toxicological effects on humans using patch testing.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Source is a TSCA submission so it likely meets criteria for acceptable methodology but lack of information about specific sampling.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data is for US.	
	Metric 3: Applicability	High	Data is for manufacturing of formaldehyde resins.	
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old (1984)	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Includes type of sampling, industrial sector and that there are no releases.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 5953645 Table: 1 of 1

Study Citation:	Andrews, K., B.A., Traskmorrell, B. J., Pakarinen, D. R. (1994). Formaldehyde release in dynamic chamber testing of cotton fabrics finished for durable press. Textile Chemist and Colorist 26(4):13-16.			
HERO ID:	5953645			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Description of release source:	Drying and storage of cotton fabrics that were treated with form aldehyde finishing agents.(1/4)			
Release or emission factors:	nan			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the commercial use and storage of fabrics, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (some discrete data, but mostly data in graph form) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in the emission estimation method. Variability is addressed by sampling fabrics with different finishing agents.
Overall Quality Determination		High		

Formaldehyde

Environmental Releases

HERO ID: 1481094 Table: 1 of 1

Study Citation:		Arthur D. Little Inc, (1987). Evaluation of chemical air emissions from the Bristol plant production facilities Rohm and Haas Delaware Valley, Inc (final report) with attachments and cover letter dated 08/10/89.			
HERO ID:		1481094			
Conditions of Use:		Plastic Manufacturing			
EXTRACTION					
Parameter		Data			
Release quantity:		0-3.66 (lb/hr)			
EVALUATION					
Domain		Metric		Rating	Comments
Domain 1: Reliability		Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness		Metric 2:	Geographic Scope	High	Data are from the U.S.
		Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
		Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old. (1986)
		Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing waste treatment methods.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	Medium	Variability addressed by multiple site visits to the same site.
Overall Quality Determination			Medium		

Study Citation:	ASRC, (2006). ASRC stack and fugitive emission release.			
HERO ID:	11272629			
Conditions of Use:	Waste handling, treatment, and disposal			
EXTRACTION				
Parameter	Data			
Description of release source:	S-Flare Thermal OxidizerS-U1/U2-RTO-1 StackS-U1/U2 Stack (Heat Cleaning Oven)S-U4-BLR 1/2 StackS-U4-BLR 3/4 StackC-Flare/S-Flare			
Release or emission factors:	Release or emission factors			
Release frequency:	365 days/year.			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
Comments:	Data in Release or Emission factor is the exhaust gas flowrate, therefore not chemical specific information (total gas emitted)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Low	Data are for waste handling, treatment, and disposal, an in-scope occupational scenario but quantity information is in total compounds and not specific to formaldehyde emissions.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (max and mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing release amount.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by describing emission factors for multiple stacks/flares, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	AST, (2020). [Redacted] Source test report for D-5 Scrubber - Holston Army Ammunitions Plant.		
HERO ID:	10602496		
Conditions of Use:	Commercial Uses: Chemical substances in outdoor use products: Explosive materials		
EXTRACTION			
Parameter	Data		
Description of release source:	inlets and outlet of the D-5 Scrubber. Testing included both the HMX and RDX lines. (p. 8)		
Release or emission factors:	Release or emission factors		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data indicate that the data should to be representative of current operations, equipment, and activities. The release data were collected no more than 5 years ago.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.
Overall Quality Determination		High	

Formaldehyde

Environmental Releases

HERO ID: 93087 Table: 1 of 1

Study Citation: ATSDR, (1999). Toxicological profile for formaldehyde.
HERO ID: 93087
Conditions of Use: Multiple

EXTRACTION

Parameter	Data
Release quantity:	21 million pounds of formaldehyde were released, representing releases to air, water, soil, and underground injection wells.
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
	Metric 1: Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness			
	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1999, but the data are from an earlier study published in 1996, after the most recent PEL (1992) but more than 20 years old.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity			
	Metric 6: Metadata Completeness	Low	no metadata were provided.
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability or uncertainty

Overall Quality Determination

Low

Study Citation:	Aydin, I., Colakoglu, G. (2005). Formaldehyde emission, surface roughness, and some properties of plywood as function of veneer drying temperature. Drying Technology 23(5):1107-1117.			
HERO ID:	5971795			
Conditions of Use:	Plywood panel			
EXTRACTION				
Parameter		Data		
Description of release source:		Plywood panel		
Release quantity:		Formaldehyde emissions increased with increase in veneer drying temperature. At 20 deg C, the formaldehyde emission was 2.62 mg/100 g oven dry panel, at 110 deg C emission is 3.44 mg/100 g oven dry panel, at 150 deg C emission is 7.83 mg/100 g oven dry panel, and at 180 deg C emission is 7.88 mg/100 g oven dry panel.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Methodology is accurate
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	Data are from an OECD country other than the U.S
		Metric 3: Applicability	High	Release data are for a scenario within the scope of the risk evaluation
		Metric 4: Temporal Representativeness	Medium	Data between 10 and 20 years old
		Metric 5: Sample Size	Low	Characterized by no statistics
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Low	No other metadata
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Medium	The release data study provides only limited discussion of the variability, no discussion on uncertainties
Overall Quality Determination			Medium	

Study Citation:	Bajaj, P. (2002). Finishing of textile materials. Journal of Applied Polymer Science 83(3):631-659.			
HERO ID:	5972253			
Conditions of Use:	Textile finishing			
EXTRACTION				
Parameter	Data			
Release or emission factors:	nan			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors may impact (e.g., potentially greater differences in regulatory emission limits, industry/ process technologies) releases relative to the U.S., or the country of origin is not specified.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent federal regulatory action or update or are more than 20 years old if no federal regulation is established. The operations, equipment, and worker activities are not available or indicate that the associated data are expected to be outdated.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.
Overall Quality Determination			Medium	

Study Citation:	Barry, A., Corneau, D., Lovell, R. (2000). Press volatile organic compound emissions as a function of wood particleboard processing parameters. Forest Products Journal 50(10):35-42.
HERO ID:	1171856
Conditions of Use:	Compressed Wood Product Manufacturing

EXTRACTION

Parameter	Data
Description of release source:	Major sources of VOC emissions- drying, resin blending, board pressing, board finishing, and panel storage areas. Emissions are mostly caused by combustion, thermolysis, and evaporation.
Release or emission factors:	Release or emission factors
Comments:	Data was also cited from HERO ID: 5904947 (0.17-0.56 lb/Mft2 for urea-formaldehyde bonded particleboard on a 3/4 inch basis and from 0.22-1.2lb/Mft2 on 3/8 inch basis for phenol-formaldehyde bonded oriented strand board.); 1190169 .Trends: Press formaldehyde emissions generally increased with both pressing temperature and pressing time;no consistent significant relation to resin solids content. Particleboard panel formaldehyde emissions decrease with the increase of press temperature and resin content.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The release data methodology is known or expected to be accurate
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data is greater than 20 years old
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, but lacks additional metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data study provides discussion of the variability in the determinants of release but only limited discussion of the uncertainty in the release results.

Overall Quality Determination**Medium**

Study Citation:	Baumann, H. (1990). Facts on formaldehyde in relation to foamed aminoplastics. Cellular Polymers 9(1):36-45.				
HERO ID:	5946972				
Conditions of Use:	Fuels and related products (motor-vehicle exhaust)				
EXTRACTION					
Parameter	Data				
Release quantity:	Media: fugitive air-50,000 tons in Germany				
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.	
	Metric 3:	Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.	
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.	
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination			Low		

Study Citation:	Black, F. M. (1991). Control of motor vehicle emissions - The US experience. Critical Reviews in Environmental Science and Technology 21(5-6):373-410.			
HERO ID:	32322			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Description of release source:	highway/motor vehicle emissions			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source ofthe release
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results
Overall Quality Determination			High	

Study Citation:	Black, F., Tejada, S., Gurevich, M. (1998). Alternative fuel motor vehicle tailpipe and evaporative emissions composition and ozone potential. Journal of the Air and Waste Management Association 48(7):578-591.			
HERO ID:	29831			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Release quantity:	4 vehicles using 4 different fuels			
Release or emission factors:	nan			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Testing was implemented at EPA/ NERL facility in RTP NC. detailed information about the testing procedures and equipment used were provided in the report including sampling using dinitrophenyl hydrazine (DNPH)-coated silica gel cartridges followed by extraction and analysis using high-performance liquid chromatography.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Low	The release data are for mobile source exhaust and evaporative sources. Not directly applicable to an occupational scenario. Combustion of fuels may have some applicability to the mass balance.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1998, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	emission factors were provided for each of 4 vehicles using 4 different fuels. As the actual results were provided, additional summary statistics were not needed.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided individual emission factors for each vehicle and each fuel allowing for an assessment of variability. The data did not provide any information about uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	Blondel, A., Plaisance, H. (2010). Validation of a passive flux sampler for on-site measurement of formaldehyde emission rates from building and furnishing materials. Analytical Methods 2(12):2032-2038.			
HERO ID:	5972412			
Conditions of Use:	emission			
EXTRACTION				
Parameter	Data			
Description of release source:	Indoor environments			
Release quantity:	Means and standard deviations of formaldehyde emission rates (ug/m2/h) measured with the passive flux sampler for different sampling times are sa follows: for 4 hr – 161.9 +/-15.5; for 6 hr – 166.3 +/- 12.4; for 8 hr – 180 +/- 6.8. Means and standard deviations of formaldehyde emission rates (ug/m2/h) measured in parallel with passive flux samplers and by the test chamber method at different temperatures are as follows: at 23 deg C – passive flux sampler – 243.9 +/- 6.5 and reference method 251.4; at 35 deg C – passive flux sampler – 829 +/- 104.5 and reference method 739.2.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	methodology is accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S
	Metric 3:	Applicability	Medium	release data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	data is between 10 and 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
Overall Quality Determination		Medium		

Study Citation:	Brown, S.K. (1990). Hydrolysis and durability of urea formaldehyde foam insulation. Polymer Degradation and Stability 27(2):121-143.			
HERO ID:	5971289			
Conditions of Use:	Building/construction materials – wood and engineered wood products; Building/construction materials not covered elsewhere			
EXTRACTION				
Parameter	Data			
Description of release source:	UFFI products see table 1			
Release quantity:	1-70 ppm			
Release or emission factors:	Release or emission factors			
Comments:	See table 4 and figure 8			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources in the scenario.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors may impact releases relative to the U.S.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data are more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.
Overall Quality Determination			High	

Study Citation:	Buyuksari, U., Ayilmis, N., Avci, E., Koc, E. (2010). Evaluation of the physical, mechanical properties and formaldehyde emission of particleboard manufactured from waste stone pine (<i>Pinus pinea</i> L.) cones. <i>Bioresource Technology</i> 101(1):255-259.
HERO ID:	1940934
Conditions of Use:	Compressed Wood Product Manufacturing

EXTRACTION	
Parameter	Data
Description of release source:	Wood particles (a 50:50 blend) consisting of pine (<i>Pinus nigra</i> Arnold var. <i>pallasiana</i>) and beech (<i>Fagus orientalis</i> Lipsky) species were obtained from a commercial particleboard plant in Gebze, Turkey. The fresh cones were collected from stone pine (<i>Pinus pinea</i> L.) trees. The cones were placed on a plastic cover under the sun. After drying, the cones opened up and the nuts fell out. The pine cones without nuts were soaked in hot water for four hours at 80 C. This treatment was believed to partially remove gum on the surface of the cones and improve the grinding process and bonding properties of cone particles. After this treatment, the wet pine cones were dried in an oven up to 20–25% moisture content (based on the oven-dry cone weight) at 60 C. The pine cones were coarsely chipped and then were classified using a horizontal screen shaker. The particles that remained between 3–1.5 mm sieves and between 1.5–0.8 mm sieves were utilized in the core and middle sections of the panels, respectively. The particles used in particleboard production were dried at 100–110 C in an oven to reach target moisture content (3%). The panels were designed to consist of 35% chips at the face layer and 65% at the core layer and the target density of the panels was 0.65 g/cm ³ . The boards were pressed under 2.6 N/mm ² pressure, at 150 C, for 7 min. Urea–formaldehyde (UF) resin at 10% adhesive level was used for the core and outer layers based on oven-dry weight. One-percent ammonium chloride (NH ₄ CL) was added to resin as a hardener. The chips were placed in a drum blender and sprayed with urea formaldehyde and ammonium chloride for 5 min to obtain a homogenized mixture.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	The release data methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Turkey - an OECD member
	Metric 3:	Applicability	Medium	The data used in this study are for pine cones found in Europe which would be similar to an occupational scenariowithin the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4:	Temporal Representativeness	Medium	The data were published in 2009, after the most recent PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Medium	Emission factors were obtained from a figure in the document of 8 different variants of pine cone particleboard combinations.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	no metadata were provided.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The study provided values for different pine cone/wood chip combinations that can be used to evaluate variability. Information about uncertainty was not provided.

Continued on next page ...

Formaldehyde

Environmental Releases

HERO ID: 1940934 Table: 1 of 1

...continued from previous page

Study Citation:	Buyuksari, U., Ayrilmis, N., Avci, E., Koc, E. (2010). Evaluation of the physical, mechanical properties and formaldehyde emission of particleboard manufactured from waste stone pine (Pinus pinea L.) cones. Bioresource Technology 101(1):255-259.
HERO ID:	1940934
Conditions of Use:	Compressed Wood Product Manufacturing

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		Low	

Formaldehyde

Environmental Releases

HERO ID: 5674656 Table: 1 of 1

Study Citation:	CARB, (2002). Ltr FR Intl Truck and Engine Corp to USEPA submitting studies on emissions from diesel and compressed natural gas vehicles, w/attachmnts and dated 042202.			
HERO ID:	5674656			
Conditions of Use:	Vehicle emissions			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	TSCA submission for the EPA so likely high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is applicable for engine emissions for vehicles.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Only includes release media and emission factors.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability and uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Carey, P. M. (1981). Mobile source emissions of formaldehyde and other aldehydes.			
HERO ID:	6112762			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Description of release source:	Automotive exhaust- formaldehyde is formed by the incomplete combustion (partial oxidation) of fuel (pdf pg. 5)			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but cover emissions from a automotive exhaust not releases from a particular site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for use of fuels and related products, an in-scope occupational scenario, but source indicates that formaldehyde is formed from the use not specifically included in the fuel product (byproduct).
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by the sampling and analytical methods. Variability is addressed by testing multiple classes of vehicles.
Overall Quality Determination		High		

Study Citation:	Cashen, N.A. (1979). Reduced formaldehyde release in durable-press finishing of cotton textiles. Textile Research Journal 49(8):480-484.			
HERO ID:	5952368			
Conditions of Use:	Processing (textile finishing)			
EXTRACTION				
Parameter	Data			
Description of release source:	""Formaldehyde is a major starting material for the aminoplast resins used for durable-press (DP) finishing of cotton. Some free formaldehyde is generated from these resins when the treated fabrics are heat-cured, and in subsequent storage of the finished fabrics."" (1/5)"			
Release or emission factors:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for textile finishing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release media and release concentrations provided but missing release quantity, waste treatment, number of sites, and release days/year.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability is addressed by sampling different fabrics and fabric finishers. Uncertainty isn't addressed.	
Overall Quality Determination		High		

Study Citation:	Celanese Corp, (2020). Comment submitted by Stephanie Daigle, Vice President, Government Affairs, Celanese Corporation regarding the draft scope of the risk evaluation for formaldehyde.			
HERO ID:	10370219			
Conditions of Use:	Multiple: Manufacture, Processing as a formulation, mixture, or reaction product- Plastic Compounding			
EXTRACTION				
Parameter	Data			
Description of release source:	Release of residual formaldehyde in polymer during heating or devolatilization in the extrusion step. Devolatilization is a commonly-used process used to remove moisture and other volatiles from molten polymer. After the polymer is melted in the extruder, the pressure on the molten polymer is reduced and off-gas collected.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Low	The release data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, such as a commercial use of plastic products.
	Metric 4:	Temporal Representativeness	High	No more than 10 years old.
	Metric 5:	Sample Size	Medium	Characterized by an average with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata but lacks clarity on the method details.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The release data study addresses variability in the determinants of release but study does not address uncertainty in the release results.
Overall Quality Determination		Medium		

Study Citation:	CEPE, (2020). SpERC Fact Sheet: Industrial application of coatings by spraying.
HERO ID:	10442901
Conditions of Use:	Industrial Use of Paints and Coatings

EXTRACTION

Parameter	Data
Description of release source:	Covers the whole process* of application of organic solvent borne, water borne liquid and powder coatings by industrial users by spraying.
Release or emission factors:	Release or emission factors
Release frequency:	Continuous release: 225 d/y
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known for some estimates (from OECD ESD) while others had no OECD ESD- industry data, which were assumption.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country(EU) other than the U.S.
	Metric 3: Applicability	Medium	The release data are for an occupational scenario within the scope of the risk evaluation (Use of Paints and Coatings) but is not chemical specific.
	Metric 4: Temporal Representativeness	High	Release data are generally no than 10 years old.
	Metric 5: Sample Size	Low	Emission factors were not characterized by statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data study addresses variability in the determinants of release(considers volatility and product). The release data study does not address uncertainty in the release results.

Overall Quality Determination**Medium**

Study Citation:	CEPE, (2020). SpERC Fact Sheet: Professional application of coatings and inks by spraying.
HERO ID:	10442902
Conditions of Use:	Use of Paints/Coatings

EXTRACTION

Parameter	Data
Description of release source:	For a coating film to form, the volatile phase of organic solvent borne and water borne coatings must evaporate into the atmosphere. A proportion of the solid phase will be contained in overspray. During application of coatings outdoors, a proportion of the applied coating can be deposited into water
Release or emission factors:	Release or emission factors
Release frequency:	Indoor- 365 days/yr, Outdoor- 225 days/yr
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known for some estimates (from OECD ESD) while others had no OECD ESD- industry data, which were assumption.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country(EU) other than the U.S.
	Metric 3: Applicability	Medium	The release data are for an occupational scenario within the scope of the risk evaluation (Use of Paints and Coatings) but is not chemical specific.
	Metric 4: Temporal Representativeness	High	Release data are generally no than 10 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data study addresses variability in the determinants of release(considers volatility and environment). The release data study does not address uncertainty in the release results.

Overall Quality Determination**Medium**

Study Citation:	Chaharsoughi, M. A., Najafi, S. K., Behrooz, R. (2019). Formaldehyde emission from PVC-wood composites containing MDF sanding dust. Journal of Vinyl and Additive Technology 25(2):159-164.			
HERO ID:	5970712			
Conditions of Use:	Incorporation into Article- Wood composites			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	nan			
Description of release source:	FA emission from wood plastic composites containing PVC, wood flour and sanding dust of MDF; from particleboard and MDF production during hot pressing and cooling. The manufactured boards are also sanded on both sides to reach the appropriate thickness. Sanding is also done to remove the dead layer where thermal degradation of adhesive occurs.			
Release quantity:	Fig 7 shows effect of MDF sanding dust on Fa emission from PVC composites: MDF sampling dust ranging from 0 to 20% exhibit between 0.005 to 0.07 mg/L for the desiccator method and from 0.05 to 1.2 mg/kg for the Flask Method.			
Comments:	""There is no standard method for formaldehyde emission determination from WPCs. For this reason, two different standard methods which are used for formaldehyde emission from wood-based materials were used: the flask method according to EN 717-3 and the desiccator method according to ISO 12460-4.""			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Peer reviewed so contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is for Iran, a non-OECD country
	Metric 3:	Applicability	High	Data is applicable to the production of wood-PVC composites with MDF sanding dust.
	Metric 4:	Temporal Representativeness	High	Data is under 10 years old (2019)
	Metric 5:	Sample Size	Medium	Characterized with uncertain statistics, only presented graphically.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes description of release and emission factors but lacks additional metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability of the possible amount of MDF used is discussed as well as the resulting differences of emissions. Only limited discussion of uncertainty during discussion of not having a standard approach used by the scientific community for estimating formaldehyde emissions from these types of boards.
Overall Quality Determination		Medium		

Study Citation:	Chen, L., Gao, Q., Zhang, J., Chen, H., Zhang, S., Li, J. (2014). Effects of assembly time on wet shear strength and formaldehyde emission of plywood bonded by urea formaldehyde resin. BioResources 9(2):2975-2986.			
HERO ID:	5947665			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Three-layered plywood using urea-formaldehyde resin fabricated by the authors			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	methodology is known or expected to be accurate but may not cover all sources in a scenario
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	Medium	characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata but missing additional metadata for releases at the site.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	does not discuss uncertainties
Overall Quality Determination		Medium		

Study Citation:	Chen, W., Mendell, M., Li, N., Kumagai, K. (2018). Formaldehyde emissions from seams and cut edges of laminate flooring: Implications for emission testing protocols and exposure estimation. Building and Environment 143:652-660.			
HERO ID:	5952378			
Conditions of Use:	Commercial Use			
EXTRACTION				
Parameter	Data			
Description of release source:	Seams and cut edges of laminate flooring			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the commercial use of floor coverings, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by a paragraph discussing study limitations. Variability addressed by sampling different flooring types with varying cores and edges..
Overall Quality Determination			High	

Study Citation:	Chew, L. T., Ong, C. L. (1989). Formaldehyde emission from Malaysian wood-based panels. Journal of Tropical Forest Science 1(4):336-340.			
HERO ID:	6008518			
Conditions of Use:	Processing (particle board and plywood emissions)			
EXTRACTION				
Parameter	Data			
Description of release source:	Wood-based particleboard and plywood produced with urea resins.			
Release or emission factors:	nan			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Malaysia, a non-OECD country.
	Metric 3:	Applicability	High	Data are for adhesives and sealant chemicals in wood product manufacturing, am in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing release quantity, waste treatment, number of sites, and release days/year.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in the conclusion of the report. Variability is addressed by sampling at 11 different sites.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 6026451 Table: 1 of 1

Study Citation:	Chin, J. Y. (2011). Characterization of biofuels blends: Emissions, permeation and apportionment of volatile organic compounds.
HERO ID:	6026451
Conditions of Use:	Gasoline vehicle emissions

EXTRACTION

Parameter	Data
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate for some data, unknown if all data has been peer-reviewed.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	Medium	The release data are for may be useful for use of fuels within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The release data were collected after the most recent federal regulatory action or update but are generally, more than 10 years old. If no federal regulation is established, the data are more than 10 years but no more than 20 years old. However, operations, equipment, and worker activities are expected to be reasonably representative of current conditions.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.

Overall Quality Determination

High

Study Citation:	Claggett, M., Miller, T. L., TRB (2006). Variability of mobile source air toxic emissions factors with MOBILE6.2. Transportation research record 1987(1):103-109.			
HERO ID:	1957829			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Description of release source:	mobile sources			
Release quantity:	For formaldehyde, emission factors vary from 0.00235 to 0.0617 g/vehicle mile traveled (VMT).			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is known or expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	data is between 10 and 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	release data study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Clement Associates., Inc, (1989). Human health risk assessment for the Ciba-Geigy St Gabriel, LA incineration project with cover letter dated 042789.
HERO ID:	1335586
Conditions of Use:	Disposal

EXTRACTION	
Parameter	Data
Description of release source:	LIQUID INCINERATOR - The organic liquids are segregated in the storage tanks according to their heating value, including: a liquid organics tank with a 15,500 gallon capacity holding wastes of high to moderate heating value (approximately 8,000 Btu/lb.); a liquid organics tank with a 17,500 gallon working capacity that stores wastes of low heating value (less than 3,000 Btu/lb.); and ten 20,000 gallon tanks that store aqueous waste. The liquid incinerator itself, is a vertically oriented, down fired, refractory-lined unit. The incinerator must be operated in a temperature range of 1,730 to 1,850°F in order to assure both efficiency and safety. In order to bring the incinerator temperature within this range, natural gas is used as an auxiliary fuel. Depending on the heating value of the waste feeds, the natural gas flowrate can be adjusted in order to maintain the required temperature during incineration. The burner is designed to provide maximum combustion efficiency of all three feeds. The natural gas fuel enters the incinerator via a ring at the top of the chamber. The liquid organic waste is injected through a gun located at the center of the natural gas ring. The aqueous waste is injected through a series of six guns located at the periphery of the center gun. Once the combustion is complete, the hot gases leave the thermal oxidizer at the bottom of the chamber and enter the contactor tube/quench pot system that cools the combustion gases to approximately 200 °F through direct contact with a water spray. The hot gases are cooled by direct contact with water sprayed from twelve nozzles directly into the gas stream. The cooled gases exit to the secondary quench tower. The gas leaving the secondary quench is thus cooled and saturated with water. This waste stream is scrubbed using a venturi-type scrubber to remove both HCl and particulates. Leaving the scrubber is a mixture of scrubbed gas and liquid droplets that must be separated which is done in the cyclone separators. The gases leaving the separators and enter the base of the vent stack, where they will be discharged to the atmosphere. Before being discharged, however, the gases must flow through a demister pad which removes most of the remaining particulates and liquid droplets. The conditioned gases are discharged from the top of the stack 145 feet above the ground. ROTARY KILN INCINERATOR - The proposed rotary kiln is a large, rotating refractory shell slanted downward at a 4° angle. The rotation of the shell moves the waste through the combustion chamber, exiting at the end of the kiln. Residence time in the combustion chamber can varied by changing the speed of the rotation. A natural gas feed is used as an auxiliary fuel feed which is applied to the outer barrel of this burner to maintain the operating temperature at approximately 1,600 °F. Organic liquid wastes is fed directly into the organic burner portion of the kiln. Aqueous wastes is fed directly into the kiln from the aqueous waste storage tanks. Waste in slurry form is fed into the kiln through the slurry lance and into the combustion zone. Waste sludge is fed into the kiln from the sludge feed hopper. Bulk solid wastes is shredded before being introduced into the kiln by the solids feed conveyor. The amount of combustion air entering the kiln is carefully regulated. Ash drops from the kiln into a water filled trough where the hot ash is quenched and moved by a conveyor to hydroclones that separate the ash from the water. Because of the variety of wastes are combusted in the rotary kilns, it is conceivable that the flue gas leaving the kiln will contain some uncombusted materials that goes through a secondary combustion chamber/afterburner. Natural gas, and a portion of organic liquids and liquid waste are fired into this second burner instead of travelling first through the rotary kiln. Residence time of the flue gases in the afterburner is approximately two seconds at an operating temperature of 1,800 °F. Hot flue gases from the rotary kiln and afterburner rise out of the upper section of the afterburner and move to the quenching unit that cools the hot flue gas and partially saturates it with water in preparation for scrubbing. Next the flue gas proceeds to the particle conditioner which a secondary quenching unit. The fully saturated and cooled flue gas leaves the top of the particle conditioner entering the scrubber system, where particulates, HCl, and other acid gases and chemicals are removed. The particulate-laden scrubbing water flows by gravity down to the entrainment separator tank, where the solids are removed and the water recirculated. Once the flue gas leave the scrubbers, it is release into the atmosphere via a vent stack 130 feet above ground.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High
			The release data methodology is expected to be accurate as it is based on a mass balance approach derived using data from trial burns.
Domain 2: Representativeness			

Continued on next page ...

Formaldehyde

Environmental Releases

HERO ID: 1335586 Table: 1 of 1

...continued from previous page

Study Citation:	Clement Associates,, Inc, (1989). Human health risk assessment for the Ciba-Geigy St Gabriel, LA incineration project with cover letter dated 042789.			
HERO ID:	1335586			
Conditions of Use:	Disposal			
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The release data are for the operation of liquid incinerators and rotary kilns which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were published in 1989, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	typical and max emission factors are provided in pounds per year or grams per second
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	the only meta data provided assumes 24-7 operations
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Coburn, T.C., Kelly, K.J., Bailey, B.K. (1998). Reduction in vehicle emissions attributable to alternative transportation fuels and its prospective impact on air quality and public health. Applied Occupational and Environmental Hygiene 13(6):395.			
HERO ID:	5700217			
Conditions of Use:	Fuels and Related Products			
EXTRACTION				
Parameter	Data			
Description of release source:	Automobile exhaust			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard error) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source ofthe release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Cocalis, J. C., Rao, C. Y., Kestenberg, K. A., Martin, J. E. (2001). Health Hazard Evaluation Report 2000-0098-2862, Robinson Run Mine, Shinnston, West Virginia, July 2001.			
HERO ID:	8016652			
Conditions of Use:	Other- Byproduct of Biocide in MWF			
EXTRACTION				
Parameter	Data			
Description of release source:		The triazine compound acts as a biocide by decomposing into formaldehyde. The absence of and/or presence of only trace amounts of triazine in the emulsion is an indicator that contact with acidic microbial waste products in the emulsion result in the decomposition of triazine and the release of formaldehyde. Most of emulsion used in the hydraulic system ends up as leakage into the mine environment. Sources of leakage include hydraulic line couplings, shield control boxes, pistons used to move shields, hydraulic line breaks, hydraulic line maintenance, and shield teardown and setup activities. (pg. 9)		
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	The release quantity was not provided, a qualitative statement is made on the release but methodology or source/support is unknown. Release is expected to cover the source of formaldehyde.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent federal regulatory action or update or are more than 20 years old if no federal regulation is established. The operations, equipment, and worker activities are not available or indicate that the associated data are expected to be outdated.
	Metric 5:	Sample Size	N/A	Qualitative information.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, oractivity that is the source of the release; and release frequency
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Cocker, D.R., Shah, S.D., Johnson, K.C., Zhu, X., Miller, J.W., Norbeck, J.M. (2004). Development and application of a mobile laboratory for measuring emissions from diesel engines. 2. Sampling for toxics and particulate matter. Environmental Science and Technology 38(24):6809-6816.			
HERO ID:	1652297			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Description of release source:	mobile, in-use diesel engines operated on the road			
Release quantity:	Mass emission rates from heavy heavy-duty diesel trucks (HHDDT) equipped with a CAT C-15 engine (model year 2000): 1487 +/- 248.9 mg/h (cold start/idle), 588 +/- 34.5 mg/mi (creep), 115 +/- 20.6 mg/mi (transient), 39 +/- 2 mg/mi (cruise). Mass emission rates from a 350 kW BUG Equipped with a CAT 3406C Engine (g/phase): 10% lead and duration 500 s - 274 +/- 54; 25% lead and duration 500 s - 256 +/- 58; 50% lead and duration 500 s - 401 +/- 54; 75% lead and duration 450 s - 624 +/- 82; 100% lead and duration 400 s - 1077 +/- 62			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	the data are more than 10 years but no more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainty
Overall Quality Determination		High		

Study Citation:	Cooke, T. F., Weigmann, H. D. (1982). The chemistry of formaldehyde release from durable press fabrics. II. Textile Chemist and Colorist 14(6):33-41.
HERO ID:	6028034
Conditions of Use:	emission

EXTRACTION				
Parameter		Data		
Description of release source:		Formaldehyde release from durable press fabrics treated with formaldehyde reactants		
Release quantity:		A study on the effect of the catalyst on formaldehyde release with buffered and unbuffered DMDHEU showed that "catalysts of predominantly Lewis acid activity (zinc nitrate, magnesium chloride, aluminum hydroxychloride) produce fabrics with lower formaldehyde release (ranging between 2 and 4.6) than do those of predominantly Brifosted activity (aluminum sulfate, magnesium chloride-citric acid, sodium hydrogen sulfate, magnesium hydrogen phosphate) (ranging between 4.8 and 12.7). The amounts of formaldehyde determined by the AATCC method generally are greater than those from the Japanese method. The standard deviation for the AATCC test is 14 ppm and for the Japanese test is 11 ppm.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Release data methodology is expected to be accurate
Domain 2: Representativeness		Metric 2: Geographic Scope	High	Data are from the United States
		Metric 3: Applicability	Low	Release data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
		Metric 4: Temporal Representativeness	Low	More than 20 years old
		Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Uninformative	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Uninformative	

Study Citation: Cordova-Orellana, C. (2017). Air toxic emissions and associated health risks in Cook County, IL.	
HERO ID: 6026136	
Conditions of Use: Use of fuels and related products	
EXTRACTION	
Parameter	Data
Description of release source:	Heavy diesel truck traffic, other automobile exhaust emissions.
Release quantity:	NIE data for Illinois total air emissions by year1999: 7,321 tons per year2002: 5,262 tons per year2005: 5,650 tons per year2011: 17,272 tons per yearNEI data for on-road air emission in Illinois by year1999: 3,151 tons per year2002: 2,543 tons per year2005: 2,480 tons per year2011: 1,492 tons per year
EVALUATION	
Domain	Metric
Domain 1: Reliability	Rating
Metric 1:	Methodology
	Medium
	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
	High
Metric 3:	Applicability
	High
Metric 4:	Temporal Representativeness
	High
Metric 5:	Sample Size
	Low
	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	High
	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	Medium
	Uncertainty not addressed. Variability addressed by considering emissions data from multiple years.
Overall Quality Determination	
High	

Study Citation:	CPSC, (1983). United States Government Memorandum: Completion of surveillance testing of consumer products for formaldehyde emissions.			
HERO ID:	10370055			
Conditions of Use:	VOC releases from products/articles			
EXTRACTION				
Parameter	Data			
Description of release source:	releases from finished products/articles containing formaldehyde			
Release quantity:	”The Lovelace report indicates CH20 emission rates (ERs) of 0.02 and 0.12 mg CH20/m2h for fibrous glass insulation and ceiling panels, respectively. These results were low in comparison to those for pressed-wood products (i.e., 0.08 - 1.4 mg CH20/m2h) but high in comparison to most apparel and non-apparel textiles(i.e., 0.0001 - 0.01 mg CH20/m2h).” pg. 13/39			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3:	Applicability	Low	The release data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, such as a consumer DIY scenario that is similar to a workerscenario
	Metric 4:	Temporal Representativeness	Low	Report is over 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently rep-resentative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.
Overall Quality Determination			Medium	

Study Citation:	Croteau, G., Dills, R., Beaudreau, M., Davis, M. (2010). Emission factors and exposures from ground-level pyrotechnics. Atmospheric Environment 44(27):3295-3303.			
HERO ID:	851253			
Conditions of Use:	Use of explosives			
EXTRACTION				
Parameter	Data			
Description of release source:	Firework display (explosive materials)			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH Method 2016 (Issued January 1998 and March 2003)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	Data are for fire work displays which are an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology and variability was presented for different firework types
Overall Quality Determination		Medium		

Study Citation:	Crouch, C.J., Melancon, T.A., Reeves, W.A. (1985). Fire resistant-durable press fabrics with low formaldehyde release. Journal of Fire Sciences 3(6):450-460.		
HERO ID:	5965968		
Conditions of Use:	Commercial use: Fabric products		
EXTRACTION			
Parameter	Data		
Description of release source:	Chemically treated fire-resistant fabrics - fire resistant-durable press (FR-DP) fabrics produced by combining decabromodiphenyl oxide, antimony oxide, Dur-O-Cote and 1,3-dimethylol 4,5-dihydroxyethyleneurea (DMDHEU) with the addition of three polyols (1,2-propanediol, ethylene glycol and glycerol).		
Release quantity:	Comparing mean formaldehyde release data for fabrics treated with only the FR-DP agent and for fabrics treated with the FR-DP agent plus each of the three polyols at 2% and 4% concentrations and cured for 3.5 and 5.0 minutes at 160 °C, it was found that the least effective polyol for reducing formaldehyde release was ethylene glycol. Control fabric treated only with FR-DP finish had a mean formaldehyde release value of 950 ug/g of treated fabric, whereas 2% propanediol reduced formaldehyde release to about 700 ug/g of treated fabric and 4% reduced the release value to about 540 ug/g of treated fabric. The most effective polyol was glycerol; 2% reduced formaldehyde release to about 680 ug/g and 4% reduced the release value to about 490 ug/g of treated fabric. Curing time also produced significant effects on formaldehyde release from treated fabrics. Curing control fabrics and fabrics with FR-DP plus ethylene glycol for 5 minutes rather than 3.5 minutes produced modest reductions in mean formaldehyde release, 20 to 30 ug/g of treated fabric. Highly significant differences in formaldehyde release were produced by the longer cure time when treating solutions contained propanediol or glycerol. With these polyols the 5-minute cure produced reductions in formaldehyde release values ranging from 80 to 100 ug/g of treated fabric. The lowest formaldehyde release (442 ug/g) was recorded for fabrics treated with 4% glycerol and cured for 5 minutes. Three sets of conditions produced fabrics with about 500 ug/g or less formaldehyde release. The conditions were: (1) the use of 4% propanediol and a 5 minute cure; (b) the use of 4% glycerol with a 3.5 minute cure; and (c) the use of 4% glycerol and a 5 minute cure.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media and process, but lacks additional metadata, such as release frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability discussed by comparing fabrics treated with different chemicals but uncertainty is not addressed.
Continued on next page ...			

Formaldehyde

Environmental Releases

HERO ID: 5965968 Table: 1 of 1

...continued from previous page			
Study Citation:	Crouch, C.J., Melancon, T.A., Reeves, W.A. (1985). Fire resistant-durable press fabrics with low formaldehyde release. Journal of Fire Sciences 3(6):450-460.		
HERO ID:	5965968		
Conditions of Use:	Commercial use: Fabric products		
Domain		EVALUATION	
Metric		Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Daniels, W., Almaguer, D., Kramkowski, R. (1987). Health Hazard Evaluation Report HETA-86-0343-1822 Sheller-Glose (Allen Industries, Inc.), Herrin, Illinois. :23.			
HERO ID:	8197552			
Conditions of Use:	Processing-Reactant-Intermediate in-Plastic materials and resin manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Airlay and Hot Oil Press Departments where formaldehyde might possibly be present from the volatilization and reaction of the resin as a result of the high temperatures of the ovens and presses. Emissions from presses have been difficult to characterize due to the wide variety of contaminants which can be present at relatively low concentrations. The chemistry surrounding the reactions of phenol-formaldehyde resins are complex, and even today, not completely understood. Contaminants can not only evolve from the resin material and release agents used at the presses, but also from the oils and other contaminants present in the cotton blanket which may vary from batch to batch.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	The release data methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent federal regulatory action or update or are more than 20 years old if no federal regulation is established. The operations, equipment, and worker activities are not available or indicate that the associated data are expected to be outdated.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Davis, A.Y., Zhang, Q., Wong, J.P., Weber, R.J., Black, M.S. (2019). Characterization of volatile organic compound emissions from consumer level material extrusion 3D printers.			
HERO ID:	5645091			
Conditions of Use:	Arts, crafts, and hobby materials (3D printing)			
EXTRACTION				
Parameter	Data			
Description of release source:	Fused filament fabrication printers			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
Comments:	Media: fugitive air - All in $\mu\text{g/h}$ - ABS filament: 24.7; PLA: 7; Nylon: 6.1; HIPS: 30.2; PVA: 21.6 (Table 3, pg 5)Methods: Chamber testing via ASTM D6670; HPLC; overall follows EPA TO-11A, ASTM D5197, ISO 16000-3 (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for arts, crafts, and hobby materials (3D printing), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, max, min, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata (regarding emission factors) provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability addressed by testing multiple 3D printer brands and filament types/colors/brands. Uncertainty is addressed by evaluating correlations between emissions of different substances.
Overall Quality Determination		High		

Study Citation:	Dement, J. M., Smith, N. D., Hickey, S., J.L., Williams, T. M. (1984). An evaluation of formaldehyde sources, exposures and possible remedial actions in two office environments. 3:99-104.			
HERO ID:	22861			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter		Data		
Description of release source:		Panneling, ceiling panels, and carpet & flooring		
Release or emission factors:		Release or emission factors		
Waste treatment methods and pollution control:		nan		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Release methodology is only briefly discussed but expected to be accurate; no indication of flaws.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	Data are for off gassing of furnishings which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent federal regulatory action (PEL) and are more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Demir, A., Aydin, I., Ozturk, H. (2018). Formaldehyde Release from Plywood Manufactured with Two Types of Urea Formaldehyde Resins after Fire Retardant Treatment of Veneers. Drvna Industrija 69(2):193-199.			
HERO ID:	4741999			
Conditions of Use:	FA use in manufactured plywood.			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Comments:	Formaldehyde release are in Figure 2 and 3 for different types of retardant chemicals (mg/100g): UF1: Beech - 0.172, 0.669, 0.202, and 0.142 for zinc borate, boric acid, MAP, ammonium sulfate; Poplar - 0.927, 1.440, 0.618, 0.563; Alder - 0.54, 0.532, 0.181, 0.152; Pine - 0.833, 0.172, 0.397, 0.328; UF2: Beech - 2.087, 1.869, 0.47, 0.37; Poplar - 4.232, 4,77, 1.626, 0.92; Alder - 1.957, 1.842, 0.432, 0.37; Pine - 3.949, 2.617, 1.007, 0.684			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Source is peer reviewed so contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is from Turkey, an OECD country
	Metric 3:	Applicability	High	Data is applicable to manufacturing of plywood.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2018).
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Only provides a general process description and emission factors.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at two different adhesive mixtures and different types of plywood.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 659922 Table: 1 of 1

Study Citation:	Dempsey, C.R. (1993). A comparison of organic emissions from hazardous waste incinerators versus the 1990 toxics release inventory air releases. Journal of the Air and Waste Management Association 43(10):1374-1379.			
HERO ID:	659922			
Conditions of Use:	Disposal			
EXTRACTION				
Parameter	Data			
Description of release source:	Stack of hazardous waste combustor			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	Data are for hazardous waste combustion which is an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Monitoring data are greater than 20 years and after the PEL- Article published in 1993	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Release media and process provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Dixit, S., Yadav, A., Dwivedi, P. D., Das, M. (2015). Toxic hazards of leather industry and technologies to combat threat: a review. Journal of Cleaner Production 87(Elsevier):39-49.			
HERO ID:	2952861			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Description of release source:	Conventional pre-tanning and tanning processes accounts for nearly 90% of the total pollution from a tannery.			
Release quantity:	Waste water generated in each process in Table 1 (m3 or kilolitre /ton of hide): soaking: 9.0-12.0, unhairing/liming: 4.0-6.0, deliming and bating: 1.5-2.0, Chrome tanning: 1.0-2.0, Post tanning: 1.0-1.5, finishing: 1.0-2.0.			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	The release data methodology is not specified, a source is cited which presumably may contain methodology for release information.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	India, non-OECD country
	Metric 3:	Applicability	High	The release data are for an occupational scenario, finishing agent for textiles, within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Release information appears to be from cited paper (2001), which would make the data exactly 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, but missing chemical specific info or frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Release data addresses variability of release per processing step but does not address uncertainty in release data.
Overall Quality Determination			Low	

Study Citation:	Dobslaw, D., Engesser, K.H., Stoerk, H., Gerl, T. (2019). Low-cost process for emission abatement of biogas internal combustion engines. Journal of Cleaner Production 227(Elsevier):1079-1092.
HERO ID:	5966014
Conditions of Use:	emissions

EXTRACTION	
Parameter	Data
Description of release source:	Three biogas plants in the region of Tuttlingen, Germany, equipped with three different types of IC Engines (Four-stroke gas engine Gas compression-ignition engine Four-stroke gas engine)
Release quantity:	Formaldehyde emission levels in ppm (in mg/m3) in restricted waste gas at the gas outlet of the chemical scrubber installed at the biogas site I: Limit – 20, during operational period – between 23.1 (30.9) and 7.8 (10.4). Formaldehyde emission levels in ppm (in mg/m3) in restricted waste gas in the mixed crude gas and at the outlet of the chemical scrubber installed at the biogas site I: high-efficiency scenario – crude gas – 32.4 (43.4), clean gas – 1.2 (1.6). Emission values for site II and site II are also provided and are similar
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.

Overall Quality Determination	Medium

Formaldehyde

Environmental Releases

HERO ID: 1952206 Table: 1 of 1

Study Citation:	Duffy, B.L., Nelson, P.F., Ye, Y., Weeks, I.A. (1999). Speciated hydrocarbon profiles and calculated reactivities of exhaust and evaporative emissions from 82 in-use light-duty Australian vehicles. Atmospheric Environment 33(2):291-307.			
HERO ID:	1952206			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Description of release source:	car exhaust emissions			
Release quantity:	Formaldehyde can account for as much as 2% w/w of the non-methane organic compounds emitted from cars.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country. other than the U.S.
	Metric 3:	Applicability	Medium	data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data is greater than 20 years
	Metric 5:	Sample Size	Low	no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty
Overall Quality Determination			Low	

Study Citation:	Dunky, M. (1998). Urea-formaldehyde (UF) adhesive resins for wood. International Journal of Adhesion and Adhesives 18(2):95-107.			
HERO ID:	5968910			
Conditions of Use:	Urea formaldehyde resin for wood based panels			
EXTRACTION				
Parameter	Data			
Description of release source:	Release comes from emission due to UF bonded to wood panels			
Release quantity:	Fig 2 gives emission over time of FA from 1 ppm down to about 0.15 ppm after 1000 hrs.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for Austria, an OECD country.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Medium	Distribution is characterized by a range of degrees of hydrolysis. It is only intended to show a trend.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by using multiple hydrolysis constants, uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Durbin, T.D., Miller, J.W., Younglove, T., Huai, T., Cocker, K. (2007). Effects of fuel ethanol content and volatility on regulated and unregulated exhaust emissions for the latest technology gasoline vehicles. Environmental Science and Technology 41(11):4059-4064.			
HERO ID:	90901			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Comments:	Study provides results in total hydrocarbons, supplemental information provides regression model for formaldehyde . Study does state "Relative comparison of ethanol and two gasoline blends with different distillation temperatures (T50 & T90). The formaldehyde data presented noted that the difference between ethanol and T50 was marginally significant;. but as T50 increased formaldehyde increased by 23%."			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Each vehicle was tested over two light duty Federal Test Procedure (FTP)s; sampling on cartridges coated with dinitrophenyl-hydrazine (DNPH) followed by high performance liquid chromatography (HPLC) analysis for carbonyls.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	Uninformative	The release data are for vehicle exhaust emissions as a result of combustion byproduct which is not an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The release data were collected (2007) more than 10 years but no more than 20 years old. However, operations, equipment, and worker activities are expected to be reasonably representative of current conditions.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty for formaldehyde.
Overall Quality Determination		Uninformative		

Formaldehyde

Environmental Releases

HERO ID: 6027211 Table: 1 of 1

Study Citation: Earhart, J.P., King, C.J., Prausnitz, J.M., Won, K.W. (1976). Extraction of Chemical Pollutants from Industrial Wastewaters with Volatile Solvents.	
HERO ID: 6027211	
Conditions of Use: Disposal	
EXTRACTION	
Parameter	Data
Description of release source:	Wastewater from petrochemical manufacturing facilities, including phenol-formaldehyde resin plants. (21/530)
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
EVALUATION	
Domain	Metric
Domain 1: Reliability	Rating
Metric 1:	Methodology
	High
	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Metric 3:	Applicability
	High
	Data are from the U.S.
Metric 4:	Temporal Representativeness
Metric 5:	Sample Size
	High
	Data are for the disposal of formaldehyde to the water, an in-scope occupational scenario.
	Data are greater than 20 years old.
	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	Low
	Release media provided but not release frequency or amounts.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	Medium
	Variability is addressed by using different solvents in the removal of formaldehyde from water. Uncertainty isn't addressed.
Overall Quality Determination	
Medium	

Study Citation:	Earthjustice, (2020). Exhibit 1 to comments of Rubbertown Emergency ACTion et al., Re: TSCA risk evaluations for High-Priority Substances and substances undergoing Manufacturer-Requested Risk Evaluations.			
HERO ID:	10385015			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Description of release source:	Release information by location			
Release quantity:	Quantity provided per location centers. Original data taken from TRI.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Release data methodology is cited, its is from TRI, which is expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	U.S. data.	
	Metric 3: Applicability	High	Releases encompass multiple occupational scenarios within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	less than 10 years old.	
	Metric 5: Sample Size	High	Appendix contains site specific release amounts.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include most critical metadata, including release media and site locations but lacks additional metadata, such as process, unit operation, and/or activity and frequency that is the source of the release.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.	
Overall Quality Determination		High		

Study Citation:	EC, (2000). Priority substances list assessment report. Formaldehyde. :1-62.		
HERO ID:	1256545		
Conditions of Use:	Use of fuels and related products		
EXTRACTION			
Parameter	Data		
Description of release source:	Motor vehicles, aircraft, marine vessels		
Release quantity:	Automobile: 11,284 (tonnes), Aircraft: 1,730 (tonnes); Marine: 1,175 (tonnes) (pg. 18/111)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from Canada, an OECD country.
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1999)
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium	

Study Citation:	ECHA, (2019). Annex XV restriction report, proposal for a restriction: Formaldehyde and formaldehyde releasers.			
HERO ID:	5155562			
Conditions of Use:	Consumer Use- Clothing			
EXTRACTION				
Parameter	Data			
Release quantity:	Study by Aldag et al. (2017) reports that emissions from clothing (e.g., pants, T-shirts and shirts) are in the ppb range (0.4-3.2 ppb) from clothes with 11-75.9 mg/kg extractable formaldehyde. Aalto-Korte et al. (2008); where the authors ; analysed four samples of textiles used in protective clothing and one other textile sample: in three cases, the analysis was negative (< 10 ppm), one sample of protective clothing contained 18 ppm formaldehyde, and the formaldehyde content of a sample of mattress textiles was 19-21 ppm			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	Emission data methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Report is from an OECD country, EU.
	Metric 3:	Applicability	Medium	Data relates to the consumer use of clothes but could potentially be useful for occupational scenarios
	Metric 4:	Temporal Representativeness	High	No more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata,but lacks additional metadata,
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Limited discussions on variability and uncertainty in results
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 4074779 Table: 1 of 1

Study Citation:	Eichhorn, W., Winters, D. (2007). Environmental compliance testing of fuser and pressure roller products for digital printers. :794-796.			
HERO ID:	4074779			
Conditions of Use:	Commercial Use: Printer Equipment			
EXTRACTION				
Parameter	Data			
Release quantity:	NIOSH Method 2541 used for Formaldehyde analysis. Figure 2 shows FA emissions from different manufacturing of printer rollers with the highest at above 50 nanograms.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Unclear if source is peer reviewed however the sampling methodology is a NIOSH method so likely high quality data.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data is from US	
	Metric 3: Applicability	High	Data is applicable to manufacture of printer rollers with formaldehyde emissions.	
	Metric 4: Temporal Representativeness	Medium	Data is from 2007, so over 10 years old.	
	Metric 5: Sample Size	Low	Characterized by a range of data in one figure.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Only includes release/emission data.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	FA emissions from different printer roller manufacturing/operation. Does not address uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	ENSR, (1991). Initial submission: AB 2588 health risk assessment for the Texaco refinery areas 1 & 2 (volume I & II) (draft report) with attachments and cover letter dated 030692.			
HERO ID:	1270212			
Conditions of Use:	Combustion Byproduct			
EXTRACTION				
Parameter	Data			
Description of release source:	Boilers, Heaters and coolers at Texaco Inc. Bakersfield Refinery Areas 1 and 2, which produces diesel and gasoline			
Release quantity:	Maximum annual emissions for formaldehyde were from heaters and boilers at 183 lbs/year, and from tanks at 1.75 lbs/yr. Area 3 pp.385 3.6 lbs/year boilers, 4.21-6.15 lbs/yr heaters			
Comments:	Most pages of the source are not read-able. Report appears to show maximum hourly air concentration but appears to be conservative model estimates based on predicted emissions but numbers are illegible			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	Uninformative	Release data are from emissions from boilers, heaters, and coolers. Based on information provided in source, EPA assumes formaldehyde produced as a combustion byproduct, which is not within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	release data study does not address variability or uncertainty.
Overall Quality Determination		Uninformative		

Study Citation:	ENSR, (1991). AB 2588 health risk assessments: Corrected and alternative emissions cases for the Taft area oil fields - Taft, California with attachments and cover letter dated 090591.		
HERO ID:	1481750		
Conditions of Use:	”Processing aids, specific to petroleum production in: oil and gas drilling, extraction, and support activities and all other basic inorganic chemical manufacturing”		
EXTRACTION			
Parameter	Data		
Release quantity:	emission factors and release quantities are provided in the included Air Toxic Emission Data System Review and Update Report Process and Emittent Data sheets. These data are provided by CAS ID, SCC and process unit description. It should be noted that report includes over 300 pages of data that are in a non-searchable graphic format. Given the age of the data, it may not be appropriate to retrieve these data.		
Release or emission factors:	Release or emission factors		
Release frequency:	monthly profiles are included in the Air Toxic Emission Data System Review and Update Report Process and Emittent Data		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Low	The Air Toxic Emission Data System Review and Update Report Process and Emittent Data include a code for the emission estimation methods, but the reference for each code is not provided.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data from the US
	Metric 3: Applicability	High	The release data are for area oil field workers, which is an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The data were published in 1991, before the most recent PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	N/A	No statistical data are provided only emission factor values and calculated release data.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Low	

Study Citation:	ENSR, (1991). Ab 2588 Health Risk Assessment For Kern River And Racetrack Oil Fields, Bakersfield, California With Attachments And Cover Letter Dated 090591.			
HERO ID:	1481756			
Conditions of Use:	”Processing aids, specific to petroleum production in: oil and gas drilling, extraction, and support activities and all other basic inorganic chemical manufacturing”			
EXTRACTION				
Parameter	Data			
Release quantity:	Racetrack:0.000454 - 0.4602 lbs/yr;1.6E-07 - 5.253E-05 lbs/hr; Kern River: 0.000275-254.1 lbs/yr; 0 - 0.127 lbs/hr (page 41 and 42)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Emissions are based on the Toxic Emissions Inventory Report (TEIR) data so methods used were not provided.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The release data are for area oil field workers, which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The data were published in 1991, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	No statistical data are provided but emissions and factors were provided for multiple individual sources.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Included release media but no other metadata were provided	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	ENSR, (1991). Acute ISC input data-full grid & AB 2588 health risk assessments: Corrected & alternative emissions cases for the Cymric area oil fields McKittrick, California with letter 090591.			
HERO ID:	1481763			
Conditions of Use:	”Processing aids, specific to petroleum production in: oil and gas drilling, extraction, and support activities and all other basic inorganic chemical manufacturing”			
EXTRACTION				
Parameter	Data			
Description of release source:	Shipping tanks, sumps, I.C. engine, heater treater/boiler, steam generator, CO generator,			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for petroleum manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old. (1991)	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release media and release frequency provided but missing waste treatment methods, release quantity.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	ENSR, (1991). AB 2588 health risk assessment for the Texaco Refinery Areas 1 and 2 Bakersfield, California.				
HERO ID:	6338980				
Conditions of Use:	Petroleum refinery				
EXTRACTION					
Parameter	Data				
Release or emission factors:	Release or emission factors				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1: Methodology	Low	Sampling/analytical methodology is not specified (for the emission totals/rates).		
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.		
	Metric 3: Applicability	High	Data are for petroleum refinery, an in-scope occupational scenario.		
	Metric 4: Temporal Representativeness	Medium	Emissions data were collected (or estimated) after the most recent PEL and greater than 10 years old.		
	Metric 5: Sample Size	Low	Emissions data is characterized by no statistics.		
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Emissions data type provided but no other metadata. No data provided on the completeness of the emission totals/rates.		
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.		
Overall Quality Determination		Low			

Formaldehyde

Environmental Releases

HERO ID: 6339343 Table: 1 of 1

Study Citation:	ENSR, (1991). AB 2588 Health risk assessment for the Texaco refinery Area 3, Bakersfield, California.			
HERO ID:	6339343			
Conditions of Use:	Petroleum refinery			
EXTRACTION				
Parameter	Data			
Release quantity:	Annual emissions (lbs/yr) for formaldehyde by the facility area 3 – 0.17 (flares); 3.6 (boiler); 14.58 (heater). Emission factor – 10^-6 per MM BTU			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	release data methodology is expected to be accurate	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data	
	Metric 3: Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	more than 20 years old	
	Metric 5: Sample Size	Low	characterized by no statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	release data study does not address variability or uncertainty	
Overall Quality Determination		Medium		

Study Citation:	Envirologic Data, (1991). Supplemental information from Rohr Industries Inc to USEPA submitting enclosed health risk assessment draft report with attachments.			
HERO ID:	1874143			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Description of release source:	Rohr industries Riverside facility			
Release quantity:	0.017 (lb/year)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for paint additives and coating additives not described by other categories in transportation equipment manufacturing (including aerospace), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old. (1991)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing waste treatment methods, emission factors.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 4214360 Table: 1 of 1

Study Citation:	Envirologic Data, (1992). Assessment of risks from potential exposure to airbourne facility emissions under California AB 2588 for the Rohr Inc Facility Riverside, Calif (vol. 1) (final report) w-letter.			
HERO ID:	4214360			
Conditions of Use:	Plastic material and resin manufacturing (aerospace interiors)			
EXTRACTION				
Parameter	Data			
Release quantity:	103.8 (lb/yr) form Rohr Industries Inc. Riverside			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for plastic material and resin manufacturing (aerospace interiors), an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old. (1992)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release media and release frequency provided but missing waste treatment methods, release frequency.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 1356128 Table: 1 of 1

Study Citation:	Environ & Ecol Engin, (1992). Health risk assessment in fulfillment of requirements under the AB2588 Air Toxics Information and Assessment Act of 1987 (final report) with attachments and letter dated 021492.			
HERO ID:	1356128			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Stack emissions from plastic material and resin manufacturing plant			
Release quantity:	1.23*10^-3 - 7.345*10^3 (lbs/year)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old. (1986)
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing waste treatment methods.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Environmental Defense Fund, (2022). Comment submitted by Environmental Defense Fund (EDF) containing the data file on fenceline and background exposure analyses in TSCA risk evaluations.			
HERO ID:	10386449			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Release quantity:	Report provides maps of releases or transfers within 10 km or 1km of each other for TRI. Background release data taken from TRI 2020.			
Release or emission factors:	nan			
Comments:	Includes excel file with distances between facilities for formaldehyde.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Release data methodology is originally TRI data, which is expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The release data covers both occupational scenarios within the scope and outside of the scope (e.g. Non-TSCA uses). Individual data per site is available such that all can be used within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Uses 2020 TRI day, less than 10 years old.
	Metric 5:	Sample Size	High	Each site releases are provided in the excel file with the calculated distances.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media and site locations but did not pull the use information from TRI within the report. Other metadata such as frequency is not available in TRI.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 7349020 Table: 1 of 1

Continued on next page ...

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Study Citation:	ERG, (1998). Air emissions inventories, volume 2: Point sources: Chapter 11: Preferred and alternative methods for estimating air emissions from plastic products manufacturing.
HERO ID:	7349020
Conditions of Use:	Chemical substances in plastic products

EVALUATION			
Domain	Metric	Rating	Comments

Study Citation:	ERG, (1998). Air emissions inventories, volume 2: Point sources: Chapter 11: Preferred and alternative methods for estimating air emissions from plastic products manufacturing.
HERO ID:	7349020
Conditions of Use:	Chemical substances in plastic products

EXTRACTION	
Parameter	Data

Description of release source:

Emissions from plastic products manufacturing come from a variety of sources and are highly dependent upon the chemical makeup of the raw materials (resins, additives) and types of production processes used. In addition, the diverse nature of these raw materials and manufacturing techniques results in a wide range of potential combinations of emission sources and pollutants. The primary sources of emissions at plastic products manufacturing facilities are the pieces of equipment (e.g., extruder hopper, die head, sander) used to handle raw materials and produce the final product. These are typically the locations where chemical reactions occur, liquid solvents and solvent blends are exposed to the atmosphere, solid resin is heated and melted, and additives are introduced. In addition to emissions generated directly from primary production processes associated with plastic products manufacturing, there may be additional emissions produced by secondary processes at these facilities. Emission sources from these secondary processes include storage tanks, equipment leaks, wastewater treatment, combustion sources, and cleaning and surface coating operations. There are multiple processes occurring at plastic products manufacturing facilities that give rise to a wide variety of pollutants. Emissions from plastic products manufacturing may be generally classified as follows: - Volatile organic compound (VOC) and hazardous air pollutant (HAP) emissions resulting from the volatilization of free monomer or solvent in the primary polymer blend during processing; - VOC and HAP emissions that result from secondary process materials, such as blowing agents, additives, and lubricants (mold release compounds); - VOC, HAP, and particulate matter (PM) emissions that result from byproducts formed by chemical reactions or formed during heating of resins; and - PM emissions generated during raw material handling and finishing operations. The following discussion provides additional information on some of the specific pollutants emitted from plastic products manufacturing facilities and the specific processes giving rise to emissions.

Free Monomer/Solvent Emissions of free monomer (a single molecule of a chemical used in a polymer) may occur when a solid resin is heated during extrusion, molding, or other processes. For example, one recent study found a monomer (styrene) to be the principle component of the emissions produced during the extrusion of acrylonitrile-butadiene-styrene (ABS) resins. Emissions of free monomer would also be expected from resins used in solvent form. Some resins may be handled using a solvent medium to store and transport the resin prior to processing. In this case, emissions would also come from the solvent used to suspend the resin prior to the polymerization step. Thermoset resins are often handled in monomer form prior to solidifying under heat or pressure, or reaction with a hardening agent to generate a solid polymer. For example, when curing of thermosets is accomplished during processing or when processing involves polymerization (such as when thermoset polyurethane elastomers are processed using reaction injection molding), substantial emissions of monomers are likely to be generated.

Secondary Process Materials In addition to the bulk polymer and additives used to form the plastic product, additional materials may be used to assist in lubrication, or, in the case of blowing agents used to manufacture foams, to decrease the density of the final product. Lubrication is used in molding and forming operations to prevent plastic material from sticking to mold surfaces. A mold release agent (lubricating or parting agent) is sprayed on a mold cavity surface in a thin waxy layer to facilitate the release or removal of the molded plastic form from the mold. Mold release agents contain carrier solvents (HAP-based and non-HAP based) that evaporate immediately when the mold release agent adheres to the mold cavity surface.

Blowing Agents Emissions also occur from blowing agents used to manufacture certain foams. In expanded polystyrene (EPS) bead manufacturing, the blowing agent is typically contained in the raw polymer beads as they come from the supplier. This causes the beads to expand when exposed to heat. There are three general classes of emissions from this type of foam production: manufacturing emissions; prompt foam cell losses, which are losses that typically occur during storage and shipping; and banked emissions, which are losses that occur through slow diffusion of blowing agents out of the foam over the life of the product. Another type of polystyrene foam is extruded polystyrene foam sheet (PSF). Pentane is the predominant hydrocarbon blowing agent used to manufacture PSF. After extrusion, sheets of intermediate product are wound into rolls and aged for 3 to 5 days. After aging, the sheets are thermoformed into consumer products and packaged for shipment. Typically 50 percent of the blowing agent is lost during the manufacturing and reclaim operations and the remainder as fugitives during warehousing, transportation, and after the product is sold. In the manufacture of polyurethane foams, large quantities of auxiliary blowing agents are used to reduce foam density. The use of these blowing agents (predominantly methylene chloride or chlorofluorocarbons) does not involve any chemical reactions, but is merely a change of the physical state of the blowing agent. Volatilization of the auxiliary blowing agent from liquid to gas provides the volume needed to increase the number and size of foam cells. One recent study estimates that approximately 60 percent of methylene chloride is lost within the first 10 minutes of the process and the remaining 40 percent is lost slowly by diffusion over the next 24 hours. The initial bulk of emissions are typically released through process vents located at the foaming equipment, while the remaining 40 percent of emissions are released fugitively while the foam is being transported and stored.

Chemical Reactions/Byproducts VOC and HAP emissions may be generated from chemical reactions occurring as a direct part of the process, as in the case of thermoset

Formaldehyde

Environmental Releases

HERO ID: 7349020 Table: 1 of 1

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Study Citation:	ERG, (1998). Air emissions inventories, volume 2: Point sources: Chapter 11: Preferred and alternative methods for estimating air emissions from plastic products manufacturing.			
HERO ID:	7349020			
Conditions of Use:	Chemical substances in plastic products			
Domain	Metric	EVALUATION Rating		Comments
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
Domain	Metric	EVALUATION Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA EIIP program
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The release data are for an occupational scenario(Plastic product manufacture) within the scope of the risk evaluation. Detailed information but not specific to formaldehyde
	Metric 4:	Temporal Representativeness	Low	1998 - more than 20 years old
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	N/A	Qualitative information provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination		Medium		

Study Citation:	Fauser, P., Illerup, J.B. (2008). Danish emission inventory for solvents used in industries and households. Atmospheric Environment 42(34):7947-7953.			
HERO ID:	1227924			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Description of release source:	Paint application, degreasing and dry cleaning, chemical products, manufacture and processing			
Release quantity:	In 2006: 503 (tonnes/year)			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Denmark, an OECD country.
	Metric 3:	Applicability	High	Data are for Paint application, degreasing and dry cleaning, chemical products, manufacture and processing, in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old. (1994)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing waste treatment methods.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Ferranti, M. M. (2001). Formaldehyde biological removal from exhaust air in the composite panel board industry - from pilot tests to industrial plant operation. :165-176.			
HERO ID:	5945201			
Conditions of Use:	Composite Panel Board Industry			
EXTRACTION				
Parameter	Data			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory emission limits, industry/ process technologies) may impact releases relative to the U.S.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	he release data were collected after the most recent federal regulatory action or update but are generally, more than 10 years old. If no federal regulation is established, the data are more than 10 years but no more than 20 years old. However, operations, equipment, and worker activities are expected to be reasonably representative of current conditions.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.
Overall Quality Determination			High	

Study Citation:	Forintek Canada Corp, (1983). The report of the technical mission on formaldehyde release control measures from particleboard in selected Scandinavian and European countries with cover letter 010986.
HERO ID:	5901048
Conditions of Use:	Particleboard mfg

EXTRACTION

Parameter	Data
Description of release source:	Resin used in particleboards manufacturing
Release quantity:	Summary of emission Levels from the Federal Republic of Germany: Emission Class – E1, Emission level – max. 0.1 ppm, Perforator value - < 10 mg/100 g of sample; Emission Class – E2, Emission level – >0.1-1.0 ppm, Perforator value - < 10 – 30 mg/100 g of sample; Emission Class – E3, Emission level – >1.0 – 2.3 ppm, Perforator value - < 30 – 45 mg/100 g of sample. The E3 class was proposed to be eliminated in 1984. In 1986, nearly 50 percent of the boards produced in Germany is E-1 class.
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High release data methodology is known or expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low data is more than 20 years old
	Metric 5:	Sample Size	Low characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low The release data study does not address variability or uncertainty.

Overall Quality Determination**Low**

Study Citation:	Friedrich, R., Obermeier, A. (1999). Chapter 1: Anthropogenic emissions of volatile organic compounds. :1-39.			
HERO ID:	6201718			
Conditions of Use:	processing into chipboard			
EXTRACTION				
Parameter	Data			
Description of release source:	Various anthropogenic sources of VOCs (including formaldehyde) application of volatile organic solvents and solvent-containing products; industrial production processes; and biological processes. VOC emissions from the production of chipboard are released during drying, bonding, and pressing of the wood shavings. The process emissions consist mainly of terpenes and aldehydes (especially formaldehyde).			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is known or expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data is more than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainty but limited discussion on variability
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 6201718 Table: 2 of 2

Study Citation: Friedrich, R., Obermeier, A. (1999). Chapter 1: Anthropogenic emissions of volatile organic compounds. :1-39.
HERO ID: 6201718
Conditions of Use: Produced during Combustion

EXTRACTION

Parameter	Data
Description of release source:	Various anthropogenic sources of VOCs (including formaldehyde) are combustion processes (internal combustion engine vehicles, combustion plants, and furnaces); production, treatment, storage, and distribution of fossil fuels;
Release quantity:	Formaldehyde emissions (mass percentages) from internal combustion engines are: 1.5 for Otto engine, 4-stroke without catalyst; 1.0 for Otto engine, 4-stroke three-way catalyst; 0.6 for Otto engine, 2-stroke without catalyst; and 8.1 for diesel engine. Formaldehyde emissions (mass percentages) from combustion installations are: 1.5 for wood and 1.8 for gas.
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	release data methodology is known or expected to be accurate
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	data are from an OECD country other than the U.S
	Metric 3: Applicability	Uninformative	release data are for an occupational scenario not within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	data is more than 20 years old
	Metric 5: Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	no discussion on uncertainty but limited discussion on variability

Overall Quality Determination **Uninformative**

Study Citation:	FWIC, (2020). Comments of the Federal Wood Industries Coalition regarding the draft scope of the risk evaluation for formaldehyde (comment submitted by Jackson Morrill).			
HERO ID:	10370211			
Conditions of Use:	Commercial Use, Building/ construction materials (wood and engineered wood products)			
EXTRACTION				
Parameter	Data			
Description of release source:	"It has long been recognized that wood, as it comes from a tree, contains no added formaldehyde, but can emit some small amounts of naturally occurring formaldehyde. Although emissions are accentuated when the wood is subjected to very high temperatures, such as during pressing of the furnish in composite wood panel manufacturing or in artificial laboratory conditions, they can be measured under normal conditions of use. As noted by Salem et al.:Formaldehyde is also detectable even if wood has never been heated as well as under more or less ambient conditions. The presence of formaldehyde in the emissions from wood that does not contain adhesive resin has been explained bythermal degradation of polysaccharides in the wood. The emission levels of formaldehyde depend on factors such as wood species, moisture content, outside temperature, and time of storage." (page 13-14 of 17)			
Release quantity:	See page 14 for a table that shows an analysis for formaldehyde emissions from a variety of species of trees with different characteristics using various test methodologies:			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	From USA	
	Metric 3: Applicability	Medium	The release data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.	
	Metric 4: Temporal Representativeness	Low	Data from 1996	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.	
Overall Quality Determination		Medium		

Study Citation:	García, C.A., Manzini, F., Islas, J. (2010). Air emissions scenarios from ethanol as a gasoline oxygenate in Mexico City Metropolitan Area. Renewable and Sustainable Energy Reviews 14(9):3032-3040.			
HERO ID:	919969			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Description of release source:	Motor vehicles including private automobiles, taxis, SUV, pick-up, micro-buses, 3t vehicles, trucks, buses, >3t vehicles, and motorcycles			
Release quantity:	Estimated annual toxic air emissions from the gasoline on-road motor vehicle fleet ranged between 3,300 tonnes and 3,800 tonnes in 2010 for 4 different fuel types (MTBE5, E10, ETBE13.7, and E6). E10 had the lowest emissions and MTBE5 had the highest.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	release data methodology is expected to be accurate but may not cover all release sources
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Low	release data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	data is between 10 and 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	addresses variability and uncertainties
Overall Quality Determination		Medium		

Study Citation:	Gardner, D.J., Wang, W. (1999). Investigation of volatile organic compound press emissions during particleboard production. 1. UF-bonded southern pine. Forest Products Journal 49(3):65-71.			
HERO ID:	6026160			
Conditions of Use:	Building/construction materials - wood and wood engineered products			
EXTRACTION				
Parameter	Data			
Description of release source:	Particleboard emissions			
Release quantity:	221.6 (mg/kg OD board)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The release data methodology is known or expected to be accurate.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.	
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The data were collected before the most recent federal regulatory action or update or are more than 20 years old if no federal regulation is established.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source ofthe release.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Geivanidis, S., Pistikopoulos, P., Samaras, Z. (2003). Effect on exhaust emissions by the use of methylcyclopentadienyl manganese tricarbonyl (MMT) fuel additive and other lead replacement gasolines. Science of the Total Environment 305(1-3):129-141.			
HERO ID:	36871			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Description of release source:	In the case of the non-catalyst car, the shift from leaded to unleaded gasoline was associated with an increase in benzene and formaldehyde emissions, a trend probably attributable to the increased aromatics content of the lead replacement fuels.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from Germany (an OECD country other than the U.S.) and include locality-specific factors (i.e., vehicle equipment and fuel) that may impact releases relative to the U.S.
	Metric 3:	Applicability	High	Data are for fuel and fuel additives, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	The release data were collected after the most recent federal regulatory action or update but are generally, more than 10 years old. Published in 2003.
	Metric 5:	Sample Size	Low	Data characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata (i.e., conventional vs. non-catalyst car) but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Gerlock, J.L., Dean, M.J., Korniski, T.J., Bauer, D.R. (1986). Formaldehyde release from acrylic/melamine coatings during photolysis and the mechanism of photoenhanced cross-link hydrolysis. Industrial and Engineering Chemistry Product Research and Development 25(3):449-453.			
HERO ID:	5951210			
Conditions of Use:	emission			
EXTRACTION				
Parameter	Data			
Description of release source:	Condensation of melamine methylol groups was found to yield melamine-melamine cross-links, releasing formaldehyde as a byproduct.			
Release quantity:	Measured formaldehyde release rate ranged between 0 to 1.5 x 10^-8 mol/(g min). The release rate of formaldehyde from triisocyanate crosslinked acrylate copolymer is zero, within experimental error, implying that all formaldehyde released during photolysis of acrylic/melamine coating arises from the melamine formaldehyde cross-linker and not the acrylate copolymer.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	methodology is known or expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data is greater than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Ghadikolaie, M.A. (2016). Effect of alcohol blend and fumigation on regulated and unregulated emissions of IC engines-A review. Renewable and Sustainable Energy Reviews 57:1440-1495.
HERO ID:	3265402
Conditions of Use:	Automobile Exhaust

EXTRACTION

Parameter	Data
Description of release source:	Releases from vehicle exhaust fumes and the emission rates varied by ethanol blend
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data is for China, a non-OECD country.
	Metric 3: Applicability	Uninformative	Data is for vehicle exhaust emissions so is not contained in an occupational COU
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old (2016)
	Metric 5: Sample Size	Medium	Characterized by statistics (mean +/- SD)
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Only includes release source and emission factors
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Addresses variability by looking at different vehicles and different mixing blends. Does not address uncertainty.

Overall Quality Determination	Uninformative

Formaldehyde

Environmental Releases

HERO ID: 1697561 Table: 1 of 1

Study Citation:	Gonzalez-Garcia, S., Feijoo, G., Widsten, P., Kandelbauer, A., Zikulnig-Rusch, E., Moreira, M. (2009). Environmental performance assessment of hardboard manufacture. International Journal of Life Cycle Assessment 14(5):456-466.			
HERO ID:	1697561			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Release quantity:	LCA 0.149 kg/m3 of finished hard board			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	The release data methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Austrian hardboard plant was studied. Austria is an OECD member country.
	Metric 3:	Applicability	High	The release data are for a hardboard wet process plant which is n occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The data were published in 2009, after the most recent PEL (1992) and more 10 but less than 20 years old.
	Metric 5:	Sample Size	Low	only a single emission factor was provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Metadata included release media but lacked additional metadata, such as process, unit operation, release frequency, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Low	

Formaldehyde

Environmental Releases

HERO ID: 5950815 Table: 1 of 1

Study Citation:	Greeson, H. K., Jr, Browning, K. J., Farrell, J. D. (2012). Formaldehyde reduction for durable press cotton fabrics. AATCC Review 13(3):36-40.			
HERO ID:	5950815			
Conditions of Use:	Processing - textile finishing			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde is released from durable-press fabrics.			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for textile finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release media provided but not release frequency or amounts.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by using two types of formaldehyde scavengers, but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Grigsby, W., Tohmura, S.I., Miyamoto, K. (2018). Assessing panelboard volatile organic compound emission profiles through renewables use. Forest Products Journal 68(4):359-364.		
HERO ID:	5964529		
Conditions of Use:	Chemical substances in construction (wood products)		
EXTRACTION			
Parameter	Data		
Description of release source:	In panelboard manufacture, the wood furnish is typically heated below 200C via rapid hot pressing, with this process potentially liberating a range of organic compounds either by volatilization or decomposition. These emissions may be released on pressing or retained within the wood matrix to potentially migrate from the panelboard with time.		
Release quantity:	Formaldehyde, a key compound in panelboard emissions, was found to be higher in soy panels (1,470 ug/m3) compared with pressing veneer (460 ug/m3).		
Comments:	Gas emissions produced during panel hot pressing and consolidation were captured, segregated, and chemically analyzed.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., veneer sourced from Japan, corn gluten meal sourced from New Zealand) may impact releases relative to the U.S.
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability addressed by [describe variability, e.g., soy and zein proteins together with a kraft lignin and condensed tannin extract], but uncertainty is not addressed.
Overall Quality Determination		Medium	

Formaldehyde

Environmental Releases

HERO ID: 6032329 Table: 1 of 1

Study Citation:	Grimaldi, F., Bacle, D., Viala, A. (1995). Emissions of carbonyl compounds from vehicles fuelled with different gasolines. Indoor Environment 4(5):297-301.			
HERO ID:	6032329			
Conditions of Use:	Vehicle emissions			
EXTRACTION				
Parameter	Data			
Description of release source:	Engine sources with and without catalytic converters.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known and appears to contain high quality data but it would not cover all releases at a site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for France, an OECD country.
	Metric 3:	Applicability	Low	Data is applicable to vehicle emissions from incomplete combustion of fuel (i.e., byproduct formation).
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1995)
	Metric 5:	Sample Size	Medium	Characterized by a range of data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes chemical concentration/emission output, description of release source, and some pollution control.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability is addressed by testing different conditions (i.e., with ot without converter, different engines, and fuel). Uncertainty is not discussed.
Overall Quality Determination			Low	

Study Citation:	Guo, H., Murray, F., Lee, S.C. (2002). Emissions of total volatile organic compounds from pressed wood products in an environmental chamber. Building and Environment 37(11):1117-1126.			
HERO ID:	4263176			
Conditions of Use:	Wood Products			
EXTRACTION				
Parameter	Data			
Description of release source:	Medium-density fibreboard, hardwood plywood paneling, particleboard, softwood plywood (Table 5, pg 8)			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S. (secondary source)	
	Metric 3: Applicability	High	Data are for wood products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old (secondary source).	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release media provided but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by comparing these emission values (via secondary source) to the TVOC values obtained from the study. Variability is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Gustafsson, O., H.N. (1986). Measurements of formaldehyde release from building-materials in a ventilated test chamber. ACS Symposium Series 316:145-153.			
HERO ID:	5937396			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Description of release source:	Offgassing			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by testing a variety of wood products and uncertainty are not addressed.
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 5937396 Table: 2 of 3

Study Citation:	Gustafsson, O., H.N. (1986). Measurements of formaldehyde release from building-materials in a ventilated test chamber. ACS Symposium Series 316:145-153.			
HERO ID:	5937396			
Conditions of Use:	Use of Floor coverings			
EXTRACTION				
Parameter	Data			
Description of release source:	Off-gassing			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Sweden, an OECD country.	
	Metric 3: Applicability	High	Data are for floor coverings and furnishings, in-scope occupational scenarios.	
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized/	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All metadata provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability is addressed by sampling a variety of wood products but uncertainty is not addressed.	
Overall Quality Determination		High		

Formaldehyde

Environmental Releases

HERO ID: 5937396 Table: 3 of 3

Study Citation:	Gustafsson, O., H.N. (1986). Measurements of formaldehyde release from building-materials in a ventilated test chamber. ACS Symposium Series 316:145-153.			
HERO ID:	5937396			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Description of release source:	Off-gassing			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Sweden, an OECD country.	
	Metric 3: Applicability	High	Data are for floor building materials, in-scope occupational scenarios.	
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized/	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All metadata provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability is addressed by sampling a variety of wood products but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Gutierrez, R.C., Valenzuela, L., Wilson, H.P. (2018). Mechanical Properties and Formaldehyde Release of Boards Manufactured with Hygrothermally Treated Tapa (Laureliopsis Philippians Looser) Particles. Drvna Industrija 69(2):113-120.		
HERO ID:	5966866		
Conditions of Use:	Building and construction materials (particleboard)		
EXTRACTION			
Parameter	Data		
Description of release source:	UF resin in particleboard		
Release or emission factors:	nan		
Waste treatment methods and pollution control:	nan		
Comments:	media: fugitive air. Table 3 (pg 6): untreated (8.2% moisture) - 17.1 and 13.2 mg/100g uncorrected and corrected values, respectively; treated (6.2% moisture) - 9.8 and 10.1 mg/100g uncorrected and corrected values, respectively. Estimation method: "This was conducted according to the perforator method (EN 120, 1992). Three samples of the average nominal board density were analysed. The perforator value was corrected in accordance with EN 312 (2010). (pg 3)"		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium Data are from Ecuador and Chile, the latter being an OECD country
	Metric 3:	Applicability	High Data are for building/construction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium Sample distribution characterized by limited statistics (average) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High All metadata (regarding emission factors) provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium Variability addressed by studying emissions from treated and untreated wood, but uncertainty is not addressed.
Overall Quality Determination		High	

Formaldehyde

Environmental Releases

HERO ID: 6233209 Table: 1 of 1

Study Citation: Handlos, V. (1984). Technical aspects of gaseous formaldehyde as a sterilant. Biomaterials 5(2):81-85.
HERO ID: 6233209
Conditions of Use: Use

EXTRACTION

Parameter	Data
Description of release source:	Autoclaves used for sterilization of hospital equipment. Four hospital autoclaves, ranging in size from 20 I to5 m3 fell into two groups according to their formaldehyderelease. Three of them showed concentrations from 2.5 to3.5 ppm both in loaded and unloaded conditions. Oneautoclave, volume 300 I, varied between 0.03 ppm inunloaded condition and 0.9 ppm when loaded with fourlab coats.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Denmark, an OECD country.
	Metric 3: Applicability	Uninformative	Data are for use as a sterilizer, which is not in-scope or similar to an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges, graphs) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release media provided but not release frequency or amounts.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability isn't addressed.

Overall Quality Determination

Uninformative

Study Citation:	Hargis, K. M., Tillery, M. I., Ettinger, H. J., Brandt, M. T., Sherman, R. J., Wheat, L. D. (1986). Industrial hygiene study of a true in-situ oil shale retorting facility. American Industrial Hygiene Association Journal 47(8):455-464.			
HERO ID:	2130334			
Conditions of Use:	”Processing aids, specific to petroleum production in: oil and gas drilling, extraction, and support activities and all other basic inorganic chemical manufacturing”			
EXTRACTION				
Parameter	Data			
Description of release source:	small crack in the surface of the overburden above Retort 24 and near the leaking offgas fan			
Release quantity:	formaldehyde concentration in the above emission source was found to be 2 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	data methodology is not fully specified
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data (oil shale retorting facility near Vernal, Utah)
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	Low	no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Harper, R.J., Andrews, B.A., Harris, J.A., Reinhardt, R.M., Vail, S.L., Bathija, A.P., Ulsamer, A.G. (1984). Formaldehyde release from labeled and unlabeled cross-linked cotton and cotton-polyester fabrics.			
HERO ID:	5950203			
Conditions of Use:	Fabric/Textile			
EXTRACTION				
Parameter	Data			
Description of release source:	Cross-linked cotton and cotton-polyester (50/50) fabrics treated with unisolated dimethyloldihydroxyethyleneurea (DMDHEU) prepared by either two- or three-component synthesis using formaldehyde. The conditions evaluated included laundering fabrics with and without chlorine bleach and drying them under various conditions; exposing fabrics to a carbon arc after tumble-drying; laundering fabrics 5, 10, 15, or 25 times and tumble-drying; and storing samples for 1, 2, 3, or 12 months.			
Release quantity:	Formaldehyde releases (p/m) from unlabeled 3-component all-cotton fabric were 513 (sealed jar test) and 16 (cold Na2SO4). Formaldehyde releases (p/m) from unlabeled 3-component 50/50 cotton-polyester fabric were 464 (sealed jar test) and 13 (cold Na2SO4). Formaldehyde releases (p/m) from unlabeled 2-component all-cotton fabric were 605 (sealed jar test) and 15 (cold Na2SO4). Formaldehyde releases (p/m) from radiolabeled 3-component all-cotton fabric were 237 (sealed jar test) and 14 (cold Na2SO4). Formaldehyde releases (p/m) from radiolabeled 3-component 50/50 cotton-polyester fabric were 173 (sealed jar test) and 11 (cold Na2SO4). Formaldehyde releases (p/m) from radiolabeled 2-component all-cotton fabric were 589 (sealed jar test) and 11 (cold Na2SO4). Formaldehyde release measured for unlabeled 100% cotton fabric for different processing conditions were: after 5, 10, 15, and 25 launderings and tumble-dry – 316 to 177 p/m; tumble-dried and hang in locker for 1, 2, 3, and 12 months – 358 to 138 p/m; and other similar conditions. In general, the laundering and storage tests showed declining values of formaldehyde release with laundering or storage, whether measured by the cold sodium sulfite method or the sealed-jar method. However, there were exceptions in the values for the cold sodium sulfite method after the spin-dry cycle of the wash (before drying), after exposure to a carbon arc, and after laundering five times. The latter instance was unexpected and needs further verification. By contrast, sealed-jar values decreased in almost every instance, when compared with original sample values, during laundering or storing of samples.See Tables 1 - 7 for more info			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
Continued on next page ...				

Formaldehyde

Environmental Releases

HERO ID: 5950203 Table: 1 of 1

...continued from previous page			
Study Citation:	Harper, R.J., Andrews, B.A., Harris, J.A., Reinhardt, R.M., Vail, S.L., Bathija, A.P., Ulsamer, A.G. (1984). Formaldehyde release from labeled and unlabeled cross-linked cotton and cotton-polyester fabrics.		
HERO ID:	5950203		
Conditions of Use:	Fabric/Textile		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Formaldehyde

Environmental Releases

HERO ID: 658817 Table: 1 of 1

Study Citation:	Hart, J.R. (1994). Comparison of emissions from burning hazardous waste in a dry-process cement kiln with emission from burning conventional fossil fuels. Hazardous Waste and Hazardous Materials 11(1):193-199.			
HERO ID:	658817			
Conditions of Use:	Combustion Byproduct			
EXTRACTION				
Parameter	Data			
Description of release source:	products of incomplete combustion in cement kiln			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The methodology is expected to be accurate.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	Data are for hazardous waste combustion which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data are greater than 20 years and prior to the PEL- Article published in 1994 but the test data are from 1982, 84, 89/90.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Release media and process/unit operation provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Hearn, D. (1995). Health Risks Due to Motor Vehicle Emissions in Melbourne. Clean Air 29(2):37.			
HERO ID:	5773789			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter		Data		
Description of release source:		Formaldehyde is present in the exhaust of both petrol and diesel-fueled vehicles as a result of the incomplete combustion of the fuel		
Release quantity:		Mass emission rates (g/km) of formaldehyde per VKT for the 1990 and 2005 Melbourne vehicle fleet: 1990 emission rate – 0.052, 2005 emission rate – 0.021 – 0.026. Estimated maximum annual average formaldehyde concentrations (ug/m3) in Melbourne: 1990 maximum concentration – 1.8, 2005 maximum concentration – 1.0 – 1.2		
Release or emission factors:		Release or emission factors		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Medium	release data methodology is known or expected to be accurate but may not cover all release sources at the site
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	data are from an OECD country other than the U.S
		Metric 3: Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
		Metric 4: Temporal Representativeness	Medium	data between 10 and 20 years old
		Metric 5: Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Hemmila, V., Meyer, B., Larsen, A., Schwab, H., Adamopoulos, S. (2019). Influencing factors, repeatability and correlation of chamber methods in measuring formaldehyde emissions from fiber- and particleboards. International Journal of Adhesion and Adhesives 95:102420.			
HERO ID:	6064683			
Conditions of Use:	FA emission from fiber and particle boards			
EXTRACTION				
Parameter	Data			
Description of release source:		There are multiple sources of formaldehyde to indoor air, which can be divided into temporary (e.g. combustion, cooking), intermitting (e.g. indoor chemistry, air cleaners) and permanent sources (e.g. building products and furniture). As wood-based boards, such as particleboards (PBs) and fiberboards (medium density-MDF and high density-HDF), are one of the main permanent formaldehyde sources to indoor air. Formaldehyde-based glues are not the only cause of formaldehyde emissions from wood-based boards. Wood itself has natural formaldehyde emissions that increase depending on the processing procedure.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Data is peer reviewed so contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data less than 10 years old (2019).
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Hemmila, V., Zabka, M., Adamopoulos, S. (2018). Evaluation of Dynamic Microchamber as a Quick Factory Formaldehyde Emission Control Method for Industrial Particleboards.		
HERO ID:	5964974		
Conditions of Use:	Multiple		
EXTRACTION			
Parameter	Data		
Description of release source:	Emission from 1 day and 7 day particle board		
Release or emission factors:	Release or emission factors		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The release methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Sweden, an OECD-country
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Data are generally more than 10 years old (2018), and particleboard was manufactured after Title VI to the Toxic Substances Control Act.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. Uncertainty is briefly discussed.
Overall Quality Determination		Medium	

Study Citation:	Hesterberg, T.W., Lapin, C.A., Bunn, W.B. (2008). A comparison of emissions from vehicles fueled with diesel or compressed natural gas. Environmental Science and Technology 42(17):6437-6445.
HERO ID:	106731
Conditions of Use:	Automobile Exhaust

EXTRACTION

Parameter	Data
Description of release source:	Transit bus exhaust
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Low	Compilation of other reports so background details are limited
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	Data are for transit bus exhaust is an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Published 2008
	Metric 5: Sample Size	High	Mean, standard error, number of samples and significance testing was included
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Baseline diesel data along with us of PM Trap, three way catalyst, oxidation catalyst and CNG data are provided
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Standard error is included but nothing on uncertainty

Overall Quality Determination

Medium

Formaldehyde

Environmental Releases

HERO ID: 6023394 Table: 1 of 1

Study Citation:	Higgins, F.B., Lee, J.A., Morris, R.B., Newirth, R., Pervier, J.W. (1975). Engineering and cost study of air pollution control for the petrochemical industry: Volume 4: Formaldehyde manufacture with the silver catalyst process.
HERO ID:	6023394
Conditions of Use:	emission

EXTRACTION

Parameter	Data
Description of release source:	production of formaldehyde
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	Atmospheric emissions generated by the silver catalyst process are associated primarily with the absorber vent gas stream. Minor quantities of hydrocarbons may be discharged by steam ejectors on the product fractionator. National Emissions Inventory

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	data is expected to be accurate
Domain 2: Representativeness	Metric 2: Geographic Scope	High	data are from the United States
	Metric 3: Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	data is more than 20 years old
	Metric 5: Sample Size	N/A	Source and treatment of emissions information
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	N/A	Source and treatment of emissions information
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	release data study does not address variability or uncertainty

Overall Quality Determination

Medium

Formaldehyde

Environmental Releases

HERO ID: 6023376 Table: 1 of 1

Study Citation:	Higgins, F.B., Lee, L.A., Morris, R.B., Newirth, R., Pervier, J.W. (1975). Engineering and cost study of air pollution control for the petrochemical industry: Volume 5. Formaldehyde manufacture with the mixed oxide catalyst process.			
HERO ID:	6023376			
Conditions of Use:	emission			
EXTRACTION				
Parameter	Data			
Description of release source:	Production of formaldehyde			
Release quantity:	Limited data is available for emissions. Reported emissions via absorber vents was 132,280 lbs/hr, and via tank vent was 0.07 lbs/hr.			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data is greater than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 5966944 Table: 1 of 1

Study Citation:	Holme, I. (1993). New developments in the chemical finishing of textiles. Journal of the Textile Institute 84(4):520-533.
HERO ID:	5966944
Conditions of Use:	fabric finishing

EXTRACTION

Parameter	Data
Description of release source:	free formaldehyde, formaldehyde hydrolytically released from finishing treatment (pg 4)
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	media: fugitive air.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low Methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium Data are from the UK, and OECD country.
	Metric 3:	Applicability	High Data are for fabric finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low Data are greater than 20 years old.
	Metric 5:	Sample Size	Low Sample distribution is characterized by no statistics (single values pulled from secondary sources).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium Variability addressed by discussing various treatment chemicals/techniques, but uncertainty is not addressed.

Overall Quality Determination	Low

Study Citation:	Hornby, S. B., Kamath, Y. K., Weigmann, H. D. (1983). Factors controlling formaldehyde release from durable press fabrics. :134-138.			
HERO ID:	6194763			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Description of release source:	Durable press (DP) effects are usually imparted to cotton fabrics by crosslinking the cotton cellulose with a variety of compounds containing formaldehyde.			
Release or emission factors:	Commercial processes generally result in fabrics having some free formaldehyde remaining in the finished product. Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for textile finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Results are characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing release quantity, waste treatment, number of sites, and release days/year.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	HPVA, (1985). Formaldehyde emissions chracteristics of 3-ply veneer core hardwood plywood 1984 - 1985 with cover letter dated 072985.			
HERO ID:	5901014			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde emissions from hardwood plywood and certain other wood panel products. The data is confined to 3-ply veneer core type hardwood plywood, the primary construction used for hardwood plywood wall panels.			
Release quantity:	The hardwood plywood paneling formaldehyde desiccator values (ug/ml), as obtained from the Clayton Environmental consultants report, provides desiccator values for six panels from each of two different hardwood plywood populations. The average desiccator value for higher plywood group is 1.99 +/- 0.78 ug/ml, and the average desiccator value for lower plywood group is 0.43 +/- 0.18 ug/ml. Hardwood plywood paneling formaldehyde emission rates (mg HCHO/m2 h) are: Interboard averages ranged between 0.075 and 0.474. Formaldehyde emission characteristics of 3-ply hardwood plywood (June 1984 to late June 1985) were between 0.1 and 1.37 ug/ml for 72 samples.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	release data is expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data is greater than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
Overall Quality Determination		Medium		

Study Citation:	Hse, C. Y. (1998). Overview of the wood adhesives industry in China. :48-51.			
HERO ID:	5937019			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Description of release source:	MDF and particleboard			
Release quantity:	Property acceptance ratio of MDF and particleboard in China from formaldehyde emission were 43% in 1995 and 75% in 1997 for MDF, and 78% in 1995 for particleboard.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Release data methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data is from an non-OECD country.	
	Metric 3: Applicability	High	Release data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Data is greater than 20 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data does address variability between different years but does not address uncertainty.	
Overall Quality Determination		Low		

Study Citation:	Huang, L., Anastas, N., Egeghy, P., Vallero, D.A., Jolliet, O., Bare, J. (2019). Integrating exposure to chemicals in building materials during use stage. International Journal of Life Cycle Assessment 24(6):1009-1026.			
HERO ID:	5964979			
Conditions of Use:	Use as chemical substance in wood products in Homes			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Low	The article applies to exposure in homes, which may be similar to exposure at commercial places.
	Metric 4:	Temporal Representativeness	High	Article is from 2018.
	Metric 5:	Sample Size	N/A	Release calculated by models, no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source ofthe release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Disposal- Incinerators			
EXTRACTION				
Parameter	Data			
Description of release source:	Incineration of general waste			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The release data methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Assumed to be US as it is referenced to an EPA document	
	Metric 3: Applicability	Low	The release data are for disposal-incinerators which is an occupational scenario within the scope of the risk evaluation, however, its for mixed waste and may include emissions due to formaldehyde byproduct formation which is out of scope. In addition, output from environmental monitoring for incineration is covered in general population assessment.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is not characterized by statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	absorber vents of formaldehyde produc-tion processes in which metal oxide catalysts are used			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	The release data methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Assumed data is U.S data based on source (Kitchens et al., 1976)
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent federal regulatory action or update or are more than 20 years old if no federal regulation is established. The operations, equipment, and worker activities are not available or indicate that the associated data are expected tobe outdated.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:		IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.		
HERO ID:		27010		
Conditions of Use:		Processing as a reactant		
		EXTRACTION		
Parameter		Data		
Description of release source:		Effluent from processing facilities		
Release or emission factors:		Release or emission factors		
		EVALUATION		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	Low	The release data methodology is not specified.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Environmental Releases

HERO ID: 27010 Table: 4 of 4

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Other Sources			
EXTRACTION				
Parameter	Data			
Description of release source:	Combustion Sources			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The release data methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Assumed to be US as it is referenced to an EPA document	
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were from before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is not characterized by statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	ICFI, (1985). Production and use of formaldehyde containing resins and options for controlling formaldehyde release from durable-press fabrics.			
HERO ID:	5901058			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Description of release source:	durable press fabrics			
Release quantity:	Emission of formaldehyde was reported to be around 100 ppm from treated fabrics in 1983. Use of DMDHEU resin yields a formaldehyde release from fabric between 500 and 1,500 kg/g (or ppm). Alternate formaldehyde resins reduce this release to below 100 to 300 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data is more than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata presented
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Inoue, A., Ono, H.K., Chiba, Y. (1991). Prediction of formaldehyde concentrations in air originating from wood-based materials: Comparison of desiccator method with chamber method and perforator method. Bulletin of the Forestry and Forest Products Research Institute 0(360):21-34.			
HERO ID:	6008525			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD Country.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range (in graph form) with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in the standards used in the report. Variability isn’t addressed.
Overall Quality Determination			Medium	

Study Citation:	IPC International, (2019). IPC presentation to EPA on formaldehyde in the electroless copper plating process.			
HERO ID:	10370204			
Conditions of Use:	Electroless copper plating			
EXTRACTION				
Parameter	Data			
Release quantity:	”According to EPA’s 2018 TRI survey, the electronics industry releases represent <0.014% of total reported on-site releases. Of the 715 facilities exceeding TRI’s formaldehyde reporting threshold: 9 were readily identified as associated with PCB manufacturing; combined off-site releases for these 9 facilities totaled 2,608 lbs.” pg. 9/10			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The report references TRI for release quantity, however, this may not include smaller sites below the reporting threshold.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data is from within the last ten years.
	Metric 5:	Sample Size	Medium	The report references TRI for release quantity, however, this may not include smaller sites below the reporting threshold.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	The report references TRI for release quantity, however, this may not include any meta-data or site info needed.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 2866133 Table: 1 of 1

Study Citation:	Jiang, H., Yu, H.Q., Guo, Q.X. (2007). Extraction-oxidation-adsorption process for treatment of effluents from resin industries. Industrial and Engineering Chemistry Research 46(6):1667-1671.			
HERO ID:	2866133			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Release quantity:	28.8 kg/hr =[1200 mg/L Formaldehyde x 24 m3/h x 1000L/m3]			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site but unclear information on measurement of flow rate.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	China, non-OECD country
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	the data are more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Low	Unclear if multiple measurements were taken.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data includes media, resulting process, and concentration. Lacks further information on measuring flow.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Jiang, T., Gardner, D.J., Baumann, M.G. (2002). Volatile organic compound emissions arising from the hot-pressing of mixed-hardwood particleboard. Forest Products Journal 52(11-12):66-77.		
HERO ID:	2863296		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Description of release source:	Particleboard mills		
Release quantity:	Researchers have extrapolated that an annual production of 265,000 m3 releases approximately 20 tons/yr. of formaldehyde emissions. Amount of formaldehyde emissions (mg/kg OD board) from hardwood-adhesive furnish and neat hardwood are as follows: urea-formaldehyde - 396.6 +/- 17.5; phenol-formaldehyde - 8.3 +/- 1.3; polymeric methylene diisocyanate resin - 0.3 +/- 0.3; Wood-only panels with no resin but pressed similar to panels with urea-formaldehyde and polymeric methylene diisocyanate resin - 1.0 +/- 0.5; Wood-only panels with no resin but pressed similar to panels with phenol-formaldehyde - 1.2 +/- 0.4.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	release data methodology is known or expected to be accurate
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	data are more than 10 years but no more than 20 years old
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	no discussion on uncertainties
Overall Quality Determination		High	

Study Citation:	John, C., Friedrich, R., Staehelin, J., Schlapfer, K., Stahel, W. A. (1999). Comparison of emission factors for road traffic from a tunnel study (Gubrist tunnel, Switzerland) and from emission modeling. Atmospheric Environment 33(20):3367-3376.			
HERO ID:	10590			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Description of release source:	traffic emission			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The model is not an EPA approved model and though little is said about sampling, the analysis was performed using gas chromatography (specifics not provided)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Switzerland - OECD member
	Metric 3:	Applicability	Low	A comparison was performed between the Stuttgart model and EPA MOBILE4.1 and 5. they found the results to be similar, but no details were provided.
	Metric 4:	Temporal Representativeness	Low	This study includes vehicles that were older than 1995. much has changed regarding, fuels, fuel consumption rates and even vehicle weight that make the emission factors presented a upper bound value.
	Metric 5:	Sample Size	Low	It is noted that European vehicles comply with a very different regulatory standards than US vehicles.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The graph includes error bars to show the range of possible values. And though there is a discussion of uncertainty in the study and measures taken to reduced the impact of the identified issues,
Overall Quality Determination		Low		

Study Citation:	Johnson, J. H. (1988). Automotive emissions. A:39-75.			
HERO ID:	31902			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The release data methodology is known or expected to be accurate and is known to cover allrelease sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The release data are for fuels and fuel additives (vehicle emissions) which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1988, before the most recent PEL (1992) and are more than 20 years old.	
	Metric 5: Sample Size	Medium	emission factors were provided as a range of values for different controls.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The study provided range of values for specific fuel and control options which can be used to assess variability; but nothing was provided on uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Jones, B.W., Turner, J.D., Snyder, L.G., Luparello, D.O. (1982). Formaldehyde finishing. Textile Research Journal 52(2):157-166.			
HERO ID:	5965785			
Conditions of Use:	Fabric finishing			
EXTRACTION				
Parameter	Data			
Description of release source:	Intro has data on PD that isnt experimental, most info/data in article on experimental procedures (pg 1)			
Release or emission factors:	nan			
Comments:	media: airFor example, some preliminary Cotton Incorporated trials on production-scale equipment showed that about three-quarters of the formaldehyde applied at 80% wet pickup (on dry weight of fabric) was lost during drying on steam-heated cans. Other workers [1] found about half of the formaldehyde applied with metal salt catalysts was lost during drying. Once dry, however, most of the remaining formaldehyde was retained during subsequent heat-curing and afterwashing. (pg 1)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The release data methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	Kado, N.Y., Okamoto, R.A., Kuzmicky, P.A., Kobayashi, R., Ayala, A., Gebel, M.E., Rieger, P.L., Maddox, C., Zafonte, L. (2005). Emissions of toxic pollutants from compressed natural gas and low sulfur diesel-fueled heavy-duty transit buses tested over multiple driving cycles. Environmental Science and Technology 39(19):7638-7649.
HERO ID:	88146
Conditions of Use:	Use of fuels and related products

EXTRACTION	
Parameter	Data
Release quantity:	The carbonyl emissions from CNG vehicles are primarily formaldehyde, with a total output approaching 1 g/mi (773 + - 256 mg/mi)for the CBD cycle. For ECD-fueled vehicles, formaldehyde was a smaller percentage of the total carbonyl emissions...For the CNG.1 vehicle following the SS driving cycle, the highest carbonyl emission was formaldehyde (78 mg/mi). (Table 6 has other details]
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan
Comments:	Gragg (Ref # 6) reported that the formaldehyde emissions from a CNG bus (equipped with oxidation catalyst) ranged from 6.7 to 23 mg/mi.

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	Data are for fuel and fuel additives, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	The release data were collected after the most recent federal regulatory action or update but are generally, more than 10 years old. Published in 2005.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata (i.e., bus type, driving cycles).
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.

Overall Quality Determination	High

Study Citation:	Kamath, Y.K., Weber, R.U., Hornby, S.B., Weigmann, H.D. (1985). Factors controlling formaldehyde release from durable press cotton. Textile Research Journal 55(9):519-529.			
HERO ID:	5945234			
Conditions of Use:	Fabric finishing			
EXTRACTION				
Parameter		Data		
Description of release source:		durable press fabrics		
Release or emission factors:		nan		
Comments:		media: fugitive air. ~5 $\mu\text{g/g}$ fabric (pg 6); other data presented throughout about extracting FA from fabric in aqueous media, as well as releases from fabrics treated with vapor formaldehyde, not really engineering data though.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for fabric finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics (single value provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata (regarding emission factors) provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by evaluating formaldehyde releases using various methods (however mostly related to extracting formaldehyde in aqueous solution), but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation: Karavalakis, G., Durbin, T.D., Shrivastava, M., Zheng, Z., Villela, M., Jung, H. (2012). Impacts of ethanol fuel level on emissions of regulated and unregulated pollutants from a fleet of gasoline light-duty vehicles. Fuel 93(1):549-558.
HERO ID: 1056410
Conditions of Use: Automobile Exhaust

EXTRACTION

Parameter	Data
Description of release source:	Light duty vehicles; pp. 556 1,3-butadiene (which is a product of fuel fragmentation and is not present originally in the fuel) is a precursor for secondary formation of formaldehyde
Release quantity:	up to ~2000 ug/ml and 5000 ug/ml for formaldehyde emissions from (a) 96 Honda Accord (b)07 FFV Chevrolet Silverado.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The release data methodology is known or expected to be accurate.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	U.S. data
	Metric 3: Applicability	Uninformative	The release data are for an occupational scenario, vehicle exhaust, which is not within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	the data are generally no more than 10 years old.
	Metric 5: Sample Size	Low	Values are only presented graphically and unknown statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data study addresses variability in the determinants of release by measuring different fuels and engines. The release data study does not addresses uncertainty in the release results.

Overall Quality Determination

Uninformative

Formaldehyde

Environmental Releases

HERO ID: 5944045 Table: 1 of 1

Study Citation:	Katovic, D., Vukusic, S. B., Hrabar, S., Bartolic, J. (2005). Microwaves in chemical finishing of textiles. :255-258.			
HERO ID:	5944045			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde is released from treated textiles in two ways. The first is release from the resin, particularly from nonpolymerized fractions, formed during the manufacturing. The second way is associated with hydrolysis of the resin in humidified air.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Croatia, a non-OECD country.
	Metric 3:	Applicability	High	Data are for textile finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range (graphs) with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	KEC, (2006). Modeling of LMAPCD Category 1 Toxic Air Contaminants.			
HERO ID:	11273144			
Conditions of Use:	Fuels and fuel products			
EXTRACTION				
Parameter	Data			
Release quantity:	Controlled Coal Combustion: 38.095 lb/yrFuel Oil Combustion: 4.15E+02U4 Powerhouse Avg. Conc. 0.00195; 0.00157			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is provided but does not cover all release media and uncertain if it covers all sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.	
	Metric 3: Applicability	Medium	The release data are for an occupational scenario but source indicates formaldehyde emission is from combustion sources, which is not specified as a COU within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The data are more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	Medium	An average concentration is provided with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data lacks some critical metadata to interpret the average concentration data. Emissions estimated based on emission factors are clear.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Keil, C.B., Akbar-Khanzadeh, F., Konecny, K.A. (2001). Characterizing formaldehyde emission rates in a gross anatomy laboratory. Applied Occupational and Environmental Hygiene 16(10):967-972.			
HERO ID:	33780			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde is emitted from the cadavers that have been prepared with a formalin solution (10% formaldehyde, 12.5% phenol, 12.5% ethylene glycol, 50% ethanol, with remaining balance water). The cadaver is placed on the table in a 4 in recessed area 25.5 inches wide by 74.25 inches long. A pair of hinged-lid doors cover the cadaver when not in use. Emission factor is applicable where the cadavers are prepared in similar embalming fluid.			
Release or emission factors:	Release or emission factors			
Comments:	Six supply diffusers and 10 air return grills provided general ventilation to the laboratory. The diffusers were uniformly spaced on the ceiling along the center line axis of the room. Eight of the air returns were at floor levels as illustrated in figure. Two additional returns were on the ceiling in the southeast and southwest corners of the laboratory. There was no recirculation of air removed from the laboratory via the returns. The air was exhausted out a roof stack			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The release data methodology is expected to be accurate and is known to cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	U.S. data	
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	The data were collected more than 20 years ago.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Release data include all associated metadata, including release media; activity that is the source of the release; and release frequency.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The study addressed variability by measuring at different locations, separate days over a 16 week span. Uncertainty was accounted for in accounting for potential interferences and comparing data with previous studies.	
Overall Quality Determination		High		

Formaldehyde

Environmental Releases

HERO ID: 5947891 Table: 1 of 1

Study Citation:	Kim, S. (2009). Environment-friendly adhesives for surface bonding of wood-based flooring using natural tannin to reduce formaldehyde and TVOC emission. Bioresource Technology 100(2):744-748.			
HERO ID:	5947891			
Conditions of Use:	Chemical substances in construction (i.e., wood products)			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Korea, an OECD country.
	Metric 3:	Applicability	High	The release data are for an occupational scenario (i.e., chemical substances in construction) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata. Metadata was focused on surface bonding strength and curing behavior not emissions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 87257 Table: 1 of 1

Study Citation:	Kirchstetter, T.W., Singer, B.C., Harley, R.A. (1999). Impact of California reformulated gasoline on motor vehicle emissions 1 Mass emission rates. Environmental Science and Technology 33(2):318-328.			
HERO ID:	87257			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Description of release source:	vehicle exhaust			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	unknown methodology
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	Data are for vehicle exhaust is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 20 years and after the PEL- Article published in 1999.
	Metric 5:	Sample Size	Medium	daily concentration values are provided for each sampling day, and fuel based emission factors are provided along with some information about % change between measurement seasons was provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Daily concentration values can be used to assess variance, but no information about uncertainty was provided.
Overall Quality Determination			Medium	

Study Citation:		Kopf, P. W. (2003). Phenolic resins.		
HERO ID:		6549167		
Conditions of Use:		Processing-Incorporation into a formulation-Plastic material and resin manufacturing		
EXTRACTION				
Parameter		Data		
Description of release source:		Benzodioxane is reasonably stable at neutral pH, but may decompose when the resin is cured, serving as a source of labile formaldehyde.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	The release data methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Low	The release data are for an occupational scenario within the scope of the risk evaluation. But the information is very limited
	Metric 4:	Temporal Representativeness	Medium	The release data were collected after the most recent federal regulatory action or update but are generally, more than 10 years old. If no federal regulation is established, the data are more than 10 years but no more than 20 years old. However, operations, equipment, and worker activities are expected to be reasonably representative of current conditions.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			Low	

Study Citation:	Leigh, I.E. (1996). Novel mini-chamber procedure for screening insulation for emission of formaldehyde and other VOCs. ASTM Special Technical Publication :67-74.			
HERO ID:	5466496			
Conditions of Use:	Fiberglass insulation products used in residential and commercial buildings containing phenol-formaldehyde resins			
EXTRACTION				
Parameter	Data			
Description of release source:	Fiberglass insulation products used in residential and commercial buildings containing phenol-formaldehyde resins.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Release data methodology is expected to be accurate	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data	
	Metric 3: Applicability	High	Release data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Data more than 20 years old	
	Metric 5: Sample Size	Low	Characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. No discussion on uncertainty	
Overall Quality Determination		Medium		

Study Citation:	Levaggi, D. A., Feldstein, M. (1970). The determination of formaldehyde, acrolein, and low molecular weight aldehydes in industrial emissions on a single collection sample. Journal of the Air Pollution Control Association 20(5):312-313.			
HERO ID:	1945839			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Description of release source:	Variety of industrial operations			
Release quantity:	Formaldehyde concentrations measured at different locations: coffee roasting - inlet -15.2 ppm and outlet - 41.3 ppm; litho-coater - inlet - 1.9 ppm, outlet at 1200 deg F - 17.5 ppm, outlet at 1400 deg F - 2.4 ppm; spray booth (auto primer) - 3.3 to 3.6 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Li, B., Zhang, J. Z., Ren, X. Y., Chang, J., Gou, J. S. (2014). Preparation and characterization of bio-oil modified urea-formaldehyde wood adhesives. BioResources 9(3):5125-5133.			
HERO ID:	2889758			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Emissions come from application of wood adhesives			
Release or emission factors:	Release or emission factors			
Comments:	Article is a controlled lab study. Tested according to Chinese Standard GB/T 17657			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country.	
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Addresses variability by looking at emission rates with different amounts of bio-oil added to the adhesive. Does not address uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Li, L., Ge, Y., Wang, M., Li, J., Peng, Z., Song, Y., Zhang, L. (2015). Effect of gasoline/methanol blends on motorcycle emissions: Exhaust and evaporative emissions. Atmospheric Environment 102:79-85.			
HERO ID:	5957109			
Conditions of Use:	Fuels and related products			
EXTRACTION				
Parameter	Data			
Description of release source:	motorcycle exhaust			
Release or emission factors:	Release or emission factors			
Comments:	media: fugitive air. Table 4 (pg 5) presents data in mg/km travelled for gasoline and M15 (15% methanol) for three different tested motorcycles (info on motorcycles in Table 1, pg 2)Table 7 (pg 6) presents data for evaporative emissions (diurnal and hot soak losses) in mg per test for two of the motorcyclesMethod: EPA standard TO-11A; Chamber testing for evaporative emissions (German SHED) (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.	
	Metric 3: Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Data are no more than 10 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All metadata (regarding emission factors) provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by evaluating multiple motorcycles and fuel types, but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	Liu, M., Wang, Y., Wu, Y., He, Z., Wan, H. (2018). "Greener" adhesives composed of urea-formaldehyde resin and cottonseed meal for wood-based composites. Journal of Cleaner Production 187(Elsevier):361-371.			
HERO ID:	5956691			
Conditions of Use:	emission (UF resin/adhesive in particle wood))			
EXTRACTION				
Parameter	Data			
Description of release source:	Free formaldehyde emission from UF-bonded wood products			
Release quantity:	The formaldehyde emission test of 10% cottonseed meal adhesive (CM), 20%CM, 30%CM with 1.45 F/U molar ratio UF resin indicated that the “greener” adhesives had higher formaldehyde emission than 1.2 F/U molar ratio UF, as follows: UF resin - 0.06 ppm, 10%CM - 0.152 ppm, 20%CM - 0.138 ppm, 30%CM - 0.132 ppm.			
Comments:	Note: This is a new method to produce UF Resin using cottonseed meal which is supposed to be ”greener”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is known and accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data is less than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties
Overall Quality Determination		Medium		

Study Citation:	Liu, R., Liu, M., Qu, Y., Huang, A., Ma, E. (2018). Dynamic moisture sorption and formaldehyde emission behavior of three kinds of wood-based panels. Holz als Roh- und Werkstoff 76(3):1037-1044.			
HERO ID:	5952097			
Conditions of Use:	Building and Construction Materials (MDF, particleboard, plywood)			
EXTRACTION				
Parameter	Data			
Description of release source:	Three types of UF resin bonded wood-based panels were made to order and purchased from the market. The major wood species was poplar (Populus tomentasa Carr.). The thickness of these panels was 18 mm (pg 2)			
Release or emission factors:	Release or emission factors			
Comments:	Table 5 (pg 6) presents equilibrium FA concentration in mg/m3 for MDF, particleboard, and plywood, at 45%, 60%, and 75% relative humidity. Figure 4 (pg 6) presents results over timeMethod: a 1 m3 chamber according to Chinese standard GB 18580–2001 (2001), which is related to the European standard EN 717-1 (pg 3)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for building and construction materials, an in-scope occupational scenario
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (only equilibrium concentrations provided, other data is graphical) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata (regarding emission factors) provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by comparing MDF, particleboard, and plywood but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Liu, Y., Shen, J., Zhu, X.D. (2015). Evaluation of mechanical properties and formaldehyde emissions of particleboards with nanomaterial-added melamine-impregnated papers. Holz als Roh- und Werkstoff 73(4):449-455.			
HERO ID:	5952103			
Conditions of Use:	Melamine formaldehyde resin (MUF) in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	MUF resin in particleboard			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for MUF resin in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by studying emissions under various temperature, times, and pressure, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 5957400 Table: 1 of 1

Study Citation:	Ionello, J.H., Christiansen, H.E., Cousseau, M.B., Macchi, G.J., Costa, N.A., Pereira, J., Ferra, J., Cruz, P., Martins, J., Magalhes, F.D., Mendes, A., Carvalho, L.H. (2013). Scavengers for achieving zero formaldehyde emission of wood-based panels. Wood Science and Technology 47(6):1261-1272.			
HERO ID:	5957400			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is expected to be accurate, but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including properties of particleboard (e.g., moisture, density).
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release.
Overall Quality Determination		Medium		

Study Citation:	Luft Environmental Consulting, (1994). AB 2588 health risk assessment for Texaco Refining and Marketing Inc’s Bakersfield Plant-Area 3, reporting year 1991, with cover letter dated 06/02/94.			
HERO ID:	1356123			
Conditions of Use:	Processing aid			
EXTRACTION				
Parameter	Data			
Description of release source:	Heater, boiler, tank, sulfur recovery unit			
Release quantity:	20.42 (lbs/year) on page 57/701			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for processing aid specific to petroleum production, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old. (1994)	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release media and release frequency provided but missing release or emission factors, waste treatment methods.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Luft Environmental Consulting, (1993). AB 2588 Health risk assessment for Texaco Refining and Marketing Inc.'s Bakersfield Plant-Areas 1 and 2 Reporting Year 1991.			
HERO ID:	6570009			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Description of release source:	Heaters, Flares, Tanks in Areas 1 and 2 Tank Farm, Wastewater treatment, cooling tower, blend area, gasoline loading area, and fugitive emissions			
Release quantity:	approximately 1700 lbs/yr			
Comments:	Quality of the pages with the emission data is poor.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	The release data methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	Low	Characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Luft Environmental Consulting, (1993). AB 2588 Health risk assessment for Texaco Refining and Marketing Inc.’s Bakersfield Plant-Area 3 Reporting Year 1991.			
HERO ID:	6570010			
Conditions of Use:	Processing: Petroleum Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source: Emission sources for the Texaco’s Bakersfield Plant in Bakersfield, CA are 3 heaters, 1 boiler, 1 flare, 9 tanks, sulfur recovery unit, wastewater treatment, cooling tower, delayed cooking unit, and fugitive emission sources (deethanizer, boilers, tank farm, amine, MEA, NH3 Tower and cooling tower).				
Comments: Copy of the document is very bad and emission quantities for formaldehyde could not be deciphered. Therefore, the rating has been performed for only ”description of release source”.				
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The release data methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the United States.	
	Metric 3: Applicability	High	Release data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	The copy of the document is really bad and as a result no emission data for formalde- hyde could be read. However, information about release sources could be obtained from the document.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	Luo, J., Li, X., Shi, R., Gao, Q., Li, J., Li, L. (2017). Determination of formaldehyde and TVOC emission behavior from interior use plywood using various post heat treatment processes. Journal of Applied Polymer Science 134(22):44909.			
HERO ID:	5958789			
Conditions of Use:	Building and Construction Materials (plywood)			
EXTRACTION				
Parameter	Data			
Description of release source:	MUF resin in plywood; The molar ratio of formaldehyde/melamine/urea (F/M/U) was 1.18:0.05:1.03			
Release or emission factors:	Release or emission factors			
Comments:	media: fugitive air; method: China National Standard (GB/T 9846.3-2004) (pg 2); Dessicator and chamber testing (pgs 2-3)			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country
	Metric 3:	Applicability	High	Data are for building and construction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (assumed means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata (regarding emission factors) provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by assessing emissions for particleboards under different conditions, but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Lörinci, G., Gebefügi, I., Kötting, G., Hilla, W., Kettrup, A. (1995). In-product environmental protection evaluation of chemical emissions from the spot welding joining technique in the automobile industry: Part II. Laboratory pyrolysis measurements with a welding chamber. Journal of Analytical and Applied Pyrolysis 33:91-101.			
HERO ID:	2131133			
Conditions of Use:	Other Byproduct			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Comments:	Without Adhesive 6 ng/50 spots with adhesive 18 ng/50 spots			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is from Germany, an OECD country
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty
Overall Quality Determination			Medium	

Study Citation:	Margosian, R. (1990). Initial formaldehyde emission levels for particleboard manufactured in the United States. Forest Products Journal 40(6):19-20.		
HERO ID:	5937165		
Conditions of Use:	Wood Product Adhesive		
EXTRACTION			
Parameter	Data		
Description of release source:	When UF adhesives are used to bond wood-based panels, small amounts of free formaldehyde are emitted for a period of time after manufacture. Formaldehyde emissions from wood products decrease with time.		
Release quantity:	The average initial emission level of all NPA Certification Program tests in 1985 and 1986 was 0.17 ppm (table 1). In 1987, 1988, and most of 1989, NPA's tests averaged 0.18 ppm. When the 89 tests from other certifiers are added for 1988, the average initial emission level is still 0.18 ppm (table 2). Average formaldehyde emission levels of particleboard manufactured in the United States have been consistently in the 0.17 to 0.18 ppm range for the 5-year period of 1985 to 1989.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data from the 1980s.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The release data study addresses variability in the determinants of release (different years). The release data study does addresses uncertainty in the release results.
Overall Quality Determination		Medium	

Study Citation:	Martin, V.B., Smith, C.B., Gupta, B.S. (1998). Identification of source emissions from finished textile fabrics. Textile Chemist and Colorist 30(2):15-19.			
HERO ID:	3561750			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Description of release source:	acrylic handbuilder, DMDHEU, melamine resin, wax water repellant (pg 2)			
Release or emission factors:	nan			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for textile finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (assumed mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by using multiple test methods. Variability addressed by analyzing multiple fabric and finishing agent types.
Overall Quality Determination			High	

Study Citation:	Marutzky, R., Dix, B. (1984). Formaldehyde release of tannin-bonded particleboards. Journal of Applied Polymer Science. Applied Polymer Symposium 40:49-57.		
HERO ID:	5944268		
Conditions of Use:	Processing/Use of particle board		
EXTRACTION			
Parameter	Data		
Description of release source:	Tannin-bonded particleboards (1/9)		
Release quantity:	”Particleboard 1: 3.0 mg FA/hr/m2 particleboard Particleboard 2: 8.1 mg FA/hr/m2 particleboard Particleboard 3: 5.0 mg FA/hr/m2 particleboard Particleboard 4: 9.4 mg FA/hr/m2 particleboard Particleboard 5: 14.4 mg FA/hr/m2 particleboard Particleboard 6: 7.9 mg FA/hr/m2 particleboard Particleboard 7: 12.9 mg FA/hr/m2 particleboard Particleboard 8: 10.7 mg FA/hr/m2 particleboard Particleboard 9: 15.6 mg FA/hr/m2 particleboard” (4/9)		
Release or emission factors:	Release or emission factors		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3: Applicability	High	Data are for adhesives and sealant chemicals in wood product manufacturing, am in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by sampling nine different types of particleboard. Uncertainty isn’t addressed.
Overall Quality Determination		Medium	

Study Citation:	Massachusetts OTA, (2013). A report on barriers to reducing the use of asthma-related chemicals.		
HERO ID:	8724621		
Conditions of Use:	All COUs		
EXTRACTION			
Parameter	Data		
Release quantity:	13,088 lbs released in 2009; TURA Data Formaldehyde 2009- Releases[No units provided in table]: Boremco Speciality Chemicals-0, Dow-10, Ineos Melamines (claims trade secret), MW Custom Papers- 6234, Raytor Compounds, Inc- 1164, Suddekor LLC- 2285, The Dodge Company- 3395; TURA Data Formaldehyde 2009 Transfers [No units provided]- Boremco Speciality Chemicals-0, Dow-5365, Ineos Melamines (claims trade secret), MW Custom Papers- 239, Raytor Compounds, Inc- 562, Suddekor LLC- 5, The Dodge Company- 2766		
Release or emission factors:	Release or emission factors		
Comments:	TURA table in appendix did not note units, likely lbs/year based on referenced data in the report.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Low	The release data methodology is not specified in report, data is pulled from TURA program for state MA. However report does not go into detail on how companies determine amounts of release.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	Data is from 2009, which is more than 10 years old but less than 20 years old.
	Metric 5: Sample Size	Medium	Amount for each site provided but uncertain if there is any statistical distributions involved in the method of release estimates.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release by providing different sites. However little is provided about the processes at the different sites. The release data study provides little discussion of the uncertainty in the release results beside noting that releases will occur outside of these sites which are not required to report to TURA.
Overall Quality Determination		Medium	

Study Citation:	Material Research, (2019). Formaldehyde: Technical report on the conditions of use.			
HERO ID:	10369883			
Conditions of Use:	Disposal			
EXTRACTION				
Parameter	Data			
Description of release source:	Disposal of formaldehyde.			
Release quantity:	The total quantity of formaldehyde released to air, water, land, underground injection wells, or transferred off site from 2013 - 2018 is 233,772,250 lbs. Facility total releases range from 1.4 lbs to 129,514,159 lbs. See Table 3 on PDF Pg. 15-42 for more info.			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by addressing releases from multiple sites, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 10369883 Table: 2 of 2

Study Citation:	Material Research, (2019). Formaldehyde: Technical report on the conditions of use.			
HERO ID:	10369883			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Manufacturing facilities.			
Release quantity:	Hexion is the largest formaldehyde manufacturer with 21 facilities. The releases for each facility range from 96 lbs to 1,163,148 lbs. The total releases and waste transfers from all 21 facilities total to 3,628,653 lbs. See full table on PDF Pg. 9.			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by addressing releases from multiple sites, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Matthews, T. G., Reed, T. J., Tromberg, B. J., Daffron, C. R., Hawthorne, A. R. (1985). Formaldehyde emission from combustion sources and solid formaldehyde-resin-containing products - Potential impact on indoor formaldehyde concentrations. Advances in Chemistry Series 210:131-150.			
HERO ID:	5943658			
Conditions of Use:	Emission from common combustion			
EXTRACTION				
Parameter	Data			
Description of release source:	FA emission from common combustion and FA resin containing products which includes gas stoves, kerosene heaters, cigarettes, textiles, carpeting, tiles, flooring, furniture, plywood			
Release quantity:	FA emission from combustion sources in Table 1 (mg/h): Gas burner - measured: 16 +/- 10, 4.3 +/- 2.6; average over 24 h: 0.67 +/- 0.41, 0.18 +/- 0.11; Gas over - measured: 4.3 +/- 2.6; average over 24 h: 0.67 +/- 0.10; Convective kerosene heater - measured: 1.0 +/- 0.66, average over 24 h: 0.33 +/- 0.22; radiant kerosene heater - measured: 4.0 +/- 2.0, average over 24 h: 1.3 +/- 0.66; Cigarettes - measured: 0.97 +/- 0.06, 1.44, average over 24 h: 0.40 +/- 0.03, 0.60; Table II provides emission rates from resin containing products (mg/m^2h) with average and range: drapery - <0.01 (<0.01 - 0.02); upholstery - <0.01 (<= 0.01); apparel textiles - 0.01 (<0.01 - 0.02); carpeting - <0.01 (<0.01); ceiling tiles - 0.01 +/- 0.01 (<0.01 - 0.02); resilient flooring - <0.01 (<0.01); industrial particle board - 0.31 +/- 0.14 (0.15-0.62); medium-density fiberboard - 1.5 +/- 0.51 (0.57 - 2.3); print overlay - 0.28 +/- 0.20 (0.05-0.63); paper overlay - 0.11 +/- 0.07 (0.03-0.27); domestic veneer overlay - 0.12 +/- 0.04 (0.07-0.24); UFFI - 0.23 +/- 0.19 (0.05-0.80); Table 3 has emission from more resin containing products (same units and format as table 2): Carpet cushion - 0.01 +/- 0.01 (<0.01-0.02); Fibrous glass insulation - 0.02 +/- 0.01 (<0.01-0.02); Softwood plywood subflooring - 0.02 +/- 0.01 (0.01 - 0.03); Particle board underlayment - 0.30 +/- 0.22 (0.11-0.78)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Source is from American Chemical Society so likely contains high
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	Low	Data is applicable to mostly consumer/at home uses
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1985)
	Metric 5:	Sample Size	Medium	Range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes what was sampled, release sources, emission factors, and emission quantities.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at multiple different sources of emission. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Matthews, T.G., Fung, K.W., Tromberg, B.J., Hawthorne, A.R. (1986). Surface emission monitoring of pressed-wood products containing urea-formaldehyde resins. Environment International 12(1-4):301-309.			
HERO ID:	22183			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Description of release source:	Other uses: off gassing of formaldehyde from particleboard, hardwood plywood, and medium density fiber boards			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The data were collected before the most recent federal regulatory action and are more than 20 years old	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Release data include all associated metadata for the type of emission monitored.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The release data study addresses variability in the determinants of release(temperature, humidity, air exchange). The release data study addresses uncertainty in the release results.	
Overall Quality Determination		High		

Study Citation:	Matthews, T.G., Hawthorne, A.R., Daffron, C.R., Corey, M.D., Reed, T.J., Schrimsher, J.M. (1984). Formaldehyde surface emission monitor. Analytical Chemistry 56(3):448-454.			
HERO ID:	2444112			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing multiple construction materials for emission rates but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Matthews, T.G., Wilson, D.L., Thompson, A.J., Mason, M.A., Bailey, S.N., Nelms, L.H. (1987). Interlaboratory comparison of formaldehyde emissions from particleboard underlayment in small-scale environmental chambers. Journal of Air Pollution Control Association 37(11):1320-1326.			
HERO ID:	5946798			
Conditions of Use:	Use in particle board			
EXTRACTION				
Parameter	Data			
Description of release source:	Particleboard Underlayment (2/8)			
Release quantity:	Can be calculated			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the commercial use of floor coverings, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by running a linear regression with a correlation coefficient. Variability addressed by sampling two types of particleboard at two different laboratories.
Overall Quality Determination			High	

Study Citation:	Mccarron, G. (2018). Air Pollution and human health hazards: A compilation of air toxins acknowledged by the gas industry in Queensland’s Darling Downs. International Journal of Environmental Studies 75(1):171-185.			
HERO ID:	6177378			
Conditions of Use:	Disposal			
EXTRACTION				
Parameter	Data			
Description of release source:	Gas wells and coal seam gas in Western Darling Downs, Australia (2/16)			
Release quantity:	”2005-2006: 0 kg/yr 2006-2007: 12 kg/yr 2007-2008: 25 kg/yr 2008-2009: 14,700 kg/yr 2009-2010: 0 kg/yr 2010-2011: 85,000 kg/yr 2011-2012: 119,000 kg/yr 2012-2013: 150,000 kg/yr 2013-2014: 160,420 kg/yr 2014-2015: 254,200 kg/yr 2015-2016: 307,200 kg/yr” (8/16)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for the disposal of formaldehyde to the air, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed by discussing limitations of the study, and where improvements can be made. Variability isn’t addressed.
Overall Quality Determination			High	

Study Citation:	Meyer, B., Carlson, N.L. (1983). Formaldehyde emission from particleboard post-cured by radio-frequency heating. <i>Holzforschung</i> 37(1):41-45.			
HERO ID:	5946053			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Board is made with an excess of formaldehyde which is either released during manufacture or from the finished product. An additional reason is that UF-resins in particleboard are spread over a very large surface and are in contact with hydroscopicwood. Furthermore, the resin does not form a uniformglue line, but is distributed as a thin uneven film that formscomplex interfaces of varying size and thickness with thewood. Such interfaces are difficult to cure. Finally, bydesign, particleboard is not a uniform material and is notuniformly heated during it manufacture, and the mat isintentionally formed in a high humidity and temperaturegradient... These engineering features are in direct conflict with uniform resin curing. The flux of heat and moisture from the face towards the core causes migration of volatile resin components that will accumulate in the aqueous phase at thecoldest point of the board...the fmished boardcontains traces of incompletely cured resin fragments, residual formaldehyde, methylene glycol, methylolurea, andother low molecular weight or weakly bonded functionthat constitute a latent source of formaldehyde release.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is expected to be accurate, but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the U.S., and the Particle board was from Canada.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	More than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including HF field exposure time and oven temp.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release.
Overall Quality Determination		Medium		

Study Citation:	Middleton, P., Sockwell, R., Carter, W.P. (1990). Aggregation and analysis of volatile organic compound emissions for regional modeling. Atmospheric Environment 24(5):1107-1133.			
HERO ID:	87136			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Description of release source:	The source of HCHO emissions are given in Appendix A and Table 4			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The data are NAPAP data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	Medium	The release data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities
	Metric 4:	Temporal Representativeness	Low	1980 data
	Metric 5:	Sample Size	Low	Only total emissions are reported.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	emission source categories are given.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	emission source categories are given.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 5958003 Table: 1 of 1

Study Citation:	Migneault, S., Koubaa, A., Riedl, B., Nadji, H., Deng, J., Zhang, T. (2011). Potential of pulp and paper sludge as a formaldehyde scavenger agent in MDF resins. Holzforschung 65(3):403-409.			
HERO ID:	5958003			
Conditions of Use:	Processing: Resin Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Medium density fiberboard manufactured with urea-formaldehyde resin. (1/7)			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Canada, an OECD Country.
	Metric 3:	Applicability	High	Data are for resin, and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range (in graph form) with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata (includes release media, process).
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by using pulp from two different mills.
Overall Quality Determination			High	

Study Citation:	Milota, M. R., Mosher, P. (2006). Emissions from western hemlock lumber during drying. Forest Products Journal 56(5):66-70.			
HERO ID:	5945959			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Description of release source:	Drying of western hemlock lumber in a kiln. (1/5)			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for wood product manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release media and emission factors provided but missing release quantity, waste treatment, number of sites, and release days/year.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in the emission estimation method. Variability addressed by sampling nine wood sources.	
Overall Quality Determination		High		

Study Citation:	Milota, M.R. (2000). Emissions from wood drying - The science and the issues. Forest Products Journal 50(6):10-20.			
HERO ID:	5944139			
Conditions of Use:	Incorporation into article- Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Emissions From Processing Wood			
Release quantity:	VOC emissions (tons/yr), including formaldehyde, from processing wood (includes only facilities with the potential to emit at least 100 tons/yr): Logging – 326 (2 facilities), Sawmills and planing mills - 17,721 (56 facilities), Softwood veneer and plywood - 16,318 (37 facilities), Hardwood veneer and plywood - 1,691 (5 facilities), Particleboard - 1,448 4 facilities), Reconstituted wood products - 12,381 (34 facilities), Pulp mills - 27,172 (40 facilities), Paper mills - 58,482 (85 facilities). Based on emissions data from steam-heated dryers, formaldehyde emission are: 0.02 lb./Mft3 for western softwood plywood, 0.01 lb./Mft3 for southern softwood plywood, 0.001 lb./Mft3 for hardwood plywood, 0.12 lb/ODT western softwood particleboard, 0.027 lb/ODT southern pine particleboard, 0.31 lb/ODT southern pine oriented strandboard, 0.57 lb/ODT hardwood oriented strandboard. Materials used to glue, coat, and finish wood may also contribute to the emissions from a facility. The most well-known example is formaldehyde from the pressing of panels containing urea- or phenol-formaldehyde resins.			
Release or emission factors:	Release or emission factors			
Comments:	Drying of wood may releases formaldehyde. "For oriented strand dryers, the values range from 0.7 to1.8 lb./ODT, with formaldehyde or acetaldehyde being dominant ” (pg. 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The release data methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data	
	Metric 3: Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	data is greater than 20 years old	
	Metric 5: Sample Size	Low	characterized by no statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data presents no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Release data study does address variability but not uncertainty.	
Overall Quality Determination		Low		

Study Citation:	Milota, M.R. (2006). Harzardous air pollutant emissions from lumber drying. Forest Products Journal 56, no. 7-8:79-84.			
HERO ID:	6036844			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Description of release source:	Drying of red alder, ponderosa pine, white wood, Douglas-fir, and western hemlock wood in a kiln. (2/6)			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for wood product manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Most critical metadata provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in the emission estimation method. Variability addressed by sampling various types of wood.	
Overall Quality Determination		High		

Study Citation:	Miyamoto, K., Grigsby, W., Tohmura, S.I. (2019). Using renewables in panelboard resins to influence volatile organic compound emissions from panels. Journal of Wood Chemistry and Technology 39(3):166-177.			
HERO ID:	5958640			
Conditions of Use:	Building and Construction Materials (Panelboard)			
EXTRACTION				
Parameter	Data			
Description of release source:	Panelboard adhesive/resin, media: fugitive air			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Japan/New Zealand, OECD member countries.	
	Metric 3: Applicability	High	Data are for building and construction materials, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Data are no more than 10 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All metadata (regarding emission factors) provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by assessing emissions during and after panelboard manufacture, but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	Moezzi pour, B., Abdolkhani, A., Doost-Hoseini, K., Ramazani, S.A., Tarmian, A. (2018). Practical properties and formaldehyde emission of medium density fiberboards (MDFs) recycled by electrical method. Holz als Roh- und Werkstoff 76(4):1287-1294.
HERO ID:	5957969
Conditions of Use:	Recycling

EXTRACTION

Parameter	Data
Description of release source:	In this study, a new recycling process based on this heating method was designed that involves various steps which are completely different from the well-known recycling process based on hydrothermal treatment. Especially with this new method, the refining step is eliminated. Furthermore, an additional preheating step helps to facilitate the recycling process. This newly defined recycling process was denominated as electrical method in this study. Emission of formaldehyde from boards are measured
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Source is peer reviewed with methodology expected to be accurate, but the source only provides emission from the boards not expected cover all releases from a recycling site.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data is for Germany, an OECD country.
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old (2018)
	Metric 5: Sample Size	Medium	Characterized with values but uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Includes description of release source, chemical concentration, waste treatment and emission factors.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Does not address variability or uncertainty.

Overall Quality Determination**Medium**

Study Citation:	Monsanto Research Corp, (1983). Detailed industrial hygiene survey: formaldehyde production, Georgia-Pacific Corporation, Albany, Oregon.			
HERO ID:	8728033			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	Leaks from equipment during manufacture			
Release quantity:	Table 12. Mass Loadings released from Sources- Daily release rate, g/dAbsorber pump #1- 9.8E-4Absorber pump #2- 2.26E-3 -5.56E-3*Loading pump- 9.43E-3*Side agitator tank F-8- 15.7E-2*Side agitator tank F-10- 13.9E-2**Breakthrough occurred- values reported are minimum.			
Release frequency:	Plant operates 7 days a week.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The release data are for an occupational scenario (manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 8728034 Table: 1 of 1

Study Citation:	Monsanto Research Corp, (1983). Detailed industrial hygiene survey: Formaldehyde production, Reichhold Chemicals, Incorporated, Hampton, South Carolina.			
HERO ID:	8728034			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	Spray tower #2 pump, spray box pump, interim product pump, blending pump, distillation pump.			
Release or emission factors:	nan			
Release frequency:	5 days/week			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data were collected prior to the most recent NESHAP.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing release quantity.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by sampling multiple release points.
Overall Quality Determination		High		

Formaldehyde

Environmental Releases

HERO ID: 9493520 Table: 1 of 1

Study Citation:	Mooney, J. J. (2004). Emission control, automotive.			
HERO ID:	9493520			
Conditions of Use:	Fuels and related products			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for fuels and related products, an in-scope occupational scenario, however, note that formaldehyde may be formed as a combustion byproduct in exhaust.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and emission factors provided but missing release quantity.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	Moubarik, A., Pizzi, A., Allal, A., Charrier, F., Charrier, B. (2009). Cornstarch and tannin in phenol-formaldehyde resins for plywood production. Industrial Crops and Products 30(2):188-193.		
HERO ID:	2867010		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Description of release source:	Emissions obtained from panels bonded with cornstarch–quebracho tannin–PF and panels bonded with control phenol–formaldehyde.		
Release quantity:	Emissions from panels bonded with cornstarch–quebracho tannin–PF were found to be 1.92 +/- 0.11 mg/m2/h, and panels bonded with control phenol–formaldehyde were found to be 2.62 +/- 0.19 mg/m2/h. Panels bonded with cornstarch–quebracho tannin–PF resin showed 26% reductions in formaldehyde emission compared to plywood prepared with control PF resins.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	OECD country (France)
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	Data is more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data addresses variability by comparing emissions from different wood adhesives but does not address uncertainty.
Overall Quality Determination		Medium	

Study Citation:	Myers, G. E. (1983). Formaldehyde emission from particleboard and plywood paneling - measurement, mechanism, and product standards. Forest Products Journal 33(5):27-37.			
HERO ID:	5945145			
Conditions of Use:	Building and Construction Materials (particleboard and plywood)			
EXTRACTION				
Parameter	Data			
Description of release source:	Table 1 (pg 2) presents boards used in study; mostly UF and PF bonded			
Release or emission factors:	Release or emission factors			
Comments:	Media: fugitive air. Table 3 (pg 4) presents dessicator test results in $\mu\text{g/mL}$ and perforator results in $\text{mg}/100\text{ g}$ Figure 4 and 5 and Table 5 (pg 7-8) present chamber testing resultsdessicator, perforator (described pg 2-3); and chamber tests (described pg 6)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building and construction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata (regarding emission factors) provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in testing methodologies. Variability addressed by testing multiple boards via multiple methods.
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 5945149 Table: 1 of 1

Study Citation:	Myers, G. E. (1984). Effect of ventilation rate and board loading on formaldehyde concentration - A critical-review of the literature. Forest Products Journal 34(10):59-68.			
HERO ID:	5945149			
Conditions of Use:	Particleboard and plywood paneling			
EXTRACTION				
Parameter	Data			
Description of release source:	Particleboard and plywood paneling			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	Release data methodology is not specified
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	US data
	Metric 3:	Applicability	High	Release data are for a scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted
Overall Quality Determination		Low		

Study Citation:	Myers, G.E., Nagaoka, M. (1981). Emission of formaldehyde by particleboard - Effect of ventilation rate and loading on air-contamination levels. Forest Products Journal 31(7):39-44.
HERO ID:	5948238
Conditions of Use:	Compressed Wood Product Manufacturing

EXTRACTION

Parameter	Data
Description of release source:	UF adhesives; Board set A was prepared with a Douglas-fir furnish using 7 percent (dry furnish basis) of a commercial UF resin containing 1.5 percent free formaldehyde; emission data were obtained before and after board aging for 30 days at 60°C... Board set D was prepared with the same furnish and the same total amount of the UF resin to which 10 percent urea and 5 percent melamine had been added; emission data reported here were obtained only for aged D boards (pg 3)
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (assumed means) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All metadata (regarding emission factors) provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by assessing emissions for multiple particleboards and multiple conditions, but uncertainty is not addressed.

Overall Quality Determination**High**

Study Citation:	Nagpure, A.S., Gurjar, B.R., Kumar, V., Kumar, P. (2016). Estimation of exhaust and non-exhaust gaseous, particulate matter and air toxics emissions from on-road vehicles in Delhi. Atmospheric Environment 127:118-124.			
HERO ID:	3372788			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Description of release source:	vehicle exhaust engines (on-road vehicles)			
Release quantity:	Exhaust emissions for formaldehyde in Figure 2 (D) going from 700 kg from all vehicles up to 3000 kg for all vehicles. Figure provides comparison between different types of vehicles.			
Release or emission factors:	Release or emission factors			
Comments:	9.3% emission growth for formaldehyde from 2011 to 2020			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Unclear if source is peer reviewed but appears to contain high quality data.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data is for India, a non-OECD country	
	Metric 3: Applicability	Medium	Data is not for occupational exposure but does contain release estimates in Delhi, India.	
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old.	
	Metric 5: Sample Size	Low	Range of data but no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Includes description of release source, quantity and emission factors.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Shows different emission amounts by different vehicles. Does not address uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Nakamura, J., Azuma, N., Kameya, T., Kobayashi, T., Urano, K. (2008). Analysis of the toxicity-weighted release amount ranking of PRTR chemicals in Japan. Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances & Environmental Engineering 43(5):452-459.			
HERO ID:	1025153			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Description of release source:	95.9% mobile sources (e.g. mobile bodies such as cars)			
Release quantity:	1.9*10^7 kg/yr to atmosphere in FY2003 (April 2003 to March 2004)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3:	Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old. (2008)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing waste treatment methods, release frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Namiesnik, J., Zygmunt, B., Kozdron-Zabiegala, B. (1994). Some aspects of indoor air pollution and analysis. Polish Journal of Environmental Studies 3(4):5-19.			
HERO ID:	6021395			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Description of release source:	Building and renovation materials and furnishings, combustion, tobacco smoke, air conditioning systems (2/15)			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Poland, an OECD country.
	Metric 3:	Applicability	Low	Data are for ambient air, which is similar to the in-scope occupational scenario use of furniture and furnishing products
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at many facilities. Uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation: NATL PARTICLEBOARD ASSOC, (1985). Letter from National Particleboard Association to USEPA submitting product emission information with attachments.				
HERO ID: 5901010				
Conditions of Use: Particleboard Production				
		EXTRACTION		
Parameter		Data		
Description of release source:		Emission measured in chamber tests		
Release quantity:		0.14 to 0.18 ppm on average		
		EVALUATION		
Domain		Metric		Rating
Domain 1: Reliability				Comments
	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The release data were collected after the most recent federal regulatory action or update but are generally, more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.
Overall Quality Determination		Medium		

Study Citation:	NATL PARTICLEBOARD ASSOC, (1986). Letter from the National Particleboard Association to USEPA concerning the issues discussed in the January 31, 1986 meeting on formaldehyde with attachments.			
HERO ID:	5901036			
Conditions of Use:	emission			
EXTRACTION				
Parameter		Data		
Description of release source:		Particleboard - Free formaldehyde , which is present in cured resin at low levels (<1%) is the most significant source of formaldehyde release from pressed-wood products in the initial period ,after they are manufactured.		
Release quantity:		Particleboard made by three different West German manufacturers was obtained by an NPA member company . The boards were all represented as E-1 grade, i.e., having emissions of 0.1 ppm or less. The three E-1 board samples were measured by large chamber methods at three different labs. The results showed that particleboard from Manufacturer A had an average emission of 0.19 ppm; particleboard from Manufacturer B had an average emission of 0.23 ppm; particleboard from Manufacturer C had an average emission of 0.17 ppm. The average of test readings for the German E-1 boards was 0.20 ppm, twice that of the E-1 standard.		
Release or emission factors:		Release or emission factors		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is known or expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S.,
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	the report is more than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Nazaroff, W. W., Coleman, B. K., Destailats, H., Hodgson, A. T., Liu, D.,-L, Lunden, M. M., Singer, B. C., Weschler, C. J. (2006). Indoor air chemistry: Cleaning agents, ozone and toxic air contaminants.			
HERO ID:	4682850			
Conditions of Use:	Reactant Products - Prominent products of the reaction of terpenes with ozone included formaldehyde			
EXTRACTION				
Parameter	Data			
Release quantity:	32 tonnes VOC per day			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	CARB study - details are provided for the emission factors presented in ppb per time period.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for a bench scale study of an occupational scenario (Janitors/maids) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	2006 - more than 10 years but less than 20
	Metric 5:	Sample Size	High	detailed study results were provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media and activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	detailed study results were provided.
Overall Quality Determination			High	

Study Citation:	NCASI, (1986). Formaldehyde, phenol and total gaseous non-methane organic compound emissions from flakeboard and oriented-strand board press vents.			
HERO ID:	5904947			
Conditions of Use:	Wood production			
EXTRACTION				
Parameter	Data			
Description of release source:	Mill A produced waferboard. Aspen logs were flaked and dried to prepare the furnish. Liquid phenol-formaldehyde resin and wax were added to the flakes in rotary blenders. The resin application rate was 5.0 percent in the core and 4.75 percent in the surface material when the vents were sampled . The flakes were spread on platens, pressed, and heated in a 16 opening press. The press operated at 400°F and pressed mats that were 8 by 24 feet. The boards were unloaded and trimmed to their final size. Mill B produced waferboard. Lodgepole pine and cottonwood logs were flaked and dried to prepare the furnish. Powdered phenol-formaldehyde resin and wax were added to the flakes in rotary blenders. The resin application rate was 2.0 percent in both the core and surface material. The flakes were spread on platens and pressed and heated in an 8 opening press. The press operated at 400°F and pressed mats that were a nominal 8 by 16 feet. The boards were unloaded and trimmed to their final size.			
Release quantity:	Formaldehyde emission rates ranged between 0.17 to 0.56 lb/MSF. At Mill A the different resins used made a difference in the FA emission rate. Emission rates shown in Table B-1: When resin A was used the FA emissions averaged 0.30 lb/MSF actual and ranged between 0.25 and 0.38 lb/MSF actual and between 0.26 and 0.39 lb/MSF on a 3/4 inch basis. FA emissions were higher when Resin B was used. Insufficient data to compare between resins A and C. Table B- shows emission rates for Mill B - averaged 0.17 lb/MSF actual and ranged between 0.14 and 0.20 lb/MSF actual, and between 0.23 and 0.35 lb/MSF on a 3/4 inch basis. 2% resin was added to flakes, this resin contained 2% free FA. Of the free FA 30% was emitted through press vents.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Source is a TSCA submission for EPA so likely high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Applicable to FA resin use in wood manufacturing.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes release source, release quantity, and emission factors.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at different mills, different dimensions of wood, and different resins. Does not address uncertainty.
Overall Quality Determination			Medium	

Study Citation:	NCASI, (1986). Survey of formaldehyde and total gaseous non-methane organic compound emissions from particleboard press vents.
HERO ID:	5904953
Conditions of Use:	Emissions (particle board press vents)

EXTRACTION

Parameter	Data
Description of release source:	Mill A produced standard and industrial grade particleboard. The board was formed in three layers. The outer layers contained more fines to create smooth surfaces. The inner layer contained coarser particles to maintain it's strength characteristics. This layering was achieved by two forming machines. Each machine projected the furnish in the appropriate direction so that the coarser material, carried by momentum, deposited where the interior of the board is being formed. UF resin in a partially polymerized state at 65% solids was blended with the furnish just prior to formation. A small amount of wax was added to bind the resin to the wood particles. The furnish was derived from Douglas-fir resident. Mills B and C description were not copied over into this document. Mill B - produced 2 gardses of particleboard during the study. 1st was a 55 lb/sq ft density board destined for commercial use. it was made in thicknesses between 0.5 and 1.25 inches. The 2nd was a 32 lb/sq ft density board used to make solid core doors. It was made in thicknesses of 1.25 to 1.5 inches. 2 dryers provided furnish for the board. The furnish was derived from aspen and ponderosa pine. The furnish was screened to segregate coarse material for the interior of the board and fine material for it's surface. UF resin was blended with the screened furnish in screw conveyers that transported it to hoppers. The surface material received 6.8% resin whereas the core received 8.8% when commercial particleboard was being produced and 9.2% when door core was being produced. When the door core was being produced a high excell formaldehyde content (high fuming) resin was used to reduce press time. This produced was not subject to the low FA off-gassing requirement of commercial grade particleboard. 6 forming heads laid the furnish on platens. The unpressed boards were trimmed to size and loaded in batches of ten into the press. After pressing they were trimmed and passed through a board cooler. The Press accepted ten boards at a time. The max board dimensions were 66 by 230 inches. The size of the board pressed changed with product specifications. The press was operated at 360 F for commercial particleboard and at 380 F for door core. The press pressure was 2600 psi for commercial particleboard and 1500 psi for door core. Mill C produced particleboard with 2 separate production lines. The mill produced premium and industrial grade particleboard during the emission tests. A UF resin and was added to the furnish in rotary blenders. The furnish was derived from western pine species and Douglas-fir. The resin application rate was 8.2% in the core and 8.9% in the surface material when the premium grade was produced. During production of the industrial grade, the resin application rate was 9.0 to 9.4% in the core and 9.1 to 10.3% in the surface material. 4 formers spread the furnish onto platens with fine material being placed on the surfaces and coarse material placed in the middle of the mat. The mats were pressed and heated in a 16 opening press. The press operated at 320 F and pressed mats that were a maximum of 64 by 216 inches, but were usually smaller. The boards were unloaded, cooled in rotary board coolers, and trimmed to their final size. Mill D - dried ponderosa pine particles were blended with was and 6.9% liquid resin. Three formers laid down surface, core, and surface material sequentially to form mats. The mats were placed into an 18 opening hot press and pressed into particleboard. The press operated at 315 and 335 F. The boards were unloaded, trimmed and stacked.
Release quantity:	3 factors affected FA emissions from the press vents: excess FA content of the resin, amount of resin used and press temperature. Across all mills FA content ranged between 0.30 to 1.20 lb/MSF. Figure 3 provides FA emission rate as a function of board resin content and figure 4 is FA emissions as a function of excess FA in the board. FA emission rates at Mill A averaged 4.4 lb/hr and ranged between 3.1 and 6.3 lb/hr with average emissions of 0.39 lb/MSF board produced and ranged between 0.32 and 0.48 lb/MSF. Corrected to a 3/4 inch thick product, the FA emission rate ranged between 0.25 and 0.60 and averaged 0.42 lbs/MSF. Mill B - average for production of commercial particleboard was 6.9 lb/hr and during manufacture of door core was 16.2 lb/hr. In terms of emissions per actual unit production these average emission rates were 0.75 lb/MSF and 2.2 lb/SF for the commercial particle board and door care grades respectively. On a 3/4 inch basis they were 0.70 lb/MSF and 1.1 lb/MSF respectively. Mill C - average of 6.8 lb/hr and ranged between 5.0 and 8.2 lb/hr. Expressed in terms of production averaged 0.33 lb/MSF actual, ranged between 0.20 and 0.40 lb/MSF actual, and between 0.22 and 0.81 lb/MSF on a 3/4 in basis. Mill D - FA emissions average 6.5 lb/hr and ranged between 5.2 and 7.3 lb/hr. Emssion rate was 0.33 lb/MSF actual and ranged between 0.29 and 0.39 lb/MSF actual, and between 0.44 and 0.53 lb/MSF on a 3/4 inch basis.
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			

Continued on next page ...

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Study Citation:		NCASI, (1986). Survey of formaldehyde and total gaseous non-methane organic compound emissions from particleboard press vents.		
HERO ID:		5904953		
Conditions of Use:		Emissions (particle board press vents)		
Domain		Metric	EVALUATION Rating	Comments
	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site (per 2nd paragraph of results section, a deviation from the standard method of reporting was used).
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to use of FA in particleboard manufacturing.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Includes release media, process, quantity and emission factors.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Address variability by looking at multiple mills and different resin concentrations used. Does not address uncertainty.
Overall Quality Determination			Medium	

Study Citation:	NCASI, (1986). Survey of emissions from dryer exhausts in the wood panelboard industry.			
HERO ID:	5904954			
Conditions of Use:	Building/construction material - wood and wood engineered products			
EXTRACTION				
Parameter	Data			
Description of release source:	Emissions from dryers processing raw material used to manufacture particleboard, flakeboard, oriented strandboard, or dry process hardboard.			
Release quantity:	0.01-2.02 (lb/hour) see Table B13			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old. (1987)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing waste treatment methods and pollution control.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling at multiple facilities, but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Nelson, P.F., Tibbett, A.R., Day, S.J. (2008). Effects of vehicle type and fuel quality on real world toxic emissions from diesel vehicles. Atmospheric Environment 42(21):5291-5303.			
HERO ID:	965984			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data is between 10 and 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by testing different vehicles, uncertainty is addressed by comparison to other studies and exploring the impact of fuel quality.
Overall Quality Determination			Medium	

Study Citation:	Nemli, G., Ayan, E., Ay, N., Tiryaki, S. (2018). Utilization potential of waste wood subjected to insect and fungi degradation for particleboard manufacturing. Holz als Roh- und Werkstoff 76(2):759-766.			
HERO ID:	5957459			
Conditions of Use:	Building and construction materials (particleboard)			
EXTRACTION				
Parameter	Data			
Description of release source:	Table 1 (pg 4) presents the particle board types studied			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
Comments:	Media: fugitive air. Table 6 (pg 6) presents EFs (in mg/100 g) for FA from 6 different particles boards, assumed mean and standard deviation. Method: perforator method based on EN 120-1 (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site (only addresses emissions from produced boards).
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Turkey, an OECD country
	Metric 3:	Applicability	High	Data are for building/construction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata (regarding emission factors) provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by studying emissions from various particleboards, but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HHE 79-128-806. Bob Gerren Ford, Inc., Manistee, MI.			
HERO ID:	8620325			
Conditions of Use:	Thermal Decomposition of Polyurethane foam			
EXTRACTION				
Parameter	Data			
Description of release source:	A 150 mg sample of the urethane foam was heated in a micro-furnace at 80, 100, and 120 degrees F, and air was drawn off and analyzed for formaldehyde (pg. 5).			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is expected to be accurate but does not cover all release sources from a site just an emission factor from one potential source.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	Low	The release data are for a non-occupational scenario (i.e., the study did not include information that process/site would heat the polyurethane foam) but that may be useful for occupational scenarios within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	are more than 20 years old	
	Metric 5: Sample Size	Medium	characterized by a range with uncertain statistics. It is unclear if analysis is representative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media; activity that is the source of the release; but lacks release frequency.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	NIOSH, (1984). In-depth survey report: Control technology for formaldehyde emissions at Dixie Furniture Plant, Lexington, North Carolina.			
HERO ID:	8728028			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source: Formaldehyde is emitted while the boards are being pressed, although the escape of vapors is restricted by the closed press. Much formaldehyde vapor is released when the press opens. The emissions of formaldehyde from the hot boards continues as the boards are unloaded, stacked, and cooled. (7/22)				
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for adhesive and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Only release source provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		Medium		

Study Citation:	Niri, V.H., Mathers, J.B., Musteata, M.F., Lem, S., Pawliszyn, J. (2009). Monitoring BTEX and Aldehydes in Car Exhaust from a Gasoline Engine During the Use of Different Chemical Cleaners by Solid Phase Microextraction-Gas Chromatography. Water, Air, and Soil Pollution 204(1-4):205-213.			
HERO ID:	2594234			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Description of release source:	gasoline engine car exhaust during engine cleaning service using different chemical cleaners			
Release quantity:	Total emission of formaldehyde during the 20-min cleaning service ranged from non-detect to 0.22 mL. Though not for formaldehyde only, the average concentration of hydrocarbons in the emission ranged from 0 (for TerraClean Black Can, Motorcraft Pressurized Injector Cleaner, and TerraClean Formula from New Reactor) to 1,606.2 (Wynn’s VIC-Vacuum Intake) ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	release data methodology is known or expected to be accurate	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	OECD country	
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	data is between 10 and 20 years old	
	Metric 5: Sample Size	Low	no statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Niu, M., Wu, Z., Lin, X., Liu, Z., Xie, Y., Bhuiyan, I.U., Wang, X. (2018). Manufacturing and properties of ultra-low density fiberboards with an unsaturated polyester resin by a dry process. Holz als Roh- und Werkstoff 76(3):853-859.			
HERO ID:	5957490			
Conditions of Use:	emission			
EXTRACTION				
Parameter	Data			
Description of release source:	Emission of formaldehyde from ultra-low density fiberboards (ULDFs)			
Release quantity:	Formaldehyde emission (mg/100 g) for the optimized specimen was not detected, compared to the requirements of Forestry Industry Standard (LY/T 1718–2007) of <=9. The optimized specimen was manufactured using the following conditions: UPR dosage of 12%, fiber consumption of 400 g, fiber treatment agent of 1% and press time of 210 s.			
Comments:	See table 3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	release data methodology is known	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	data are from a non-OECD country	
	Metric 3: Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	High	data no more than 10 years old	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty	
Overall Quality Determination		Medium		

Study Citation:	Nonaka, T., Okawa, N., Ohashi, K., Takeda, K., Fujimoto, T. (2005). Examination of emission test method for VOC evaluation from printer. :2185-2188.			
HERO ID:	5943653			
Conditions of Use:	Electrical and electronic products			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde was emitted from laser printers (1/4).			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Japan, an OECD Country.	
	Metric 3: Applicability	High	Data are for the use of electronic products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability is addressed by sampling at three humidity levels, but uncertainty isn't addressed.	
Overall Quality Determination		High		

Formaldehyde

Environmental Releases

HERO ID: 1577139 Table: 1 of 1

Study Citation:	Northrop Corporation, (1992). Northrop corporation aircraft division: Health risk assessment for west complex (final report) with attachments and cover letter dated 021492.			
HERO ID:	1577139			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Release quantity:	West Complex: 155.5 lbs/year Peak 0.66 lbs/hr			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	Emissions based on 1989 Facility Emissions Inventory Report, submitted for compliance with AB 2588 Air Toxic Inventory Report. details of the methods used are not provided.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Low	It is unclear what the emission sources are as only stacks are identified.
	Metric 4:	Temporal Representativeness	Low	The report is based on data published in 1991 Air Toxics Inventory report, prior to the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	only total annual emissions and peak emissions are provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata are provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	NRDC, (2020). Comments of the Natural Resources Defense Council on EPA’s draft scope of the risk evaluation for formaldehyde.			
HERO ID:	10370217			
Conditions of Use:	All conditions of use			
EXTRACTION				
Parameter	Data			
Release quantity:	Union County, Arkansas [PDF Pg. 40]Combined total emissions in 2018 from all facilities: 16,312 lbsShelby County, Tennessee [PDF Pg. 42]Combined total emissions in 2018 from all facilities: 62 lbsHarris County, Texas [PDF Pg. 44]Combined total emissions in 2018 from all facilities: 74,657 lbs			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	Methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for all in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by discussing emissions in multiple states, but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	OECD, (2004). Emission scenario document on textile finishing industry.			
HERO ID:	6558533			
Conditions of Use:	textile processing			
EXTRACTION				
Parameter		Data		
Description of release source:		E.g., 1) The coating agents, their by-products, and crack-products can cause a considerable off-gas load. Emissions of ammonia, formaldehyde (e.g. ex melamine resins), and residual monomers are typical. 2) Surfactants (organic polar compounds with at least one hydrophobic part and at least one hydrophilic group) are widely spread in textile finishing industry...Following chemical components are mainly in use: Anionic surfactants e.g., condensation products of formaldehyde.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	Data are from Europe, all OECD countries.
		Metric 3: Applicability	High	Data are for textile processing, an in-scope occupational scenario.
		Metric 4: Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
		Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	OECD, (2009). Emission scenario documents on pulp, paper and board industry.			
HERO ID:	6558581			
Conditions of Use:	production/preparation of paper			
EXTRACTION				
Parameter	Data			
Description of release source:		Figure 4.1 Potential emission pathways. Table 4.1 Water use in UK paper mills (cubic meter per air dried tonne). Table 4.2 waste generation from stock prep.		
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Europe (and the UK), all OECD countries.
	Metric 3:	Applicability	High	Data are for paper production/preparation, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Sample type provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Offermann, F.J. (2017). Formaldehyde emissions from laminate flooring. ASHRAE Journal 59(3):102-105.			
HERO ID:	5943040			
Conditions of Use:	Use of Floor coverings			
EXTRACTION				
Parameter	Data			
Description of release source:	MDF core of laminate flooring. The free formaldehyde results in initially higher emission rates following installation, while hydrolysis caused by indoor relative humidity is responsible for the long-term emission rates. The top layer of flooring is MDF, which is not a significant emitter, but formaldehyde emits from the four edges and perimeter of the room.			
Release or emission factors:	Release or emission factors			
Comments:	Model parameters: Air Exchange Rate (AER: h-1): uniform distribution, min = 0.10, max =1.21; Ceiling Height (H – m): constant, 2.44 m (8 ft);Laminate floor coverage (% of total floor area): 100. Article states that the tested material (Lumber Lubricator Laminate no longer sells as of 2016)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Emission appears to have been done by CPCS, report models the emission over time. Methodology is expected to be accurate but may not cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	Data are no more than 10 years old.	
	Metric 5: Sample Size	N/A	modeled EFs	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release media provided but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by reporting a lognormal distribution of emission factors, and uncertainty is noted as formaldehyde emission would depend on resin used.	
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 1441911 Table: 1 of 1

Study Citation:	Oil., Shell (1978). Tertiary water treatment I. A preliminary assessment of active carbon sorption.			
HERO ID:	1441911			
Conditions of Use:	Disposal			
EXTRACTION				
Parameter	Data			
Waste treatment methods and pollution control: Waste treatment methods and pollution control				
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the disposal of formaldehyde, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (percent reduction, adsorption constant) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and pollution prevention specified, but not release quantities or frequencies.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in results summaries and estimated in percent reduction calculations. Variability is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Oliva-Teles, M.T., Paiga, P., Delerue-Matos, C.M., Alvim-Ferraz, M.C. (2009). Evaluation of Formaldehyde in Foundry Waste Sands Using Liquid Chromatography. Analytical Letters 42(3):492-504.			
HERO ID:	4084759			
Conditions of Use:	use			
EXTRACTION				
Parameter	Data			
Description of release source:	foundry waste sands			
Release quantity:	Data was obtained from two foundries - Foundry P was using phenolic alkaline resin (PR) and foundry F was using furanic resin (FR). Results showed that the phenolic alkaline process generated waste sands with higher formaldehyde content than the furanic process; the highest value was 7.6x10^-3 % (w/w). In this work, formaldehyde content decreased with time in all of the samples studied, revealing that most formaldehyde was released to the occupational environment. The samples with the highest formaldehyde percentage in the FR process was 1.3x10^-3 - 2.0x10^-3 %. Four of these samples were waste fines of reduced dimensions, obtained after thermal and/or mechanical treatment; all of these sands had been submitted to high casting temperatures. Results of the analysis of PR samples on the first days show the highest formaldehyde content for a fine sand obtained after thermal treatment (7.6x10^-3 %).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	data more than 10 years but no more than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Otwell, L.P., Hittmeier, M.E., Hooda, U., Yan, H., Su, W., Banerjee, S. (2000). HAPs release from wood drying. Environmental Science and Technology 34(11):2280-2283.			
HERO ID:	1173736			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter		Data		
Description of release source:		Emissions from heating dry pine and aspen flakes.		
Release or emission factors:		Release or emission factors		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	
	Metric 3:	Applicability	High	
	Metric 4:	Temporal Representativeness	Medium	
	Metric 5:	Sample Size	Medium	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by comparing emissions from different types of wood but uncertainty not addressed.
Overall Quality Determination			Medium	

Study Citation:	Outapa, P., Thepanondh, S. (2014). Development of air toxic emission factor and inventory of on-road mobile sources. Air, Soil and Water Research 7:1-10.			
HERO ID:	5587959			
Conditions of Use:	emission			
EXTRACTION				
Parameter	Data			
Description of release source:	Air toxic compounds emitted from vehicles in Bangkok, Thailand			
Release quantity:	Formaldehyde is emitted by on-road vehicles and non-road equipment. Air toxic emission inventories are estimated according to vehicle fleet distribution, average travel distances per year, and developed emission factors. Taxis have the highest emission factors for formaldehyde. Annual emission amount of formaldehyde is mostly contributed by passenger cars, motorcycles and taxis. Emission inventory of formaldehyde is increased from 8,288 tons/year in 2009 to 11,772 tons/year in 2024. Normally, the highest ambient concentrations of formaldehyde were found at urban roadside sites. It appears that summer photochemical activity contributes more formaldehyde to ambient air than direct vehicle emissions do, as strong seasonal effects are observed.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of t
	Metric 4:	Temporal Representativeness	High	data less than 10 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Pang, H.C., Fu, H.Y., Gao, T.Z. (2014). Treatment of high concentration wastewater containing phenols and aldehyde from a small phenolic resin plant. Advanced Materials Research 864-867:1552-1555.
HERO ID:	2905404
Conditions of Use:	Disposal

EXTRACTION

Parameter	Data
Description of release source:	Waste treatment process described in Figure 1. In the presence of catalyst hydrochloric acid, addition condensation reaction was taken place in phenol and formaldehyde. Heating circumfluence made the phenol and formalin in the wastewater condensed into resins completely. In this stage, not only recovered the useful substances in the wastewater, but also reduced the pressure in the subsequent treatment. Then a small amount of phenols, aldehydes, alcohols and other organic matters in the wastewater could be oxidized and decomposed effectively by fenton oxidation in oxidation reactor. Finally, coal fly ash adsorption could further remove COD, phenol and chroma in wastewater, and sand filter could remove fine free fly ash in the wastewater. The final effluent quality could reach the required standard after this combination process. Wastewater in phenolic resin plant were collected into a tank, then pumped into the secondary condensation cauldron, added hydrochloric acid to adjust pH value between 1 and 2. Hydrochloric acid was catalyst of the condensation reaction of phenol and aldehyde. The reaction lasted for 3 hours in the boiling wasterwater with steam heating circumfluence. In the presence of catalyst under acid condition, phenolic resin was synthesized with phenol and formaldehyde in the wastewater. After standing for 15 minutes, resin was released from the bottoms of cauldron. Then did it second time to ensure that the condensation reaction was carried out completely to get more resins and remove more phenol and formaldehyd in the wastewater. The concentration of phenol <300mg/L, COD<1 000 mg/L in the effluent of condensation cauldron. After secondary condensation, the wastewater was bumped to the oxidation reactor, adjusted the pH value of water about 3 in the reactor. Added Fenton reagent to the reactor, hydroxyl radical has the advantages of strong oxidation, rapidly reaction, so phenol, formaldehyde, methanol et al organic matter in the water can be oxidized and decomposed effectively(oxidation reaction temperature is about 50°C, stirring 30min~60min until the wastewater color was light yellow). Then adjusted pH value of the water to neutral using alkali liquor (or limewater), filtered the precipitate in the reactor. Then wastewater was upgraded to the adsorption tower which was filled with coal fly ash. After 60 minutes' absorption in the tower, the concentration of phenol in the effluent was less than 0.5mg/L. Then the effluent water was pumped to a sand filter through a middle tank, in which fine fly ash and other suspended solids in the water were retained. The water flowed into clean water tank upon itself gravity. If the effluent quality deteriorated after the sand filter, backwashed the sand filter using centrifugal pump in the clean water tank. Ensure that the effluent water quality can meet the discharge standard. List of major equipment and structures provided in Table 2.Release comes from wastewater from phenolic resin production containing high concentrations of phenol and formaldehyde. The main raw material for the production of phenolic resin is phenols (phenol, xylene), formaldehyde, ammonia and methanol et al. Usually, producing 1 ton of phenolic resin generated 0.9m3 of high strength acid organic wastewater. The wastewater not only contains large amounts of phenol and free formaldehyde, but also contains methanol and low molecular weight resin.
Release quantity:	Influent water quality had 13300~15100 mg/L and have a discharge standard of <=1.0 mg/L.
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Source is from a published book that is unclear if it is peer reviewed but likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is from China, a non-OECD country.
	Metric 3:	Applicability	High	Data is applicable to the waste treatment of resin production containing formaldehyde.
	Metric 4:	Temporal Representativeness	High	Source is less than 10 years old.
	Metric 5:	Sample Size	Low	Most data is qualitative and not characterized by statistics.
Domain 3: Accessibility/ Clarity				

Continued on next page ...

Formaldehyde

Environmental Releases

HERO ID: 2905404 Table: 1 of 1

...continued from previous page

Study Citation:	Pang, H.C., Fu, H.Y., Gao, T.Z. (2014). Treatment of high concentration wastewater containing phenols and aldehyde from a small phenolic resin plant.			
HERO ID:	Advanced Materials Research 864-867:1552-1555.			
Conditions of Use:	2905404			
	Disposal			
		EVALUATION		
Domain	Metric	Rating	Comments	
	Metric 6:	Metadata Completeness	High	Contains process and unit operations, release media, release quantities and waste treatment methods.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Patel, S. H., Xanthos, M. (2001). Environmental issues in polymer processing: A review on volatile emissions and material/energy recovery options. Advances in Polymer Technology 20(1):22-41.			
HERO ID:	7324730			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Description of release source:	Sources discussed in this article include processing of polyethylene, including LDPE, HDPE, PP, and carpets with PVC backing. Polyolefins also emitted formaldehyde.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Release data methodology is expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Provides only limited discussion of the variability in the determinants of exposure but no discussion of the uncertainty in the exposure estimates.
Overall Quality Determination		Medium		

Study Citation:	Pellizzari, E. D., Sheldon, L. S., Sparacino, C. M., Bursey, J. T., Wallace, L., Bromberg, S. (1984). Volatile organic levels in indoor air. :303-308.			
HERO ID:	21953			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde is a common indoor organic contaminant with many sources in the residential environment			
Release quantity:	In one of the studies for Texas mobile homes, the mean indoor formaldehyde concentration for the 164-home initial survey was 0.15 ppm, with a standard deviation of 0.12 ppm. Concentrations ranged from below detection limit (0.02 ppm) to 0.78 ppm; 85% of the homes were below 0.25 ppm. County means were as follows: Harris = 0.18 ppm, Tarrant = 0.24 ppm, Midland = 0.11 ppm, and El Paso = 0.06 ppm. Outdoor formaldehyde concentrations were in general below measurement detection limits.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The release data methodology is known or expected to be accurate	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data is from U.S.	
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	more than 20 years old	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.	
Overall Quality Determination		Medium		

Study Citation:	Pervier, J.W., Barley, R.C., Field, D.E., Friedman, B.M., Morris, R.B. (1974). Survey reports on atmospheric emissions from the Petrochemical Industry.			
HERO ID:	5441658			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Leaks in pump seals or piping leaks. (173/341)			
Release quantity:	212 million lbs/yr of formaldehyde was estimated to be released in 1980. (22/341)			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the production of formaldehyde, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			High	

Study Citation:	Petersen, H. (1987). Formaldehyde and new concepts for its application in textile finishing. Colourage 34(12):23-32.			
HERO ID:	5946609			
Conditions of Use:	commercial use (textile finishing)			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde liberated by partial hydrolysis on finished textiles			
Release quantity:	For the formaldehyde liberation according to Law 112 are: 350 ppm at 173 deg C, 400 at 160 deg C, 450 at 148 deg C, and 500 ppm at 136 deg C a catalyst ratio of 100 g/I of Fixapret CPN and a curing time of 5 minutes. As the catalyst ratio in the regression equation is not contained as a significant term, the isograms run parallel to the catalyst axis. At temperatures above 150” C, when 100 g/I of crosslinking agent was used with a curing time of 5 minutes with 5 to 50 % of magnesium chloride hexahydrate, the formaldehyde liberation according to Law 112 was less than 450 ppm. For formaldehyde liberation of 550 ppm at a temperature of above 150 deg C, the curing time can be 2 min; at a curing time of 6 min, the same formaldehyde liberation was achieved at a temperature of only approximately 135 deg C. For the various levels of formaldehyde liberation, there is a strong temperature time influence; this applies to Fixapret COC as well as to Fixapret CPN.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	methodology is expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data is greater than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Low		

Formaldehyde

Environmental Releases

HERO ID: 5955197 Table: 1 of 1

Study Citation:	Petersen, H., Pai, P.S. (1981). Reagents for low-formaldehyde finishing of textiles. Textile Research Journal 51(4):282-302.
HERO ID:	5955197
Conditions of Use:	Textile finishing

EXTRACTION

Parameter	Data
Description of release source:	Formaldehyde is released during drying and curing.
Release quantity:	Amounts of formaldehyde released with different handling techniques listed in Table 4 (very difficult to read), Table 5, and Figure 12.
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data were collected before the most recent federal regulatory action or update or are more than 20 years old if no federal regulation is established. The operations, equipment, and worker activities are not available or indicate that the associated data are expected to be outdated.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.

Overall Quality Determination

Medium

Study Citation:	Petinarakis, J.H., Kavvouras, P.K. (2006). Technological factors affecting the emission of formaldehyde from particleboards. Wood Research 51(1):31-40.		
HERO ID:	5946610		
Conditions of Use:	emissions		
EXTRACTION			
Parameter	Data		
Description of release source:	Emission of formaldehyde from particleboards produced from low formaldehyde emission (E1 type) adhesive		
Release quantity:	Emission of formaldehyde increases with the moisture content of the wood-glue mixture before entering the press, decreases with the density of the products, and the temperature of the press, within certain limits, reduces emission. For moisture content of 8% and board density of 700 kg/m3, formaldehyde emission decreases from 15.52 to 12.23 mg/kg when pressing temperature increases from 160 to 190 deg C. Similarly, for moisture content of 14% and board density of 700 kg/m3, formaldehyde emission decreases from 18.27 to 12.35 mg/kg when pressing temperature increases from 160 to 190 deg C. The authors studied the following moisture contents: 8, 10, 12, and 14 percents. Also, 3 pressing temperatures were studied – 160, 175, and 190 deg C. For moisture content of 8% and pressing temperature of 160 deg C, formaldehyde emission decreases from 15.52 to 12.2 mg/kg when board density increases from 700 to 800 kg/m3. Similarly, for moisture content of 14% and pressing temperature of 160 deg C, formaldehyde emission decreases from 18.27 to 12.86 mg/kg when board density increases from 700 to 800 kg/m3. For this study, 3 board densities were studied – 700, 750, and 800 kg/m3. For board density of 700 kg/m3 and pressing temperature of 160 deg C, the formaldehyde emissions increases from 15.52 mg/kg to 18.27 mg/kg when the moisture content increases from 8% to 14%.		
Release or emission factors:	Release or emission factors		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	methodology is expected to be accurate
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	data are from an OECD country other than the U.S
	Metric 3: Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Medium	data is between 10 and 20 years old
	Metric 5: Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	does not discuss uncertainties
Overall Quality Determination		Medium	

Study Citation:	programs, E.O. (1974). Air pollution control engineering and cost study of the paint and varnish industry.			
HERO ID:	6580284			
Conditions of Use:	release			
EXTRACTION				
Parameter	Data			
Description of release source:	There are two major types of emissions from a paint plant. These are confined (or non-fugitive) and fugitive. Fugitive emissions can be pigment particulates and paint solvents. Solvent emission can occur during thinning, filtering, grinding, dispersion, and packaging. Fugitive emissions can also happen from tanks. The number of regulated emissions emanating from a paint plant will vary significantly with the type of operation involved. Some trade sales plants that manufacture none of their own resins and make no effort to confine solvent losses during dispersion, filtering, or storage, will have no non-fugitive emissions. On the other hand, resin plants or paint plants producing resins and varnishes are likely to have a number of non-fugitive emissions. These emissions consist primarily of organic vapors in air or inert gas streams. Major sources included varnish cooking, resin cooking, and thinning. Minor sources include handling and storage, milling, blending and finishing, and filling.			
Release quantity:	Though total emissions from pain plant and resin plant are provided, no information is provided regarding formaldehyde emissions from these plants.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is known or expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data is more than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Puškár, M., Jahnátek, A., Kuric, I., Kádárová, J., Melichar, K., Šoltésová, M. (2019). Complex analysis focused on influence of biodiesel and its mixture on regulated and unregulated emissions of motor vehicles with the aim to protect air quality and environment. Air Quality, Atmosphere and Health 12(7):1-10.			
HERO ID:	5707806			
Conditions of Use:	Fuels and Related Products			
EXTRACTION				
Parameter	Data			
Description of release source:	Automobile exhaust (diesel vs. biodiesel) (pg 2 for details)			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Slovakia, an OECD country.
	Metric 3:	Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (assumed mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata (regarding emission factors) provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing different fuel types and engine operations, but uncertainty is not addressed.
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 2373425 Table: 1 of 1

Study Citation:	Qiu, K., Yang, L., Lin, J., Wang, P., Yang, Y., Ye, D., Wang, L. (2014). Historical industrial emissions of non-methane volatile organic compounds in China for the period of 1980-2010. Atmospheric Environment 86:102-112.			
HERO ID:	2373425			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Description of release source:	Four major sources of NMVOCs are production of NMVOCs, storage and transport, industrial processes using NMVOCs as raw materials, and processes using NMVOCs-containing products.			
Release quantity:	Total industrial NMVOC emissions in China in 2010 were 13.35 Tg, of which 2.63 Tg were from the production of NMVOCs, 1.295 Tg from storage and transport, 1.769 Tg from industrial processes using NMVOCs as raw materials, and 7.662 Tg from processes using NMVOC-containing products.			
Release or emission factors:	Release or emission factors			
Comments:	The article discusses NMVOCs. Formaldehyde is a NMVOC. Industrial NMVOCs emissions had increased by 11.6 times from 1980 to 2010. The article lists the emission factors for different industries with processes using NMVOC-containing products			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	methodology well described
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	non-OECD country
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	the article is less than 10 years old
	Metric 5:	Sample Size	Low	no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	addresses variability and uncertainty
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 1482016 Table: 1 of 1

Study Citation:	Radian Corp (1995). Douglas Aircraft Company Long Beach facility AB 2588 air toxics ”hot spots” health risk assessment based on revised 1991 emissions with cover letter dated 10/20/95.			
HERO ID:	1482016			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Release quantity:	7,747.7 (lb/year) page 31/349			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old. (1995)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing release source, waste treatment methods.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Radian Corp, (1991). Air toxic hot spots - AB 2588 health risk assessment (volume I & II) (final reports) with attachments and cover letter dated 032991.			
HERO ID:	1356137			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Release quantity:	390.3 lbs/yr			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The release data appears to be accurate and is known to cover allrelease sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	he release data are for refinery operations, which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report was published in 1991, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a single value for individual sources.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, though it notes the process ID it lacks information that links the ID to processes, unit operations, or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided values for specific sources that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Study Citation:	Radian Corp, (1991). Air toxic hot spots - AB 2588 health risk assessment - Shell Oil Company Martinez Refinery (volume I and II) with attachments, cover sheets and letter 040291.			
HERO ID:	1356138			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Release quantity:	940 lbs/yr			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is not specified, but it appears that the methodology has been accepted by the district and is known to cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The release data are for refinery releases, which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The data were published in 1991, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Medium	emission factors are provided for individual sources, additional statistical analysis is not provided.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source ofthe release.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	values are provided for individual sites which can be used to assess variability. The is discussion of uncertainty related to the risk assessment, but not the inventory component of the study.	
Overall Quality Determination		Medium		

Study Citation:	Radian Corp, (1991). Letter from Chevron Corporation to USEPA submitting enclosed submission of four Chevron USA oil production facility risk assessment facilities in California with attachments.			
HERO ID:	1481749			
Conditions of Use:	”Processing aids, specific to petroleum production in: oil and gas drilling, extraction, and support activities and all other basic inorganic chemical manufacturing”			
EXTRACTION				
Parameter	Data			
Description of release source:	Stack releases to the air			
Release frequency:	365			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for petroleum manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old. (1991)
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing waste treatment methods.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 4213948 Table: 1 of 1

Study Citation:	Radian Corp, (1991). Air toxic hot spots - AB 2588 health risk assessment Douglas Aircraft Company Long Beach Facility volume I with cover letter dated 081291.			
HERO ID:	4213948			
Conditions of Use:	Plastic material and resin manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Source identification numbers given in Table 2-2.			
Release quantity:	4,380.1 (lbs/year)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old. (1991)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing waste treatment methods, release or emission factors.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Radian Engineering, (1997). General Electric Engine Services Test Cell Complex - AB 2588 air toxic "hot spots" 1991 health risk assessment, with cover letter dated 10/21/1997.			
HERO ID:	5665035			
Conditions of Use:	Jet fuel in aircraft engines			
EXTRACTION				
Parameter	Data			
Release quantity:	Test 1: Maximum: 1.66 x 10^0 lbs/hr. Annual: 2.65 x 10^2. Test 2: Maximum: 1.55 x 10^0 lbs/hr. Annual: 3.12 x 10^2. Appendix 1 shows calculated air toxic emissions from tests: Power settings for engine models: Idle - 1.43 x 10^2 lb/yr, 2.21 x 10^1 lb/yr, 3.78 lb/yr, 17.2 lb/yr, 1.10 x 10^2 lb/yr, 3.40 x 10^1 lb/yr, 2.18 x 10^1 lb/yr, 3.71 x 10^1 lb/yr; 30% - 4.68 x 10^-1 lb/yr, 6.65 x 10^-2 lb/yr, 2.73 x 10^-2, 2.88 x 10^-1, 3.59 x 10^-1, 1.02 x 10^-1, 1.57 x 10^-1, 6.22 x 10^-1; 85% - 6.44 lb/yr, 1.12 lb/yr, 1.59 x 10^-1, 8.79 x 10^-1, 4.93, 1.73, 1.62, 2.36; 100% - 7.39 lb/yr, 1.22 lb/yr, 2.81 x 10^-1, 1.09, 5.66, 1.87, 1.62, 2.36.			
Comments:	Table 3 (pg. 70/230) provide emission factors for jet engines.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Data is TSCA submission for EPA so likely contains high quality data.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	High	Data is applicable to use in aircraft engines as fuel.	
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.	
Overall Quality Determination		Medium		

Study Citation:	Reda, A. A., Czech, H., Schnelle-Kreis, J., Sippula, O., Orasche, J., Weggler, B., Abbaszade, G., Arteaga-Salas, J. M., Kortelainen, M., Tissari, J., Jokiniemi, J., Streibel, T., Zimmermann, R. (2015). Analysis of gas-phase carbonyl compounds in emissions from modern wood combustion appliances: Influence of wood type and combustion appliance. Energy and Fuels 29(6):3897-3907.			
HERO ID:	3027869			
Conditions of Use:	Combustion Byproduct			
EXTRACTION				
Parameter		Data		
Release quantity:		Emission factors provided in Table 3. Average Emission Factors (mg/kg): birch (masonry heater) - 66.0 +/- 9; spruce (masonry heater) - 108.0 +/- 9.5; beech (masonry heater) - 112.1 +/- 21.0; normal plt (pellet boiler) - 3.1 +/- 0.5; unoptimized plt (pellet boiler) - 3.4 +/- 0.5; pine (fireplace) - 1165; oak (fireplace) - 759; eucalyptus (fireplace) - 599; birch (wood stove) - 422; maritime pine (wood stove) - 653 +/- 151; eucalyptus (wood stove) 1038 +/- 66; cork oak (wood stove) - 1080 +/- 48; Holm oak (wood stove) - 988 +/- 166; pyrenean oak (wood stove) - 1772 +/- 649; Figure 5 shows a comparison of the emission factors with the other tested VOCs		
Release or emission factors:		Release or emission factors		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	Study is by both Finland and Germany, both OECD countries.
		Metric 3: Applicability	Low	Data is not for an in-scope use but could be applied to disposal or waste management of wood products.
		Metric 4: Temporal Representativeness	High	Data is less than 10 years old.
		Metric 5: Sample Size	Medium	Characterized by a range of data with uncertain statistics.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Low	Only contains emission factors.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Medium	Addresses variability by looking at different emission rates of different woods. Does not address uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Reeves, W.A., Day, M.O., McLellan, K.R., Vigo, T.L. (1981). Formaldehyde release in formaldehyde-finished and resin-finished fabrics. Textile Research Journal 51(7):481-485.			
HERO ID:	5960898			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Description of release source:	"Formaldehyde is released to the atmosphere in finishing plants during application for these finishes and is later released from treated fabrics in storage, cutting rooms, and retail stores. (1/5)"			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for textile finishing and the use of fabric, which are in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling two fabric types with five different finishing agents.
Overall Quality Determination		High		

Study Citation:	Roffael, E., Dix, B., Schneider, T. (2007). Influence of pulping process on the emission of formaldehyde and volatile organic acids from pulps and medium density fibreboards (MDF). Holz als Roh- und Werkstoff 65(2):145-148.			
HERO ID:	5963848			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known but may not cover all releases sources at a site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country, Germany.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	More than 10 years old (2007).
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	release data includes all associated metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Release data provides discussion on variability but no discussion on uncertainty in the release results.
Overall Quality Determination		Medium		

Study Citation:	Roffael, E., Gabriel, M., Schneider, T., Behn, C. (2018). Influence of pulping technology on the release of formaldehyde and volatile organic acids from oak fibres and medium density fibreboards (MDF) prepared therefrom. Holz als Roh- und Werkstoff 76(1):397-399.			
HERO ID:	5963839			
Conditions of Use:	Medium Density fibreboard preparation/production			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde emissions from MDF boards			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data is for Germany, an OECD country.	
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Addresses variability by looking at two different possible production methods. Does not address uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Roffael, E., Huester, H.G. (2012). Complex chemical interactions on thermo hydrolytic degradation of urea formaldehyde resins (UF-resins) in recycling UF-bonded boards. Holz als Roh- und Werkstoff 70(4):401-405.			
HERO ID:	5956769			
Conditions of Use:	Building and construction materials (particleboard)			
EXTRACTION				
Parameter	Data			
Description of release source:	UF resin in particleboard			
Release or emission factors:	Release or emission factors			
Comments:	"The particles were tested for the release of formaldehyde and volatile organic acids using the flask method originally developed for measuring the formaldehyde release (Roffael 1975, EN 717-3)... The released formaldehyde was photometrically determined using the acetyl acetone method according to EN 717-3" (pg 2)			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	Data are for building/construction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by studying emissions for different temperatures/durations, but uncertainty is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 5941518 Table: 1 of 1

Study Citation:	Rosca, I., Tanczos, I., Schmidt, H. (2004). Formaldehyde emissions from wood-melamine-formaldehyde resin compounds during the extrusion process.			
HERO ID:	5941518			
Conditions of Use:	Resin in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde emissions during extrusion or compression-moulding process.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Unclear if peer reviewed by appears to contain high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for Austria, an OECD country.
	Metric 3:	Applicability	High	Data is applicable to use of FA resins in wood products.
	Metric 4:	Temporal Representativeness	Low	Data is over 10 years old (2004).
	Metric 5:	Sample Size	Medium	Characterized by range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes release source, the operation and emission factors.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability (different initial moisture) but does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Saffari, M. (2011). Effects of hardener type and particles size on formaldehyde emission pollution. 8:242-244.		
HERO ID:	5946626		
Conditions of Use:	Use of Resin in Particleboards		
EXTRACTION			
Parameter	Data		
Description of release source:	Release by emission from particleboards.		
Release or emission factors:	Release or emission factors		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country (Iran), and locality-specific factors may impact (e.g., potentially greater differences in regulatory emission limits, industry/ process technologies) releases relative to the U.S.
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data indicate that the data should to be representative of current operations, equipment, and activities. The release data were collected after the most recent federal regulatory action (e.g., NE-SHAP for air release or effluent limit guideline (ELG) for water release) or update or are no more than 10 years old, whichever is shorter. If no federal regulation is established, the data are generally no more than 10 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.
Overall Quality Determination		High	

Study Citation:	Sallem-Idriss, N., Vanderghem, C., Pacary, T., Richel, A., Debecker, D. P., Devaux, J., Sclavons, M. (2016). Lignin degradation and stability: Volatile Organic Compounds (VOCs) analysis throughout processing. Polymer Degradation and Stability 130:30-37.			
HERO ID:	3421333			
Conditions of Use:	Other Byproduct			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Comments:	Article looks at exposure of various VOCs from lignin which is used in wood processing			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data from Belgium - OECD country.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include release media and process.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by comparing different processes but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Salthammer, T. (2019). Data on formaldehyde sources, formaldehyde concentrations and air exchange rates in European housings. Data in Brief 22:400-435.		
HERO ID:	6039334		
Conditions of Use:	Fuels and related products		
EXTRACTION			
Parameter	Data		
Description of release source:	Burning of fuel in ethanol fireplaces		
Release or emission factors:	Release or emission factors		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Low	Methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3: Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by assessing emissions from multiple types of scented candles, but uncertainty is not addressed.
Overall Quality Determination		Medium	

Study Citation:	Salthammer, T. (2019). Data on formaldehyde sources, formaldehyde concentrations and air exchange rates in European housings. Data in Brief 22:400-435.			
HERO ID:	6039334			
Conditions of Use:	Cleaning and Furniture Care Products			
EXTRACTION				
Parameter	Data			
Description of release source:	Cleaning activities with All-purpose spray cleaning agent, All-purpose liquid cleaning agent, Kitchen cleaning agent, Floor cleaning agent, Furniture polish, and Floor polish.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Methodology is not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.	
	Metric 3: Applicability	High	Data are for cleaning and furniture care products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Data are no more than 10 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release media provided but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by addressing releases from multiple cleaning products, but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Salthammer, T. (2019). Data on formaldehyde sources, formaldehyde concentrations and air exchange rates in European housings. Data in Brief 22:400-435.			
HERO ID:	6039334			
Conditions of Use:	Personal care products (covered by TSCA)			
EXTRACTION				
Parameter		Data		
Description of release source:		Burning of scented candles.		
Release or emission factors:		Release or emission factors		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Low	Methodology is not specified.
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.
		Metric 3: Applicability	High	Data are for Personal care products (covered by TSCA), an in-scope occupational scenario.
		Metric 4: Temporal Representativeness	High	Data are no more than 10 years old.
		Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Medium	Variability addressed by assessing emissions from multiple types of scented candles, but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation: Salthammer, T. (2019). Data on formaldehyde sources, formaldehyde concentrations and air exchange rates in European housings. Data in Brief 22:400-435.	
HERO ID: 6039334	
Conditions of Use: Adhesives and Sealants; Paint and coatings	
EXTRACTION	
Parameter	Data
Description of release source:	nan
Release or emission factors:	Release or emission factors
EVALUATION	
Domain	Metric
Domain 1: Reliability	Rating
Metric 1:	Methodology
	Low
	Methodology is not specified.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Metric 3:	Applicability
	Medium
	High
	Data are from Germany, an OECD country.
	Data are for Adhesives and Sealants; Paint and coatings, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness
Metric 5:	Sample Size
	High
	High
	Data are no more than 10 years old.
	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	Low
	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	Medium
	Variability addressed by addressing emission factors from multiple paints and coatings, but uncertainty is not addressed.
Overall Quality Determination	
Medium	

Study Citation:	Salthammer, T. (2019). Data on formaldehyde sources, formaldehyde concentrations and air exchange rates in European housings. Data in Brief 22:400-435.		
HERO ID:	6039334		
Conditions of Use:	Fabric, textile, and leather products not covered elsewhere		
EXTRACTION			
Parameter	Data		
Description of release source:	Curtains, pants, t-shirts.		
Release or emission factors:	Release or emission factors		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Low	Methodology is not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3: Applicability	High	Data are for Fabric, textile, and leather products not covered elsewhere, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by addressing emission factors from multiple fabrics, but uncertainty is not addressed.
Overall Quality Determination		Medium	

Study Citation:	Salthammer, T. (2019). Data on formaldehyde sources, formaldehyde concentrations and air exchange rates in European housings. Data in Brief 22:400-435.			
HERO ID:	6039334			
Conditions of Use:	Building/ construction materials (wood and engineered wood products)			
EXTRACTION				
Parameter	Data			
Description of release source:	Burning of wood in fireplaces and wood stoves.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	Methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	Data are for Building/ construction materials (wood and engineered wood products), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by addressing emission factors from multiple wood types, but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Scheyer, L.E., Kachman, S.D., Polsani, M. (2001). Use of soy protein hydrolyzate to reduce formaldehyde emissions from pigment print pastes. AATCC Review 1(8):45-48.			
HERO ID:	5939036			
Conditions of Use:	chemical substances in fabric pigment			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Sampling/analytical methodology is an approved AATCC method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for chemical substances in fabric pigment, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Emission data were more than 10 years old (2001), not currently more than 20 years.
	Metric 5:	Sample Size	High	Distribution is characterized by mean and standard deviation, number of samples are known.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data are only on emissions per weight of fabric, not included process information to conclude releases by operation or site.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by including varying binder, scavenger, and resins type. Uncertainty is not discussed on emission values but is discussed on feasibility of scavenger as an emission control.
Overall Quality Determination			High	

Study Citation:	Scheyer, L.E., Polsani, M. (2000). Use of chemically modified wheat gluten to reduce formaldehyde emissions during curing of pigment print pastes on fabrics. Starch 52(11):420-422.			
HERO ID:	5740641			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Release or emission factors:	nan			
Comments:	Wheat gluten was added into fabric print pastes to reduce formaldehyde emissions.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Report is more than 20 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by comparing 2 types of print pastes but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Schifter, I., Diaz, L., Lopez-Salinas, E., Ramos, F., Avalos, S., Lopez-Vidal, G., Castillo, M. (2000). Estimation of motor vehicle toxic emissions in the metropolitan area of Mexico City. Environmental Science and Technology 34(17):3606-3610.
HERO ID:	4087479
Conditions of Use:	Vehicle Exhaust

EXTRACTION	
Parameter	Data
Description of release source:	Formaldehyde is the most prevalent aldehyde in vehicle exhaust and comes from incomplete combustion of the fuel.
Release quantity:	Table 11 shows estimation of emission in tons/yr: Vehicles: 205.3, 36.7, and 15.7 for years 1984-1990, 1991-1996, 1997-1999; Taxis: 1984-1990 - 138.7; minibus: <1995-1996 - 23.1
Release or emission factors:	Release or emission factors
Release frequency:	Assumed to be 365 days/yr

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High
			Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium
	Metric 3:	Applicability	Uninformative
	Metric 4:	Temporal Representativeness	Low
	Metric 5:	Sample Size	Low
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium
			Includes release source, emission factors, quantities, and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium
			Addresses variability by looking at multiple years of emissions. Does not address uncertainty.

Overall Quality Determination **Uninformative**

Study Citation:	Schripp, T., Wensing, M. (2009). Emission of VOCs and SVOCs from electronic devices and office equipment. :405-430.			
HERO ID:	9493521			
Conditions of Use:	Electrical and electronic products (plastics/resins)			
EXTRACTION				
Parameter	Data			
Description of release source:	TV sets, VCRs, Cathode ray tube PCs, Thin-film transistor PCsalso states: "Additional quantitative data for individual VOCs aswell as for formaldehyde and acetaldehyde emissions from device casing materialsand electronic components may be found in Funaki et al . (2003) , Nakagawa et al . (2003) , M ö ller et al . (2004) , and Wensing (2004).” pg. 2/26			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for electrical and electronic products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (uncertainty) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release media and emission factors provided but missing release quantity and waste treatment methods.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed by sampling methods. Variability addressed by investigating emission factors from multiple products.	
Overall Quality Determination		High		

Study Citation:	Sekizawa, J., Ohtawa, H., Yamamoto, H., Okada, Y., Nakano, T., Hirai, H., Yamamoto, S., Yasuno, K. (2007). Evaluation of human health risks from exposures to four air pollutants in the indoor and the outdoor environments in Tokushima, and communication of the outcomes to the local people. Journal of Risk Research 10(6):841-851.			
HERO ID:	3839231			
Conditions of Use:	Various			
EXTRACTION				
Parameter	Data			
Release quantity:	Media: Air - 2002: 5.07 tpy in Tokushima Prefecture, 342 tpy nationwide in Japan (pg 5)			
Comments:	Release sources not specified (i.e., total releases presented). Release data obtained from Japan’s Pollutant Release and Transfer Register (PRTR) data (pg. 5)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1: Methodology	Low	Methodology is not specified (article is secondary source of data).	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Japan, an OECD country.	
	Metric 3: Applicability	Low	Data are total annual releases from unspecified sources (i.e., doesn’t specify whether it includes all industries, facilities of all sizes, etc.)	
	Metric 4: Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics (only totals given).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release media provided but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Low		

Study Citation:	Shishlov, O., Dozhnikov, S., Glukhikh, V., Eltsov, O., Kraus, E., Orf, L., Heilig, M., Stoyanov, O. (2017). Synthesis of bromo-cardanol novolac resins and evaluation of their effectiveness as flame retardants and adhesives for particleboard.			
HERO ID:	5496386			
Conditions of Use:	Industrial/Commercial Use			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Emission factors from an European Standard.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Standard from 1996.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed in emissions between different particleboards but uncertainty not addressed.
Overall Quality Determination			Medium	

Study Citation:	Simon, S. I. (1980). Using the Verkor FD-EX chamber to prevent formaldehyde emission from boards manufactured with urea formaldehyde glues. 14:163-171.			
HERO ID:	6017724			
Conditions of Use:	Building and Construction Materials (particleboard)			
EXTRACTION				
Parameter	Data			
Description of release source:	UF resin in particleboard (1:12 to 1:2.1 U:F molar ratios) (pg 4)			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
Comments:	media: fugitive air			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from various European OECD countries.
	Metric 3:	Applicability	High	Data are for building and construction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Low	Sample distribution (for control technology) is described qualitatively (graphically).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	N/A	controls data
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by evaluating free formaldehyde content for various boards and treatment times, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Singh, D., Shukla, S. P., Sharma, M., Behera, S. N., Mohan, D., Singh, N. B., Pandey, G. (2014). GIS-based on-road vehicular emission inventory for Lucknow, India. Journal of Hazardous, Toxic and Radioactive Waste 20(4):A4014006.			
HERO ID:	5705158			
Conditions of Use:	Fuels and Related Products			
EXTRACTION				
Parameter	Data			
Description of release source:	Automobile exhaust			
Release quantity:	Presented graphically (pg 4)			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3:	Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	N/A	Net EFs derived from government (CPCB) and equations.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata (regarding source of government EFs and equation to derive net EFs) provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Variability addressed by evaluating multiple types of vehicles and fuels. Uncertainty is addressed by stating that the EFs presented don’t encompass the entire driving cycle (braking, accleration, idling, etc.)
Overall Quality Determination			High	

Study Citation:	Smith, T.J., Quinn, M.M., Marsh, G.M., Youk, A.O., Stone, R.A., Buchanich, J.M., Gula, M.J. (2001). Historical cohort study of US man-made vitreous fiber production workers: VII. Overview of the exposure assessment. Journal of Occupational and Environmental Medicine 43(9):809-823.			
HERO ID:	5949992			
Conditions of Use:	Incorporation into articles			
EXTRACTION				
Parameter	Data			
Description of release source:	Table 2 provides a description of emission sources particularly to workers and occupational exposure: Furnace: glass making - furnace fume, trace metals, crystalline silica dust; fiberizer: wool forming (nominal diameter) staple forming: >12 um, steam blowing: 5-12 um, rotary blowing: <2; 2-4; 4-8 um, Flame attenuation: <2, 2-4 um - airborne fibers, FA, aerosol of uncured PF binder; Curing oven - FA, condensation oil aerosol, pyrolysis products, polycyclic aromatic hydrocarbon; Curing press - FA, condensation oil aerosol, pyrolysis products, polycyclic aromatic hydrocarbons; Trimming and packaging - fibers, resin particles, amorphous glass particles; off-line fabrication - fibers, resin particles, paint and amorphous glass particles; Continuous filament forming (filament diameter: 5-25 um) - starch particles, epoxy vapor, or particles from sizing for filaments; Yarn and textile production (filaments) - amorphous particles of sizing and glass (some glass shards meet fiber definition), resin vapors; roofing (filament matt treated with asphalt) - asphalt, amorphous particles; Material handling - fibers, amorphous particles			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The release data were collected after the most recent federal regulatory action or update but are generally, more than 10 years old. If no federal regulation is established, the data are more than 10 years but no more than 20 years old. However, operations, equipment, and worker activities are expected to be reasonably representative of current conditions.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides no discussion of the uncertainty in the release results.
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Study Citation:	Smith, T.J., Quinn, M.M., Marsh, G.M., Youk, A.O., Stone, R.A., Buchanich, J.M., Gula, M.J. (2001). Historical cohort study of US man-made vitreous fiber production workers: VII. Overview of the exposure assessment. Journal of Occupational and Environmental Medicine 43(9):809-823.		
HERO ID:	5949992		
Conditions of Use:	Incorporation into articles		
Domain		EVALUATION	
Metric		Rating	Comments
Overall Quality Determination		High	

Study Citation:	Snow, R., Baker, L., Crews, W., Davis, C. O., Duncan, J., Perry, N., Siudak, P., Stump, F., Ray, W., Braddock, J. (1989). Characterization of emissions from a methanol fueled motor vehicle. Journal of the Air and Waste Management Association 39(1):48-54.			
HERO ID:	31779			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The release data methodology is known or expected to be accurate. Aldehyde samples were collected from the dilution tunnel through a heated (110°C) sample line using dinitrophenyl hydrazine (DNPH)-coated silica gel cartridges that were subsequently analyzed by high performance liquid chromatography.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The release data are for on road vehicles which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1989, before the most recent PEL (1992) and are more than 20 years old.	
	Metric 5: Sample Size	Medium	aggregated emission factors were provided two fuels (gasoline and M85) and three emission points (tailpipe, evaporative, refueling) plus an aggregated factor.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The release data study does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Soljacic, I., Katovic, D. (1988). The effect of heating on the release of formaldehyde from durable-press finished fabrics. Journal of the Society of Dyers and Colourists 104(10):384-386.			
HERO ID:	5938493			
Conditions of Use:	Processing (textile finishing)			
EXTRACTION				
Parameter	Data			
Description of release source:	The effect of subsequent heating on formaldehyde release from DMDHEU-finished fabric has been examined.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data from more than 20 years ago.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling different fabrics with different initial concentrations of formaldehyde.
Overall Quality Determination		Medium		

Study Citation:	Solt, P., Konnerth, J., Gindl-Altmutter, W., Kantner, W., Moser, J., Mitter, R., Herwijnen, H.W. (2019). Technological performance of formaldehyde-free adhesive alternatives for particleboard industry. International Journal of Adhesion and Adhesives 94:99-131.			
HERO ID:	5961865			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Description of release source: Emissions can originate from 1) synthetic free formaldehyde that is not polymerized into the network, and which will emit during or quickly after panel production; 2) formaldehyde can be released due to adhesive hydrolysis, which will emit over the life time of the panel depending on moisture and temperature; 3) biogenic sources. (3/33)				
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S.	
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The data are generally no more than 10 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		Medium		

Study Citation:	Stroud, C.A., Zaganescu, C., Chen, J., Mclinden, C.A., Zhang, J., Wang, D. (2016). Toxic volatile organic air pollutants across Canada: multi-year concentration trends, regional air quality modelling and source apportionment. Journal of Atmospheric Chemistry 73(2):137-164.			
HERO ID:	3259673			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter		Data		
Description of release source:		Primary contributors are mobile sources to ambient levels of toxic VOCs at urban locations across Canada. The large secondary contribution for formaldehyde is likely coming from the oxidation of biogenic emissions, in particular, isoprene OH-oxidation which forms formaldehyde at high gas-phase yield.		
Release quantity:		As per 2006 Canadian NPRI, emission of formaldehyde amount to 33 kilotons/yr. Formaldehyde emissions declined marginally from 2004 to 2010 for the average of all 15 sites monitored. The summertime and wintertime average observed formaldehyde are 2.4 ± 1.1 ppbv and 1.14 ± 0.73 ppbv. Primary mobile emissions contribute 19 % and 10% to formaldehyde and acetaldehyde in Edmonton in the summer. In the summer, primary mobile emissions are 12 % and 6 % for formaldehyde and acetaldehyde in Toronto, while area/point formaldehyde emissions are 17 % and 9 %.		
Release frequency:		varying releases during weekday and weekend		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is known
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	data is between 10 and 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Stump, F.D., Knapp, K.T., Ray, W.D. (1996). Influence of ethanol-blended fuels on the emissions from three pre-1985 light-duty passenger vehicles. Journal of the Air and Waste Management Association 46(12):1149-1161.			
HERO ID:	42346			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Release or emission factors:	nan			
Comments:	Study provides emission factors in terms of mg/mi for base fuels and ethanol for three vehicles (1977 ford mustang, 1980 Chevrolet citation 1984 Buick century) and 3 different temperatures (40,75,90). The Buick was tested with and without catalytic converter.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Federal test procedure was used Aldehyde samples were collected on silica gel cartridges coated with acidified 2,4-dinitrophenylhydrazine and analysis was performed using liquid chromatography
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The release data are for vehicle exhaust which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1996 after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range of values provided in graphs for each test vehicle and each temperature setting. It is unlikely that the analysis is representative of the current vehicle fleet and engine technologies.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The study addresses variability in providing data on different vehicles, fuels and temperatures. Uncertainty is considered in the sampling and analysis methods.
Overall Quality Determination			High	

Study Citation:	Stump, F.D., Knapp, K.T., Ray, W.D., Siudak, P.D., Snow, R.F. (1994). Influence of oxygenated fuels on the emissions from three pre-1985 light-duty passenger vehicles. Journal of the Air and Waste Management Association 44(6):781-786.			
HERO ID:	6590			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The release data is derived using CFR Title 40 procedures
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The release data are for an occupational scenario, vehicle emissions, which is within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities - specifically the discontinued use of MBTE and data based on older vehicles. The data were published in 1994, after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range of values for base fuel and MTBE for four different vehicles and three different temperatures. It is unclear if analysis is representative. information on uncertainty not included.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study provides limited information about variability for different fuels, vehicles and temperature.But there is no discussion of the uncertainty in the release results.
Overall Quality Determination		Medium		

Study Citation:	Stump, F.D., Knapp, K.T., Ray, W.D., Snow, R., Burton, C. (1992). The composition of motor vehicle organic emissions under elevated temperature summer driving conditions (75 to 105°F). Journal of the Air and Waste Management Association 42(2):152-158.			
HERO ID:	43449			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Description of release source:	vehicle exhaust			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The release data methodology is known; a constant volume sample system was used and aldehyde analyses were done using liquid chromatographic procedures.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The release data are for vehicle exhaust an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) but more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by an average value for fuel injection vehicles including standard deviation. The vehicle equipped with a carburetor only had an average value. Uncertainty statistics were not provided. It is unclear if this analysis is representative given the age of the vehicles included in the study.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	the data provided were derived from 7 vehicles with different cylinder displacement, number of cylinders and whether equipped with fuel injectors or carburetors manufactured between 1986 to 1990, which is useful in evaluating variability. Uncertainty was assumed to be addressed in the analysis methodology.	
Overall Quality Determination		High		

Study Citation:	Stump, F.D., Knapp, K.T., Ray, W.D., Snow, R., Eudy, L. (1992). The composition of motor vehicle organic emissions under elevated temperature summer driving conditions (75 to 105 F): Part II. Journal of the Air and Waste Management Association (1990-1992) 42(10):1328-1335.			
HERO ID:	1650380			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Description of release source:	Emissions from nine popular late-model motor vehicles with four-cylinder engines were characterized - six vehicles were fueled by throttle body injection (TBI) and three by port fuel injection (PFI).			
Release quantity:	Tailpipe emissions at 75 deg F (mg/min): TBI - 2.96 +/- 1.55, PFI - 3.20 +/- 1.7. Tailpipe emissions at 90 deg F (mg/min): TBI - 2.61 +/- 1.22, PFI - 3.80 +/- 1.95. Tailpipe emissions at 105 deg F (mg/min): TBI - 2.77 +/- 1.18, PFI - 3.55 +/- 1.84.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	no more than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	does not provide discussion on uncertainty
Overall Quality Determination			High	

Study Citation:	Tang, T., Claggett, M., Byun, J., Roberts, M., Granell, J., Aspy, D. E. (2005). MOBILE6.2 modeling of exhaust air toxic emission factors - Trend and sensitivity analysis. Transportation research record 1941(1):99-106.			
HERO ID:	1970148			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Description of release source:	motor vehicle			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The release data methodology is known or expected to be accurate	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	Low	The release data pertain to vehicle exhaust. This may have some application to the Occupational Exposure and Release assessment but judged to be low applicability.	
	Metric 4: Temporal Representativeness	Medium	The release data is between 10 and 20 years old	
	Metric 5: Sample Size	Low	characterized by no statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data study provides only discussion on variability but not on uncertainty	
Overall Quality Determination		Medium		

Study Citation:	Tetra Tech (1991). Letter from Exxon Chemical Inc to USEPA submitting information concerning the California Assembly Bill 25588, the toxic hot spots information and assessment act of 1987 w-attachments.			
HERO ID:	1874145			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Release quantity:	1610 lbs per year from EXXON BENICIA REFINERYAB 2588 TOXIC HOT SPOTS RISK SUMMARY			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for exposure at a refinery which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1991, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	only a singular emission release value is provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Tetra Tech, (1991). Initial Submission: Dow Chemical Torrance Facility ab 2588 risk assessment (final Report) with attachments and cover letter dated 122491.			
HERO ID:	1356132			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Description of release source:	The plant includes two batch type reactor systems and a blending operation. The primary raw materials for this process include base epoxy resin, tetrabrombisphenol-A, acetone, xylene and various additives. These materials are reacted and /or blended to form a wide variety of liquid epoxy resin products. The final products are stored in tanks prior to shipment offsite in drums or tank trucks.			
Release quantity:	Point 59 18.4 lbs/yr (0.0055 lbs/hr); Point 60 18.4 lbs/yr (0.0055 lbs/hr);			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	The release data methodology is not specified. All that is know is that the data comes from the Air Toxics Inventory Report. Annual average (lbs/hr) are provided in table A-2 for heaters
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The release data are for an epoxy resin plant which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was submitted in 1991, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	only aggregated annual values are provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, and unit operation, but lacks additional metadata, such as process, and/or activity that is the source of the release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Low		

Study Citation:	Texaco Chem Co (1991). Letter from Texaco Refining & Marketing inc to USEPA Submitting Enclosed Information and Studies Concerning Several 8(d) Chemicals with Attachments.			
HERO ID:	1270201			
Conditions of Use:	”Processing aids, specific to petroleum production in: oil and gas drilling, extraction, and support activities and all other basic inorganic chemical manufacturing”			
EXTRACTION				
Parameter	Data			
Description of release source:	petroleum refinery			
Release quantity:	0-6.15E (lb/year)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for petroleum manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old. (1991)
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing waste treatment and pollution control methods.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by emissions collected from multiple sources, but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Tohmura, S. I., Miyamoto, K., Inoue, A. (2015). Effects of Ethanol-Supplemented Phenol-Resorcinol-Formaldehyde Resin on Formaldehyde and Acetaldehyde Emissions from Glued-Laminated Timbers. Forest Products Journal 65(1-2):31-37.		
HERO ID:	2895587		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Description of release source:	Emissions from glued-laminated timbers bonded with phenol-resorcinol-formaldehyde resin adhesives, some of which included ethanol as a solvent.		
Release quantity:	GLA through GLB were glue-laminated timber for which PRF resin of company A through D were used. Formaldehyde emissions from GLB and GLD specimens were initially 680 and 583 ug/m2/h, respectively; they rapidly decreased to below 100 ug/m2/h within 3 weeks. This was probably because the formaldehyde emissions were trapped immediately following production by wrapping the timber specimens. Formaldehyde emissions from GLA and GLC specimens behaved nearly the same as that from the GLS specimen (control – prepared without application of an adhesive). Emissions from GLA and GLC were less than 100 ug/m2/h initially and decreased to less than 10 ug/m2/h within a week. The observed differences in the two classes of emission levels might be related to the curing rate. In the effect of ethanol content of PRF resin experiment, formaldehyde emission rates varied from 10 to 25 ug/m2/h in the early stages of the experiment, they decreased within a week. No relationship between the orientation of the exposed wood surfaces of the glued-laminated timbers and formaldehyde emission was observed.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	OECD country
	Metric 3: Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	No discussion on uncertainties but variability addressed by comparing PRF resins from different resin manufacturer.
Overall Quality Determination		Medium	

Study Citation:	Tong, X., Shen, W., Chen, X., Corriou, J.P. (2018). Qualitative and quantitative analysis of gaseous pollutants for cleaner production in pulp and paper mills. Journal of Cleaner Production 198:1066-1075.				
HERO ID:	5956412				
Conditions of Use:	Processing: Paper manufacturing				
EXTRACTION					
Parameter	Data				
Release or emission factors:	Release or emission factors				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	Methodology is not specified.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country	
	Metric 3:	Applicability	High	Data are for paper manufacturing, an in-scope occupational scenario	
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.	
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination			Low		

Study Citation:	U.S. EPA, (2022). DMR Data for TCEP, formaldehyde, trans-1,2-dichloroethylene, 1,1-dichloroethane, and 1,2-dichloroethane.			
HERO ID:	11181053			
Conditions of Use:	All			
EXTRACTION				
Parameter	Data			
Description of release source:	Provides company name and site location of release source.			
Release quantity:	Provides annual and period release quantities.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Methodology used by submitters to estimate release data is not known.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	DMR is U.S. based data	
	Metric 3: Applicability	High	DMR includes industries included in the scopes of multiple chemicals	
	Metric 4: Temporal Representativeness	High	DMR data are less than 10 years old.	
	Metric 5: Sample Size	Medium	Universe is limited to NPDES permit holders; statistical representativeness is unclear.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	DMR includes release source and release quantity, but is missing emission factors, waste treatment information, and release frequency.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability is addressed by including multiple years of DMR data. DMR does not address uncertainty in submitter provided data.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2023). National Analysis TRI dataset (TRI): Formaldehyde (CAS RN: 50-00-0), reporting years 2016-2021.			
HERO ID:	11204097			
Conditions of Use:	All			
EXTRACTION				
Parameter	Data			
Release quantity:	Provides release data			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Methodology used by submitters to estimate release data is not known.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	TRI is U.S. based data
	Metric 3:	Applicability	High	TRI includes industries included in the scope of FA.
	Metric 4:	Temporal Representativeness	High	TRI data are from 2016-2021
	Metric 5:	Sample Size	Medium	Due to reporting requirements, statistical representativeness is unclear.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	TRI only includes release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	TRI does not address variability or uncertainty in submitter provided data.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1995). AP-42: Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition.			
HERO ID:	46492			
Conditions of Use:	Combustion Byproduct			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde is formed and emitted during combustion of hydrocarbon-based fuels such as coal and oil. Formaldehyde is present in the vapor phase of the flue gas.			
Release quantity:	Formaldehyde emission from multiple hearth sewage sludge incinerators: Cyclone/venturi – 1.3 g/Mg (2.6 e-3 lb/ton), venturi – 0.4 g/Mg (8 e-4 lb/ton).			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	release data methodology is expected to be accurate	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	Medium	The release data are for multiple sources specific to formaldehyde and general and include sources outside and within the scope.	
	Metric 4: Temporal Representativeness	Low	more than 20 years old	
	Metric 5: Sample Size	Low	characterized by no statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release data include release media but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release, but no discussion of theuncertainty in the release results.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2015). Chapter 5: Petroleum industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	5097885			
Conditions of Use:	Distribution in commerce			
EXTRACTION				
Parameter	Data			
Description of release source:	valves, pumps, compressors, pressure relief valves, connectors, flanges, and open-ended lines.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	EPA equipment leaks study	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The release data are for an occupational scenario (petro chemical manufacture) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	1995 after PEL (1992) - more than 20 years old	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The release data study addresses variability in the determinants of release and uncertainty in the release results noted in detailed appendix.	
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2015). Chapter 5: Petroleum industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	5097885			
Conditions of Use:	Incorporation into a formulation, mixture or reaction product: Petrochemical manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	valves, pumps, compressors, pressure relief valves, connectors, flanges, and open-ended lines.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA equipment leaks study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The release data are for an occupational scenario (petro chemical manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1995 after PEL (1992) - more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release and uncertainty in the release results noted in detailed appendix.
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (2015). Chapter 5: Petroleum industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	5097885			
Conditions of Use:	Non incorporated activities - Oil and Gas drillings, extraction and support activities			
EXTRACTION				
Parameter	Data			
Description of release source:	valves, pumps, compressors, pressure relief valves, connectors, flanges, and open-ended lines.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA equipment leaks study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The release data are for an occupational scenario (petro chemical manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1995 after PEL (1992) - more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release and uncertainty in the release results noted in detailed appendix.
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (1999). Flexographic printing - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385709			
Conditions of Use:	commercial use: chemical substances in packaging, paper, plastics and hobby products.			
EXTRACTION				
Parameter	Data			
Description of release source:	This scenario examines the environmental releases that occur during makeready and during the actual production run of the flexographic press. The only releases discussed in this study are air releases, although the only expected significant water releases would be from potential rinsing of spent containers or from equipment cleaning if these wastes are not recycled or collected for incineration as expected.Environmental release quantities depend on many variables, including the volatile content of the ink mixture, whether exhaust streams contain air control devices, the ink consumption rates, and whether the ink was mixed with additives prior to use.			
Release or emission factors:	Release or emission factors			
Release frequency:	Facilities are expected to operate 300 days per year			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
Comments:	Note, formaldehyde is not specifically mentioned in the report, but the provided data are relevant to account for process and operational assumptions.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	USA
	Metric 3:	Applicability	Medium	The release data are for an occupational scenario within the scope of the risk evaluation, but no formaldehyde specific information.
	Metric 4:	Temporal Representativeness	Low	The data are more than 20 years old (1999)
	Metric 5:	Sample Size	Low	Data/parameters characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit process, activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2019). National Emissions Inventory (NEI) [database]: CASRNs 79-00-5, 75-34-3, 107-06-2, 78-87-5, 84-61-7, 106-99-0, 106-93-4, 50-00-0, 85-44-9, 106-46-7, 85-68-7, 84-74-2, and 115-86-6.			
HERO ID:	6535959			
Conditions of Use:	All			
EXTRACTION				
Parameter	Data			
Description of release source:	Provides unit/process of release.			
Release or emission factors:	Release or emission factors			
Release frequency:	Provides annual operating time for some submissions			
Waste treatment methods and pollution control:	nan			
Comments:	Large dataset of facilities and reported formaldehyde emissions spanning across multiple COUs.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Submitters provide general method used to calculate emissions, but details not provided.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	NEI is U.S. based data
	Metric 3:	Applicability	High	NEI includes industries included in the scopes of the risk evaluation
	Metric 4:	Temporal Representativeness	High	NEI data are from 2017, less than 10 years old.
	Metric 5:	Sample Size	Medium	Dataset is limited to units subject to NESHAP with threshold potential to emit, although states may have different requirements; statistical representativeness is unclear.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	NEI includes release media and generally also includes daily and annual operating time, specific unit/process that is the source of release, and presence of engineering controls.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	NEI does not address variability or uncertainty in submitter provided data.
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 7310513 Table: 1 of 3

Study Citation:	U.S. EPA, (1995). Chapter 6: Organic chemical process industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.
HERO ID:	7310513
Conditions of Use:	Paint/Varnish Manufacturing (6.4)

EXTRACTION

Parameter	Data
Description of release source:	"The primary factors affecting emissions from paint manufacture are care in handling dry pigments, types of solvents used, and mixing temperature. Varnish cooking emissions, largely in the form of volatile organic compounds, depend on the cooking temperatures and times, the solvent used, the degree of tank enclosure and the type of air pollution controls used. (PDF pg 29/162)"
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Methodology is known and expected to be accurate but covers only air release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Medium	Data are for an in-scope occupational scenario but does not contain chemical-specific emission factors
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old and older than the most recent NESHAP for Paints and Allied Products Manufacturing
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (assumed mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, but missing frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by providing data for paints and different varnish types, but uncertainty is not addressed.

Overall Quality Determination

Medium

Formaldehyde

Environmental Releases

HERO ID: 7310513 Table: 2 of 3

Study Citation:	U.S. EPA, (1995). Chapter 6: Organic chemical process industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7310513			
Conditions of Use:	Printing Ink Manufacturing (6.7)			
EXTRACTION				
Parameter	Data			
Description of release source:	Varnish preparation by heating is by far the largest source of ink manufacturing emissions. Cooling the varnish components produces odorous emissions.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate but covers only air release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	AP-42 is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media, controls, and emission factors provided but missing release quantity and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability is addressed by comparing emission factors from different types of varnish.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1995). Chapter 6: Organic chemical process industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7310513			
Conditions of Use:	Pharmaceutical Production (6.13)			
EXTRACTION				
Parameter	Data			
Description of release source:	escaped solvents from dryers, reactors, distillation systems, and storage tanks			
Release quantity:	Provides table of annual amounts of solvents (Mg) purchased by U.S. pharmaceutical companies and ultimate disposition (in % of purchased solvent). Multiply the values together to calculate releases by media.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but cover only air release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	AP-42 is based on U.S. data
	Metric 3:	Applicability	Medium	The release data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and older than the latest NESHAP for the Pharmaceuticals Production Industry.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete release percentages and quantities provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media, quantity, controls,and emission factors provided but missing release frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by explaining how control efficiency and disposal methods are highly dependent on individual processes. Variability addressed by listing release information for many different solvents and based on data from 26 sites.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.
HERO ID:	7315820
Conditions of Use:	Application of paints and coatings (4.2.1)

EXTRACTION

Parameter	Data
Description of release source:	Coating an architectural surface or automobile refinishing. Architectural surface coating is considered to involve both industrial and nonindustrial structures. Automobile refinishing pertains to the painting of damaged or worn highway vehicle finishes and not to the painting of vehicles during manufacture.
Release quantity:	Table 4.2.1-1 National Emissions and Emission factor-Emission factors based on national emissions dataPer Capita(given in kg/yr and g/day)"Architectural Surface Coating - 5.8 g nonmethane VOC/dayAutomobile Refinishing - 2.7 g nonmethane VOC/day"Per employee"Architectural Surface Coating - 2.09 kg nonmethane VOC/person/yrAutomobile Refinishing - 0.84 kg nonmethane VOC/person/yr"
Release frequency:	365 for architectural, 312 for automobile refinishing
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	Chapter 4.2.1 Nonindustrial Surface Coating

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Medium	Data are for an in-scope occupational scenario but does not contain chemical-specific emission factors
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old and older than the most recent NESHAP for Paint Stripping and Miscellaneous Surface Coating Operations
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (assumed mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release media and frequency provided but missing other metadata.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by providing data for coating types (architectural and automobile), but uncertainty is not addressed.

Overall Quality Determination**Medium**

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.
HERO ID:	7315820
Conditions of Use:	Application of paints and coatings (4.2.2.12)

EXTRACTION

Parameter	Data
Description of release source:	Specific operations that emit VOC are the coating application process, the flashoff area and the bake oven.
Release quantity:	Table 4.2.2.12-3 presents VOC emissions in kg/yr and kg/hr broken down by plant size and control techniques. Also, the chapter provides an equation to calculate VOC emissions per hour if the use knows their own parameters.
Release or emission factors:	Release or emission factors
Release frequency:	Operating schedule is 2000 hr/yr. It is unknown how this is broken down into days/yr.
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Medium	Data are for an in-scope occupational scenario, but it is not chemical specific.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and older than the latest NESHAP for Surface Coating of Metal Furniture
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (average values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All metadata provided.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability is addressed by considering different plant sizes and transfer efficiencies. Also, by providing different estimation methods.

Overall Quality Determination**Medium**

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7315820			
Conditions of Use:	Application of paints and coatings (4.2.2.6)			
EXTRACTION				
Parameter	Data			
Description of release source:	The main emission points from paper coating lines are the coating applicator and the oven (see Figure 4.2.2.6-1). In a typical paper-coating plant, about 70 percent of all solvents used are emitted from the coating lines, with most coming from the first zone of the oven. The other 30 percent are emitted from solvent transfer, storage, and mixing operations and can be reduced through good housekeeping practices. All solvent used and not recovered or destroyed can be considered potential emissions.			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for an in-scope occupational scenario, but it is not chemical specific.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old and older than the latest NESHAP for Paper and Other Web Coating
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by providing data for different coating types, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 7315820 Table: 4 of 7

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7315820			
Conditions of Use:	Application of paints and coatings (4.2.2.1)			
EXTRACTION				
Parameter	Data			
Description of release source:	Essentially all of the VOC emitted from the surface coating industry is from the solvents which are used in the paint formulations, used to thin paints at the coating facility, or used for cleanup.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for an in-scope occupational scenario, but it is not chemical specific.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old and older than the most recent NESHAP for Paint Stripping and Miscellaneous Surface Coating Operations
	Metric 5:	Sample Size	High	Discrete value provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release media provided but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by providing data for different coating types, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 7315820 Table: 5 of 7

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7315820			
Conditions of Use:	Application of paints and coatings (4.2.2.2)			
EXTRACTION				
Parameter	Data			
Description of release source:	Base coating, lithographic coating, side seam spray coating, interior body spray coating, end sealing			
Release quantity:	”3-pc base coating line: 160 Mg VOC/yr3-pc lithographic coating: 50 Mg VOC/yr3-pc side seam spray coating: 18 Mg VOC/yr3-pc interior body spray coating: 80 Mg VOC/yr2-pc coating line: 260 Mg VOC/yr2-pc end sealing: 14 Mg VOC/yr”			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for an in-scope occupational scenario, but it is not chemical specific.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and older than the latest NESHAP for Surface Coating of Metal Cans
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media, quantity, and controls provided but missing emission factors and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability is addressed by considering different can coating types (2 vs 3-pc) and operations.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7315820			
Conditions of Use:	Application of paints and coatings (4.2.2.8)			
EXTRACTION				
Parameter	Data			
Description of release source:	Solvent wipe, phosphating treatment, application of prime coat, curing of prime coat, application of guide coat, curing of guide coat, application of topcoat, curing of topcoat, final repair operations			
Release quantity:	Table 4.2.2.8-1 provides release quantities in kg VOC/hour broken down by vehicle type and coating type. Releates rates ranged from 12-1,208 kg/hr for automobiles and 10-732 kg/hr for light duty trucks			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for an in-scope occupational scenario, but it is not chemical specific.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and older than the latest NESHAP for Surface Coating of Automobiles and Light-Duty Trucks
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media, controls, quantities, and emission factors provided but missing release frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability is addressed by considering different paint types and different vehicles.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7315820			
Conditions of Use:	Application of paints and coatings (4.2.2.5)			
EXTRACTION				
Parameter	Data			
Description of release source:	”Emissions of VOCs at flat wood coating plants occur primarily from reverse roll coating of filler, direct roll coating of sealer and basecoat, printing of wood grain patterns, direct roll or curtain coating of topcoat(s), and oven drying after 1 or more of those operations. ”			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for an in-scope occupational scenario, but it is not chemical specific.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and older than the latest NESHAP for Surface Coating of Wood Building Products
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (average values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media, controls, and emission factors provided but missing release frequency and quantity.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability is addressed by considering different paint types (fillers, basecoat, etc.).
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 7315841 Table: 1 of 1

Study Citation:	U.S. EPA, (1995). AP-42: Chapter 4.12 - Manufacture of Rubber Products.			
HERO ID:	7315841			
Conditions of Use:	Rubber Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	mixing, milling, extrusion, calendaring, curing, and grinding of rubber			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	AP-42 is based on U.S. data
	Metric 3:	Applicability	Low	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical. Also release factors are for total VOC, not formaldehyde.
	Metric 4:	Temporal Representativeness	Low	Assessment was published in 2008, but is based on data that is greater than 20 years old and older than the latest NESHAP for Group I Polymers and Resins.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media, and emission factors provided but missing release quantity and frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty addressed by including how double counting is possible during mass balance calculations, and how overestimation of VOCs is likely. Variability is addressed by comparing 23 formulations of rubber.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 7315971 Table: 1 of 1

Study Citation: U.S. EPA, (1995). AP-42: Chapter 11.1 - Hot mix asphalt plants.
HERO ID: 7315971
Conditions of Use: Asphalt Production

EXTRACTION

Parameter	Data
Description of release source:	vehicular traffic generating fugitive dust on paved and unpaved roads, aggregate material handling, aggregate processing, rotary drum drying, hot-side conveying, classifying, mixing equipment, transport and handling of the HMA
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Methodology is known and expected to be accurate but covers only air release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	AP-42 is based on U.S. data
	Metric 3: Applicability	High	Data is for an in-scope occupational scenario and contain chemical-specific emission factors
	Metric 4: Temporal Representativeness	Low	Assessment was published in 2004, but is based on data that is greater than 20 years old and prior to the lastest NESHAP for Processing and Asphalt Roofing Manufacturing
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean, range, median, SD) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release media, quantity, controls,and emission factors provided but missing release frequency.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability is addressed by considering different asphalt plant types and processing methods.

Overall Quality Determination

Medium

Study Citation:	U.S. EPA, (2021). National Analysis TRI dataset (TRI): Data used for TSCA Risk Evaluations, reporting year 2019.			
HERO ID:	8347325			
Conditions of Use:	Various			
EXTRACTION				
Parameter	Data			
Description of release source:	Provides use, facility information and NAICS information associated with releases			
Release quantity:	Provides lb/year estimates of releases on a per site basis. TRI data			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The release data are for occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	the data are generally no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The release data study addresses variability in the determinants of release (i.e., data from multiple sites). The release data study, however, does not address uncertainty in the release results.
Overall Quality Determination		High		

Formaldehyde

Environmental Releases

HERO ID: 8784984 Table: 1 of 1

Study Citation:	U.S. EPA, (2019). TRI on-site and off-site reported disposed of or otherwise released (in pounds), for all industries.
HERO ID:	8784984
Conditions of Use:	Various

EXTRACTION

Parameter	Data
Release quantity:	Total on-site disposal or other releases: 19,900,990 (lbs)Total off-site disposal or other releases: 910,659 (lbs)Total on- and off-site disposal or other releases: 20,811,649 (lbs)
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for in-scope occupational scenarios.
	Metric 4: Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Release media provided but missing pollution control and emission factors and frequency of release.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by giving both on- and off-site releases at multiple sites, but uncertainty is not addressed.

Overall Quality Determination	Medium

Study Citation:	U.S. EPA, (n.d.). AP-42: Chapter 5 - Petroleum industry.
HERO ID:	9102566
Conditions of Use:	Distribution in commerce - Petroleum products

EXTRACTION**Parameter****Data**

Description of release source:

Evaporative emissions from the transportation and marketing of petroleum liquids may be considered, by storage equipment and mode of transportation used, in four categories: 1. Rail tank cars, tank trucks, and marine vessels: loading, transit, and ballasting losses. 2. Service stations: bulk fuel drop losses and underground tank breathing losses. 3. Motor vehicle tanks: refueling losses. 4. Large storage tanks: breathing, working, and standing storage losses. Loading losses are the primary source of evaporative emissions from rail tank car, tank truck, and marine vessel operations. Loading losses occur as organic vapors in "empty" cargo tanks are displaced to the atmosphere by the liquid being loaded into the tanks. These vapors are a composite of (1) vapors formed in the empty tank by evaporation of residual product from previous loads, (2) vapors transferred to the tank in vapor balance systems as product is being unloaded, and (3) vapors generated in the tank as the new product is being loaded. The quantity of evaporative losses from loading operations is, therefore, a function of the following parameters: - Physical and chemical characteristics of the previous cargo; - Method of unloading the previous cargo; - Operations to transport the empty carrier to a loading terminal; - Method of loading the new cargo; and - Physical and chemical characteristics of the new cargo. In the splash loading method, the fill pipe dispensing the cargo is lowered only part way into the cargo tank. Significant turbulence and vapor/liquid contact occur during the splash liquid droplets will be entrained in the vented vapors. A second method of loading is submerged loading. Two types are the submerged fill pipe method and the bottom loading method. In the submerged fill pipe method, the fill pipe extends almost to the bottom of the cargo tank. In the bottom loading method, a permanent fill pipe is attached to the cargo tank bottom. During most of submerged loading by both methods, the fill pipe opening is below the liquid surface level. Liquid turbulence is controlled significantly during submerged loading, resulting in much lower vapor generation than encountered during splash loading. The recent loading history of a cargo carrier is just as important a factor in loading losses as the method of loading. If the carrier has carried a nonvolatile liquid such as fuel oil, or has just been cleaned, it will contain vapor-free air. If it has just carried gasoline and has not been vented, the air in the carrier tank will contain volatile organic vapors, which will be expelled during the loading operation along with newly generated vapors. Cargo carriers are sometimes designated to transport only one product, and in such cases are practicing "dedicated service". Dedicated gasoline cargo tanks return to a loading terminal containing air fully or partially saturated with vapor from the previous load. Cargo tanks may also be "switch loaded" with various products, so that a nonvolatile product being loaded may expel the vapors remaining from a previous load of a volatile product such as gasoline. These circumstances vary with the type of cargo tank and with the ownership of the carrier, the petroleum liquids being transported, geographic location, and season of the year. Ballasting losses are a major source of evaporative emissions associated with the unloading of petroleum liquids at marine terminals. It is common practice to load several cargo tank compartments with sea water after the cargo has been unloaded. This water, termed "ballast", improves the stability of the empty tanker during the subsequent voyage. Although ballasting practices vary, individual cargo tanks are ballasted typically about 80 percent, and the total vessel 15 to 40 percent, of capacity. Ballasting emissions occur as vapor-laden air in the "empty" cargo tank is displaced to the atmosphere by ballast water being pumped into the tank. Upon arrival at a loading port, the ballast water is pumped from the cargo tanks before the new cargo is loaded. The ballasting of cargo tanks reduces the quantity of vapors returning in the empty tank, thereby reducing the quantity of vapors emitted during subsequent tanker loading. Regulations administered by the U. S. Coast Guard require that, at marine terminals located in ozone nonattainment areas, large tankers with crude oil washing systems contain the organic vapors from ballasting. This is accomplished principally by displacing the vapors during ballasting into a cargo tank being simultaneously unloaded. In other areas, marine vessels emit organic vapors directly to the atmosphere. In addition to loading and ballasting losses, losses occur while the cargo is in transit. Transit losses are similar in many ways to breathing losses associated with petroleum storage. Emissions from gasoline truck cargo tanks during transit depend on the extent of venting from the cargo tank during transit, which in turn depends on the vapor tightness of the tank, the pressure relief valve settings, the pressure in the tank at the start of the trip, the vapor pressure of the fuel being transported, and the degree of fuel vapor saturation of the space in the tank. The emissions are not directly proportional to the time spent in transit. If the vapor leakage rate of the tank increases, emissions increase up to a point, and then the rate changes as other determining factors take over. Truck tanks in dedicated vapor balance service usually contain saturated vapors, and this leads to lower emissions during transit because no additional fuel evaporates to raise the pressure in the tank to cause venting. Service Stations - Another major source of evaporative emissions is the filling of underground gasoline storage tanks at service stations. Gasoline is usually delivered to service stations in 30,000-liter (8,000-gal) tank trucks or smaller account trucks. Emissions are generated when gasoline vapors in the underground storage tank are displaced to the atmosphere by the gasoline being loaded into the tank. As with other loading losses, the quantity of loss in service station tank filling depends on several variables, including the method and rate of filling, the tank configuration, and the gasoline temperature, vapor pressure and composition. A second source of vapor emissions from service stations is underground tank breathing. Breathing losses occur daily and are attributable to gasoline evaporation and barometric pressure changes. The frequency with which gasoline is withdrawn from the tank, allowing fresh air to enter to enhance evaporation, also has a major effect on the quantity of these emissions. An average breathing emission rate is 120 mg/L (1.0 lb/1000 gal) of throughput.

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Formaldehyde

Environmental Releases

HERO ID: 9102566 Table: 1 of 2

...continued from previous page

Study Citation:	U.S. EPA, (n.d.). AP-42: Chapter 5 - Petroleum industry.
HERO ID:	9102566
Conditions of Use:	Distribution in commerce - Petroleum products

Domain	Metric	EVALUATION Rating	Comments
Release or emission factors:	nan		
Waste treatment methods and pollution control:	nan		

		EVALUATION		
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The release data are for an occupational scenario(petrochemical distribution) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The document may have been reformatted in 2008 but none of the references are later than 1995 which is more than 20 years old
	Metric 5:	Sample Size	Low	Generally there were no statistics for the emission factors
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.

Overall Quality Determination	Medium

Study Citation:	U.S. EPA, (n.d.). AP-42: Chapter 5 - Petroleum industry.
HERO ID:	9102566
Conditions of Use:	incorporation into a formulation - petrochemical manufacture : Refinery

EXTRACTION**Parameter****Data**

Description of release source:

Air emissions from catalytic cracking processes are (1) combustion products from process heaters and (2) flue gas from catalyst regeneration. Emissions from process heaters are discussed below. Emissions from the catalyst regenerator include hydrocarbons, oxides of sulfur, ammonia, aldehydes, oxides of nitrogen, cyanides, carbon monoxide (CO), and particulates. The particulate emissions from FCC units are much greater than those from TCC units because of the higher catalyst circulation rates used. FCC particulate emissions are controlled by cyclones and/or electrostatic precipitators or wet scrubbers. Particulate control efficiencies are as high as 80 to 85 percent.^{3,5} Carbon monoxide waste heat boilers reduce the CO and hydrocarbon emissions from FCC units to negligible levels.³ TCC catalyst regeneration produces similar pollutants to FCC units, but in much smaller quantities. The particulate emissions from a TCC unit are normally controlled by high-efficiency cyclones. Carbon monoxide and hydrocarbon emissions from a TCC unit are incinerated to negligible levels by passing the flue gases through a process heater firebox or smoke plume burner. In some installations, sulfur oxides are removed by passing the regenerator flue gases through a water or caustic scrubber. The major source of emissions from compressor engines is combustion products in the exhaust gas. These emissions include CO, hydrocarbons, nitrogen oxides, aldehydes, and ammonia. Sulfur oxides may also be present, depending on the sulfur content of the natural gas. All these emissions are significantly higher in exhaust from reciprocating engines than from turbine engines. The major emission control technique applied to compressor engines is carburetion adjustment similar to that applied on automobiles. Catalyst systems similar to those of automobiles may also be effective in reducing emissions, but their use has not been reported. Fugitive emission sources include leaks of hydrocarbon vapors from process equipment and evaporation of hydrocarbons from open areas, rather than through a stack or vent. Fugitive emission sources include valves of all types, flanges, pump and compressor seals, process drains, cooling towers, and oil/water separators. Fugitive emissions are attributable to the evaporation of leaked or spilled petroleum liquids and gases. Normally, control of fugitive emissions involves minimizing leaks and spills through equipment changes, procedure changes, and improved monitoring, housekeeping, and maintenance practices. - Oil/water separators (waste water treatment). All refineries employ some form of waste water treatment so water effluents can safely be returned to the environment or reused in the refinery. The design of waste water treatment plants is complicated by the diversity of refinery pollutants, including oil, phenols, sulfides, dissolved solids, and toxic chemicals. Although the treatment processes employed by refineries vary greatly, they generally include neutralizers, oil/water separators, settling chambers, clarifiers, dissolved air flotation systems, coagulators, aerated lagoons, and activated sludge ponds. Refinery water effluents are collected from various processing units and are conveyed through sewers and ditches to the treatment plant. Most of the treatment occurs in open ponds and tanks. The main components of atmospheric emissions from waste water treatment plants are fugitive VOCs and dissolved gases that evaporate from the surfaces of waste water residing in open process drains, separators, and ponds. Treatment processes that involve extensive contact of waste water and air, such as aeration ponds and dissolved air flotation, have an even greater potential for atmospheric emissions. Section 4.3, "Waste Water Collection, Treatment And Storage", discusses estimation techniques for such water treatment operations. The control of waste water treatment plant emissions involves covering systems where emission generation is greatest (such as oil/water separators and settling basins) and removing dissolved gases from water streams with sour water strippers and phenol recovery units before their contact with the atmosphere. These control techniques potentially can achieve greater than 90 percent reduction of wastewater system emissions- Storage. All refineries have a feedstock and product storage area, termed a "tank farm", which provides surge storage capacity to ensure smooth, uninterrupted refinery operations. Individual storage tank capacities range from less than 160 m³ to more than 79,500 m³ (1,000 to 500,000 bbl). - Transfer operations; although most refinery feedstocks and products are transported by pipeline, some are transported by trucks, rail cars, and marine vessels. They are transferred to and from these transport vehicles in the refinery tank farm area by specialized pumps and piping systems. - Cooling towers are used extensively in refinery cooling water systems to transfer waste heat from the cooling water to the atmosphere. The only refineries not employing cooling towers are those with once-through cooling. The increasing scarcity of a large water supply required for once-through cooling is contributing to the disappearance of that form of refinery cooling. In the cooling tower, warm cooling water returning from refinery processes is contacted with air by cascading through packing. Cooling water circulation rates for refineries commonly range from 7 to 70 L/minute per m³/day (0.3 to 3.0 gal/minute per bbl/day) of refinery capacity. Atmospheric emissions from the cooling tower consist of fugitive VOCs and gases stripped from the cooling water as the air and water come into contact. These contaminants enter the cooling water system from leaking heat exchangers and condensers. Control of cooling tower emissions is accomplished by reducing contamination of cooling water through the proper maintenance of heat exchangers and condensers. The effectiveness of cooling tower controls is highly variable, depending on refinery configuration and existing maintenance practices.

Release or emission factors:

Release or emission factors

Waste treatment methods and pollution control:

Waste treatment methods and pollution control

EVALUATION

Continued on next page ...

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Study Citation:	U.S. EPA, (n.d.). AP-42: Chapter 5 - Petroleum industry.
HERO ID:	9102566
Conditions of Use:	incorporation into a formulation - petrochemical manufacture : Refinery

EVALUATION

Domain	Metric	Rating	Comments	
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The release data are for an occupational scenario (refinery)within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Though date is not specified it appears to be updated in April 2015 - less than 10 years old
	Metric 5:	Sample Size	Low	Distribution of Emission Factors is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.

Overall Quality Determination**Medium**

Study Citation:	U.S. EPA, (n.d.). AP-42: Chapter 10 - Wood products industry.			
HERO ID:	9263849			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Releases sources for plywood manufacturing are in Section 10.5.3 pg. 3-4, for particleboard manufacturing in Section 10.6.2.3 pg. 4 , for hardboard and fiberboard manufacturing in Section 10.6.4.3 pg. 8, waferboard/oriented strandboard manufacturing in Section 10.6.1.3 pg. 3			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known but may notcover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data are more than 20 years old.
	Metric 5:	Sample Size	Medium	Statistics on emission factors are uncertain.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release; and release frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of release. The release data study addresses uncertainty in the release results.
Overall Quality Determination			High	

Study Citation:	URS Corporation, (2015). Revised Strategic Toxic Air Reduction (STAR) environmental acceptability demonstration for 2013 and 2014.			
HERO ID:	11273429			
Conditions of Use:	Fuels and related products			
EXTRACTION				
Parameter	Data			
Description of release source:		Coal Fired Boilers - 2 [BOILER]NG/Fuel Oil Boiler Stack [BOILER3]		
Release or emission factors:		Release or emission factors		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	Medium	The release data are for an occupational scenario but source is combustion, which is close to use of fuels.
	Metric 4:	Temporal Representativeness	High	The release data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and activity that is the source, but lacks additional metadata, such as release frequency of the release.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results.
Overall Quality Determination			Medium	

Study Citation:	Victorin, K., Stahlberg, M., Alsberg, T., Strandell, M., Westerholm, R., K-E, Egeback (1988). Emission of mutagenic irritating and odorous substances from gasoline fueled vehicles with different emission control systems. Chemosphere 17(9):1767-1780.			
HERO ID:	2814006			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Sampling or analytical methodology is not specified, but it was noted that for the analysis of aldehydes a chemisorption technique with 2,4-dinitrophenylhydrazine (2,4-DNFH) coated on Dowex ion exchange were used. The analysis was carried out by means of HPLC using a column packed with 3 um Spherisorb ODS-phase. Identification was done on a JEOL JMS-D300 mass spectrometer with a Finnigan data system.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden - an OECD member
	Metric 3:	Applicability	High	The release data are for mobile sources an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report was published in 1988, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	average value provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Walker, B.L., Cooper, C.D. (1992). Air pollution emission factors for medical waste incinerators. Journal of the Air and Waste Management Association 42(6):784-791.			
HERO ID:	78369			
Conditions of Use:	Disposal			
EXTRACTION				
Parameter	Data			
Description of release source:	40 medical waste incinerators in the U.S. and Canada.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The methodology is specified and is expected to be accurate.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US and Canada
	Metric 3:	Applicability	High	Data are for medical waste incinerators which is an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Published in 1992
	Metric 5:	Sample Size	Low	just single number provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional data provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	no discussion of variance or uncertainty
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 5940230 Table: 1 of 1

Study Citation:	Wallwork, D. T. (1986). Low formaldehyde release reactant finishing. American Dyestuff Report 75(9):40-41.			
HERO ID:	5940230			
Conditions of Use:	Processing (Finishing agents in textiles)			
EXTRACTION				
Parameter	Data			
Description of release source:	Textile finishing agents made with glycolated glyoxal reactants and magnesium chloride catalysts. (1/2)			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for textile finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by comparing different catalysts and reactants but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Wang, C., Wei, L., Cheng, Z., Xu, H., Daniel, R., Shuai, S. (2016). Hydrocarbon and aldehyde emissions from combustion of 2-methylfuran. Combustion Science and Technology 188(3):329-345.			
HERO ID:	4081491			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Description of release source:	Combustion of a biofuel called 2-methylfuran in engines, compared to other common fuels. (3/18)			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from the U.K, an OECD Country.	
	Metric 3: Applicability	High	Data are for the use of fuels and related products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Data are no more than 10 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range (in graph form) with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release media and release frequency provided but missing release quantity, waste treatment, number of sites, and release days/year.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability is addressed by sampling different fuels. Uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	Wang, W. L., Gardner, D. J., Baumann, D., M.G. (1999). Volatile organic compound hot-press emissions from southern pine furnish as a function of adhesive type.			
HERO ID:	5937853			
Conditions of Use:	Incorporation into Article-Wood Product Manufacturing (Resins)			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde hot-pressing emissions from Southern Pine panels come from two main sources: free formaldehyde in the adhesives and emissions from the wood furnish itself. Two of the three predominant adhesives, UF and PF resins, contain free formaldehyde but the third, pMDI, does not. A portion of the free formaldehyde in UF and PF will be emitted from the mat during hot pressing, and the amount of formaldehyde emitted is affected by the press conditions. Appropriate press conditions are determined by the physical and chemical properties of the adhesive, such as curing rate and curing temperature.			
Release quantity:	Formaldehyde emissions during hot-pressing of panels with UF resin ranged from 80.05 to 445.98 mg per kg oven-dried board (mg/kg OD board), which was significantly higher than emissions from panels pressed with either PF or pMDI resin. Emissions from panels pressed with pMDI ranged from 0.10 to 60.11 mg/kg OD board and with PF ranged from 8.79 to 16.20 mg/kg OD board. The UF resins are known to contain higher levels of free formaldehyde and are subject to hydrolysis, releasing formaldehyde, so the higher levels of formaldehyde emissions for this resin were expected. For panels bonded with PF and pMDI under similar conditions, the PF panels emitted significantly less formaldehyde than pMDI panels. Furnish pressed at the center level press variables with pMDI and with no resin exhibited emission levels of 33.07 and 41.10 mg/kg OD board, respectively. Thus, formaldehyde was emitted from the wood furnish alone and application of the pMDI resin reduced emissions by approximately 20 percent. However, panels bonded with PF resin showed even greater reductions relative to furnish pressed with no resin. At the center point of the press variables, formaldehyde emissions from particles with PF resin were 11.91 mg/kg OD board, which were also much lower than from the neat wood particles, 71.33 mg/kg OD board, a reduction by approximately 70 percent.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Unclear if peer reviewed, likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to processing of FA resins into wood products and furnishing products.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1999)
	Metric 5:	Sample Size	Medium	Characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Includes description of release source and release/emission factors.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by explaining reductions in emission amounts based on experimental conditions and types of resin. Does not address uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Wang, W.L., Gardner, D.J., Baumann, M.G. (2002). Volatile organic compound emissions during hot-pressing of southern pine particleboard: Panel size effects and trade-off between press time and temperature. Forest Products Journal 52(4):24-30.			
HERO ID:	2886898			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	Release data is for emissions of particleboard during pressing operations, expected to be within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	the data are more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The release data study provides only limited discussion of the variability and no discussion on uncertainty in the release results
Overall Quality Determination			Medium	

Study Citation:	Warzyn Inc, (1993). AB2588, health risk assessment, lax facility of phenol with cover letter dated 100293.			
HERO ID:	4213972			
Conditions of Use:	Aircraft maintenance			
EXTRACTION				
Parameter	Data			
Description of release source:	Mobile generators (Table 2-2, pg 33)			
Release quantity:	Media: air - 81.7 lb/year, max hourly (assumed 365 days/yr, 8 release hours/day) emissions of 0.034 lbs/hr (Table 2-1, pg 32)			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for paints and coatings, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean yearly value, max for hourly value) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release media and release frequency provided but missing metadata such as controls.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by stating assumptions. Variability is not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 3867301 Table: 1 of 1

Study Citation:	Wei, L., Cheung, C. S., Ning, Z. (2017). Influence of waste cooking oil biodiesel on combustion, unregulated gaseous emissions and particulate emissions of a direct-injection diesel engine. Energy 127:175-185.
HERO ID:	3867301
Conditions of Use:	emission

EXTRACTION	
Parameter	Data
Description of release source:	Emissions from a direct-injection diesel engine fueled with diesel, B20 (20% biodiesel on volume basis), B50, B75 and biodiesel.
Release quantity:	Brake specific formaldehyde emissions increase with increasing biodiesel concentration in the tested fuels. By conducting Student's t-test, there are no significant differences for the weighted brake specific formaldehyde emissions between diesel and B20 and among B50, B75 and biodiesel; however, significant increases are observed between biodiesel and diesel and between biodiesel and B20. The weighted brake specific formaldehyde emissions exhibit very high correlation coefficients (0.93 for weighted brake specific formaldehyde) with the biodiesel concentration which indicate that the weighted brake specific carbonyl compound emissions are proportional to the biodiesel content.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country
	Metric 3:	Applicability	Medium	The release data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The release data study provides limited discussion on variability but does not address uncertainty.

Overall Quality Determination	Medium

Study Citation:	Wei, W., Wang, S.X., Chatani, S., Klimont, Z., Cofala, J., Hao, J.M. (2008). Emission and speciation of non-methane volatile organic compounds from anthropogenic sources in China. Atmospheric Environment 42(20):4976-4988.			
HERO ID:	622601			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Release quantity:	The only formaldehyde data is a summary of sources of formaldehyde 72% transportation, 25% incomplete combustion of biofuels and commercial energy carriers			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China - not an OECD member
	Metric 3:	Applicability	Uninformative	Data are from an national emission inventory of China which reflect national regulatory context which may not be comparable to the US
	Metric 4:	Temporal Representativeness	Medium	data are greater than 10 years old but no more than 20 years old - published 2008
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	Release media and other critical metadata not provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty for formaldehyde are not addressed.
Overall Quality Determination		Uninformative		

Formaldehyde

Environmental Releases

HERO ID: 1701632 Table: 1 of 1

Study Citation:	Westerholm, R., Christensen, A., Rosen, A. (1996). Regulated and unregulated exhaust emissions from two three-way catalyst equipped gasoline fuelled vehicles. Atmospheric Environment 30(20):3529-3536.			
HERO ID:	1701632			
Conditions of Use:	Combustion Byproduct			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Sweden is an OECD country
	Metric 3:	Applicability	Uninformative	The release data are for an occupational scenario that does not apply to an in-scope COU of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	no discussion on the uncertainty
Overall Quality Determination		Uninformative		

Study Citation:	Wicks, Z. W., Jr, Jones, F. N. (2013). Coatings.			
HERO ID:	6301611			
Conditions of Use:	Processing-Incorporation into a formula-Painting and coating manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	Mixed methyl butyl ether class I MF resins have lower Tgand viscosity and sometimes can be formulated into coatings having somewhat lower VOC emissions. Another ongoing goal has been to minimize emission of free formaldehyde in the resins and formaldehyde evolved during coating cure and even afterward.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	The release data methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu- ated.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data indicate that the data should to be representative of current operations, equipment, and activities. The releasedata were collected after the most recent federal regulatory action (e.g., NESHAP for air release or effluent limit guideline (ELG) for water release) or update or are no more than 10 years old,whichever is shorter. If no federal regulation is established, the data are generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 58470 Table: 1 of 1

Study Citation:	Wilkins, E. S., Wilkins, M. G. (1985). Review of toxicity of gases emitted from combustion, pyrolysis of municipal and industrial wastes. Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances & Environmental Engineering 20(2):149-175.			
HERO ID:	58470			
Conditions of Use:	Disposal			
EXTRACTION				
Parameter	Data			
Description of release source:	plastics combustion; smoldering of other solids; a flue-fed apartment incinerator (PDF pg. 5/28)			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The methodology is unknown although the data source contains references for most of the extracted data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The geographic association of the data is unknown but references for most of the extracted data are stated.
	Metric 3:	Applicability	Medium	The data pertain to waste disposal of plastic and other solid wastes, including apartment incineration. The data do not pertain to disposal of material containing formaldehyde per se.
	Metric 4:	Temporal Representativeness	Low	The data source was published in 1985.
	Metric 5:	Sample Size	Medium	range provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional data provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	range of values were provided but nothing on uncertainty
Overall Quality Determination			Low	

Study Citation:	Winebrake, J.J., Deaton, M.L. (1999). Hazardous air pollution from mobile sources: a comparison of alternative fuel and reformulated gasoline vehicles. Journal of the Air and Waste Management Association 49(5):576-581.			
HERO ID:	10584			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Release quantity:	97,506 tons for 1990			
Release or emission factors:	Release or emission factors			
Release frequency:	annual (emisson factors were also provided in mg/mi)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	testing was performed by NREL at EPA dynamometers using urban driving cycles
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The release data are for mobile sources which is a scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report was published in 1999 and is therefore more than 20 years old. Testing was performed in 1998 on vehicles that have a model year ranging from 1992-1995.
	Metric 5:	Sample Size	Medium	Individual emission factors are provided for a limited number of (8) vehicles.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source ofthe release
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The emission factors were provided for individual vehicles with different ages and mileage allow for an approximation of variance. The study did not provide any discussion of the uncertainty in the release results, though it is likely that the NREL methodology accounted for them.
Overall Quality Determination			Medium	

Study Citation:	Woodring, J. L., Duffy, T. L., Davis, J. T., Bechtold, R. R. (1985). Measurements of combustion product emission factors of unvented kerosene heaters. American Industrial Hygiene Association Journal 46(7):350-356.			
HERO ID:	1641076			
Conditions of Use:	Combustion Byproduct			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	Uninformative	The data are for an occupational scenario that is not in the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	the data are more than 30 years old. Published in 1985
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Uninformative		

Formaldehyde

Environmental Releases

HERO ID: 1545143 Table: 1 of 1

Study Citation:	Xin, H, Ireland, J.C., Zigler, B.T., Ratcliff, M.A., Knoll, K.E., Alleman, T.L., Luecke, J.H., Tester, J.T. (2010). The impacts of mid-level alcohol content in gasoline on sidi engine-out and tailpipe emissions.			
HERO ID:	1545143			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Description of release source:	Emissions from vehicle exhaust; different emissions measured per different operating			
Release quantity:	[ppm]10-20 [ppm]			
Release or emission factors:	nan			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	U.S. data.
	Metric 3:	Applicability	Low	The release data are from an occupational scenario that is not clear on if formaldehyde is present within the fuel or if precursor chemicals generate formaldehyde which is outside the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on current industry conditions and data is more than 10 years old but no more than 20 years old. (2010)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing multiple fuel types but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Xiong, J., Zhang, P., Huang, S., Zhang, Y. (2016). Comprehensive influence of environmental factors on the emission rate of formaldehyde and VOCs in building materials: Correlation development and exposure assessment. Environmental Research 151:734-741.			
HERO ID:	3455178			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Description of release source:	Building materials (such as medium density fiberboard)			
Release quantity:	E, which is the steady state emission rate as ug/(m2 h), increases with increase in relative humidity and indoor temperature. As relative humidity increases from 20 to 80 percent, the E increases from approx. 200 to 1200 for an indoor temperature of 25 deg C. As temperature increases from 25 to 50 deg C, the E increases from approx. 60 to 4100 for a relative humidity of 50 percent. The ratio of E in summer to that in winter is about 1.63, and this ratio can be regarded as the ratio of formaldehyde concentration in indoor environment in the two seasons.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is known or expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data no more than 10 years old
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Yao, Z., Jiang, X.,i, Shen, X., Ye, Y.,u, Cao, X., Zhang, Y., He, K. (2015). On-Road Emission Characteristics of Carbonyl Compounds for Heavy-Duty Diesel Trucks. Aerosol and Air Quality Research 15(3):915-925.
HERO ID:	3073483
Conditions of Use:	Automobile Exhaust

EXTRACTION

Parameter	Data
Description of release source:	Releases come from in use heavy duty diesel trucks (HDDTs) and measured against different emission standards. Emissions varied by different emission standards, with formaldehyde emission increasing with increasingly stringent emission standards. Emissions also were lower on highway HDDTs versus non-highway HDDTs.
Release quantity:	Emissions consisted of 47.9% formaldehyde (out of the total percent of carbonyl compounds)
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	Note: this only gives the percent of formaldehyde as a function of overall carbonyl content in emissions not as a function of total emissions

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	Low	Data is for China, a non-OECD country.
Metric 3:	Applicability	Low	Data is not explicitly for a specific use of formaldehyde, it is just an emission from diesel as a fuel in an engine.
Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2015)
Metric 5:	Sample Size	Medium	Characterized by a range of data with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Provides emission factors, description of release source, concentration of formaldehyde in emissions, and specifies the effect of pollution control devices but does not state what those devices are.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	Addresses variability by showing data from other similar literature sources and the emissions of different engines with different pollution controls. Does not address uncertainty.

Overall Quality Determination

Medium

Formaldehyde

Environmental Releases

HERO ID: 5707798 Table: 1 of 1

Study Citation:	Yoon, S.H. (2007). Comparisons of mobile source air toxics risks associated with using conventional and reformulated gasoline.			
HERO ID:	5707798			
Conditions of Use:	Fuel and fuel related products			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Source is dissertation from a research institute so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US
	Metric 3:	Applicability	High	Data is applicable to engine emissions.
	Metric 4:	Temporal Representativeness	Medium	Data is over 10 years old (2007).
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Only includes emission factors.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at different types of gasoline. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Younesi-Kordkheili, H., Pizzi, A., Niyatzade, G. (2016). Reduction of formaldehyde emission from particleboard by phenolated kraft lignin. Journal of Adhesion 92(6):485-497.
HERO ID:	5953822
Conditions of Use:	emission

EXTRACTION	
Parameter	Data
Description of release source:	Formaldehyde emission from particleboard modified by lignin and phenolated lignin
Release quantity:	Formaldehyde emission differs greatly among the cured resins. It can be observed that if lignin is incorporated into the UF resin, the formaldehyde emission from the panels decreases independently if the lignin component as such is modified or not. Lignin addition, leading to lower F/U ratio, significantly decreases formaldehyde emission from the panels. Formaldehyde emission from manufactured particleboards made from synthesized resins are: 4.3 mg/(100g oven dry basis) with lignin content 0%; 3.5 mg/(100g oven dry basis) for LUF and 3.2 mg/(100g oven dry basis) for PLUF with lignin content 10%; 3.4 mg/(100g oven dry basis) for LUF and 2.9 mg/(100g oven dry basis) for PLUF with lignin content 15%; 3.1 mg/(100g oven dry basis) for LUF and 2.6 mg/(100g oven dry basis) for PLUF with lignin content 20%. The results also indicate that the panels made from PLUF resins exhibited lower formaldehyde emission than those made from LUF and UF resins, respectively.

		EVALUATION		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	methodology is known or expected to be accurate
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	release data are for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	data less than 10 years old
	Metric 5:	Sample Size	Medium	characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Release data include release media but additional metadata for scenario.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	no discussion on uncertainties

Overall Quality Determination	Medium

Study Citation:	Yu, H., Stuart, A. (2016). Exposure and inequality for select urban air pollutants in the Tampa Bay area. Science of the Total Environment 551:474-483.			
HERO ID:	3276086			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Description of release source:	A comprehensive set of source categories were captured, including stationary point, on-road mobile, biogenic, non-point, and non-road mobile sources.			
Release quantity:	Formaldehyde annual emissions (tonnes) from different sources in Florida are as follows: Major roads in Hillsborough County – 66, Minor roads in Hillsborough County – 147, On-road emissions outside the county – 115, Non-road mobile – 226, Point – 22, Non-point – 57, Biogenic – 659, Total – 1290.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	release data methodology is known or expected to be accurate
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	Medium	The release data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4:	Temporal Representativeness	High	no more than 10 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Zervas, E., Montagne, X., Lahaye, J. (2001). Emission of specific pollutants from a compression ignition engine Influence of fuel hydrotreatment and fuel/air equivalence ratio. Atmospheric Environment 35(7):1301-1306.		
HERO ID:	14152		
Conditions of Use:	Automobile Exhaust		
EXTRACTION			
Parameter	Data		
Release or emission factors:	Release or emission factors		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	sampling and analytic methods not provided, but formaldehyde was collected using using acidified DNPH solution and analyzed by HPLC/UV
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	France - OECD member
	Metric 3: Applicability	Medium	The release data are for a diesel vehicle exhaust is an occupational scenario within the scope of the risk evaluation, but the engine and fuels used in twenty years ago may not be equivalent to current US vehicles and fuels.
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 2000, after release of the most recent PEL (1992) and approximately 20 years old.
	Metric 5: Sample Size	Medium	The distribution of samples is characterized by individual testing data points. Uncertain was discussed in terms of the reproducibility of results.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	supplemental metadata were not provided to make the data applicable for emission inventories or risk assessment, this includes emission per mile, fuel efficiency, or total exhaust volume
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	data provided could be used to assess variance between the reference fuel and hydrotreated diesel and for different fuel air ratios. Uncertain was discussed in terms of reproducibility of results
Overall Quality Determination		Low	

Study Citation:	Zhang, S., Song, F., Gao, Q., Li, J. (2011). Preparation and properties of low formaldehyde emission plywood with flame resistance. Advanced Materials Research Volume 139-141:649-652.			
HERO ID:	5955419			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde-treated flame retardant plywood. (1/4)			
Release or emission factors:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for the use of wood products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Zhang, Z.H., Cheung, C.S., Chan, T.L., Yao, C.D. (2010). Experimental investigation of regulated and unregulated emissions from a diesel engine fueled with Euro V diesel fuel and fumigation methanol. Atmospheric Environment 44(8):1054-1061.				
HERO ID:	388167				
Conditions of Use:	Automobile Exhaust				
EXTRACTION					
Parameter	Data				
Description of release source:	Diesel Engine Exhaust				
Release or emission factors:	Release or emission factors				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	unknown methodology	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Chinese vehicle using European fuel	
	Metric 3:	Applicability	Low	Data are for vehicle exhaust which is an in-scope occupational scenario.	
	Metric 4:	Temporal Representativeness	Medium	published in 2010	
	Metric 5:	Sample Size	Low	no statistical data are provided for formaldehyde	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no additional data provided	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty and error was provided for all ofther pollutants	
Overall Quality Determination			Low		

Study Citation:	Zhao, F., Song, K., Gao, W., Zhang, S. (2012). Study on preparation and properties of recycled plastic-poplar plywood. Applied Mechanics and Materials 121-126:2917-2921.			
HERO ID:	5953397			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Description of release source:	traditional adhesives were replaced by recycled plastics to make poplar plywood by hot-pressing. The little formaldehyde was caused by the chemical composition reaction of the wood itself.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
Comments:	Method: Formaldehyde emission was determined referring to GB 18580-2001 (Indoor decorating and refurbishing materials-Limit of formaldehyde emission of wood-based panels and finishing products). The selected specimens were put into the wild-mouth bottle (500ml) below 20°C for 24h. The release amount was tested by formaldehyde detector. (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata (regarding emission factors) provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by evaluating multiple plywoods with different % plastics and hot-pressing times/temperatures, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Zhao, P., Cheng, Y.H., Lin, C.C., Cheng, Y.L. (2015). Effect of resin content and substrate on the emission of BTEX and carbonyls from low-VOC water-based wall paint. Environmental Science and Pollution Research 23(4):3799-3808.			
HERO ID:	3042143			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Release quantity:	Emission of paints on different surfaces: stainless steel - 1.2, 1.2, 1.3, 1.4; Calcium silicate - 0.8, 0.9; Cement - 0.94, 1.08; Figures 4, 5, 8, and 9 provides emission profile			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The methodology is known and expected to be accurate, however, it only covers re-release/emission from the drying paint (not emissions during paint application).
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is for Taiwan, a non-OECD country.
	Metric 3:	Applicability	High	Data is applicable to emission rates of paints
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2015).
	Metric 5:	Sample Size	Medium	Characterized by a range of data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Only provides emission factors.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Addresses variability by looking at different emission rates on different paint surfaces. Addresses uncertainty in Table 2 for major uncertainties described in the study.
Overall Quality Determination		Medium		

Study Citation:	Zhou, Z., Tan, Q., Deng, Y.,e, Song, D., Wu, K., Zhou, X., Huang, F., Zeng, W., Lu, C. (2020). Compilation of emission inventory and source profile database for volatile organic compounds: A case study for Sichuan, China. Atmospheric Pollution Research 11(1):105-116.			
HERO ID:	6072297			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Comments:	Release quantities are given for classes of chemicals, not formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for use of fuels and related products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Data less than 10 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (range) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The release data study provides only limited discussion of the variability in the determinants of release. The release data study provides only limited discussion of the uncertainty in the release results	
Overall Quality Determination		High		

Study Citation:	Zhu, J., Cao, X.L., Pigeon, R., Mitchell, K. (2003). Comparison of vehicle exhaust emissions from modified diesel fuels. Journal of the Air and Waste Management Association 53(1):67-76.			
HERO ID:	39179			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Description of release source:	Vehicle Exhaust Emissions			
Release quantity:	Base fuel: cold start 40.4 +/-1.1 mg/mi; hot start 45.0+/-1.2 mg/mi. 2-EHN fuel: cold start 36.4 mg/mi; hot start 36.8 mg/mi. DEDM: cold start 40.9 mg/mi; hot start 37.2 mg/mi.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The methodology is known and expected to be accurate. Samples were collected on Sep-Pak 2,4-dinitrophenylhydrazine (DNPH)-silica cartridges and analyzed using a HPLC instrument using a modified American Society for Testing and Materials (ASTM) Standard Test Method D5197.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - OECD member
	Metric 3:	Applicability	High	The release data are for vehicle exhaust which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The data were collected after the most recent federal regulatory action but are generally, more than 10 years old and less than 20 years old. However, equipment are expected to be reasonably representative of current conditions.
	Metric 5:	Sample Size	Medium	The statistical distribution of samples is characterized by a margin or error. Because the emission factors were derived from a single 1996 GM Light duty diesel pick up truck, it is uncertain if the data are representative of the current US fleet of light duty diesel trucks.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The study provided mean value and the margin of error which could be used to evaluate variability. Uncertainty is accounted for in the methods used to analyze the samples.
Overall Quality Determination			High	

Study Citation:	Zhu, L.,ei, Deng, B., Guo, Y. (2013). A unified model for VOCs emission/sorption from/on building materials with and without ventilation. International Journal of Heat and Mass Transfer 67:734-740.			
HERO ID:	5972633			
Conditions of Use:	Commercial Use - Building/construction materials			
EXTRACTION				
Parameter	Data			
Description of release source:	Building materials under variable ventilation and no ventilation conditions.			
Release quantity:	Under steady state conditions, formaldehyde concentrations in airtight chamber from MDF3 and MDF4 were found to be 1800 ug/m3 and 2400 ug/m3.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The release data methodology is known or expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from a non-OECD country.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Release data include release media but no other metadata.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The release data study does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Zhu, Q., Kato, S., Ataka, Y., Seo, J. (2005). Study on full-scale test chamber method for measuring emission rate of aldehydes and vocs released from furniture. :1980-1985.			
HERO ID:	5945315			
Conditions of Use:	Buidling and construction materials			
EXTRACTION				
Parameter	Data			
Description of release source:	partion panels used in offices, furniture (abstract)			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Methodology is known(Method: small test chamber method; (ASTM, 1997, ECA-IAQ, 1989, 1991 and ENV 13419-1, 1999, and JIS A 1901, 2003); (pg 1) HPLC and GC/MS (pg 2)) and expected to be accurate but may not cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from China and Japan, the latter being an OECD country	
	Metric 3: Applicability	High	Data are for building and construction materials, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (assumed mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All metadata (regarding emission factors) provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by studying emissions for different temperatures and furniture, but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Zhu, X.D., Liu, Y., Shen, J. (2016). Volatile organic compounds (VOCs) emissions of wood-based panels coated with nanoparticles modified water based varnish. Holz als Roh- und Werkstoff 74(4):601-607.			
HERO ID:	5956543			
Conditions of Use:	Building and construction materials; Paints and coatings			
EXTRACTION				
Parameter	Data			
Description of release source:	veneered particleboards: original, coated with waterborne polyurethane varnish, and 3 different nanoparticle treatment types (pg 3)			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are on emissions of particleboard, which is not within the scope.
	Metric 4:	Temporal Representativeness	High	Data are no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All metadata (regarding emission factors) provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by evaluating multiple particleboards with different finishes/treatments, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Zielinska, B., Sagebiel, J.C., Harshfield, G., Gertler, A.W., Pierson, W.R. (1996). Volatile organic compounds up to C20 emitted from motor vehicles: measurement methods. Atmospheric Environment 30(12):2269-2286.			
HERO ID:	84044			
Conditions of Use:	Automobile Exhaust			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate; samples were collected using 2,4-dinitrophenylhydrazine and cartridges and analyzed using HPLC
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The release data are for vehicle exhaust which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1996, after the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	The distribution of samples is characterized by an average and range. It is unclear if the analysis is representative given the age of the vehicles.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release data include most critical metadata, including release media and release frequency, but lacks additional metadata, such as process, unit operation, and/or activity that is the source of the release
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The study provides a range of values that can be used to assess variability, the study provided sufficient detail in the methods used to suggest that uncertainty was accounted for in the analysis..
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 3001786 Table: 1 of 1

Study Citation:	Łebkowska, M., Narożniak-Rutkowska, A., Pajor, E. (2013). Effect of a static magnetic field of 7 mT on formaldehyde biodegradation in industrial wastewater from urea-formaldehyde resin production by activated sludge. Bioresource Technology 132:78-83.			
HERO ID:	3001786			
Conditions of Use:	Disposal			
EXTRACTION				
Parameter	Data			
Description of release source:	Wastewater treatment from urea-formaldehyde resin production			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
Comments:	Study focuses on effect of a magnetic field on formaldehyde biodegradation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate and is known to cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for Poland, an OECD country.
	Metric 3:	Applicability	High	Data is applicable to waste treatment methods that could be used in a manufacturing plant of urea-formaldehyde resin.
	Metric 4:	Temporal Representativeness	High	Study conducted less than 10 years ago (2013).
	Metric 5:	Sample Size	Medium	Characterized by a range of data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Only contain information about the waste treatment method and efficiency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at different concentrations of formaldehyde during the waste treatment process. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Hussain, M., He, Y.L., Mohamad, A.A., Tao, W.Q. (2015). A new hybrid algorithm for numerical simulation of VOC emissions using single-layer and multilayer approaches. Numerical Heat Transfer Part B: Fundamentals 67(3):211-230.			
HERO ID:	4714918			
Conditions of Use:	Building/construction materials – wood and engineered wood products			
EXTRACTION				
Parameter	Data			
Description of release source:	Medium-density fiberboard.			
Release or emission factors:	Release or emission factors			
Comments:	Lattice Boltzmann Method (LBM) was used for simulation of formaldehyde concentration in an airtight chamber.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Model is peer-reviewed and free of mathematical errors, based on sound approaches/methods, and uses appropriate equations and parameters.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Model can be applied to Building/construction materials – wood and engineered wood products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Model is based on current industry conditions and based on data no more than 10 years old.
Domain 3: Accessibility/ Clarity	Metric 5:	Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent. Rationales for choice of approach, equations, and parameter values provided.
Domain 4: Variability and Uncertainty	Metric 6:	Metadata Completeness	High	Uncertainty is addressed by assumptions made for the model; for example, that the concentration of VOCs is totally mixed in the test chamber. Variability addressed by using two concentrations of formaldehyde in MDF.
Overall Quality Determination			High	

Study Citation:	Kumar, A., Madasu, R., Manocha, A. (1996). Health risk assessment for toxic emissions from a manufacturing facility. Environmental Monitoring and Assessment 42(3):211-228.			
HERO ID:	1986608			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	Facility stack emissions			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Model is peer-reviewed and free of mathematical errors, based on sound approaches/methods, and uses appropriate equations and parameters.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Model can be applied to manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Model is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Domain 3: Accessibility/ Clarity	Metric 5:	Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent. Rationales for choice of approach, equations, and parameter values provided.
Domain 4: Variability and Uncertainty	Metric 6:	Metadata Completeness	Medium	Variability addressed by testing multiple stack parameters, but uncertainty is not addressed
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 3161045 Table: 1 of 1

Study Citation:	Manoukian, A., Buiron, D., Temime-Roussel, B., Wortham, H., Quivet, E. (2016). Measurements of VOC/SVOC emission factors from burning incenses in an environmental test chamber: influence of temperature, relative humidity, and air exchange rate. Environmental Science and Pollution Research 23(7):6300-6311.
HERO ID:	3161045
Conditions of Use:	Other Byproduct

EXTRACTION

Parameter	Data
Release quantity:	Emission factor (ug/g): minimum - 772; maximum - 2550. Model for emission factors and concentrations: emission factor (ug/g) - 822 +/- 66, 2304 +/- 226; parameters listed and air exchange rate; Peak concentrations (after 30 min burning) (ug/m^3): 12.9 +/- 1.0, 27.0 +/- 2.6.
Release or emission factors:	Release or emission factors

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Source is peer reviewed so mathematical model is likely free of errors.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data is from France or Germany, both OECD countries.
	Metric 3: Applicability	Uninformative	Model is for emission factor of burning incense
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old.
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent and clear and can be evaluated.
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	Medium	Model has limited characterization of variability and uncertainty.

Overall Quality Determination **Uninformative**

Study Citation:	Matthews, T.G., Hawthorne, A.R., Thompson, C.V. (1987). Formaldehyde sorption and desorption characteristics of gypsum wallboard. Environmental Science and Technology 21(7):629-634.			
HERO ID:	2443347			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Equations and choice of parameter values appears to be appropriate for the model’s application and scientifically sound	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Research conducted by well known U.S. laboratory.	
	Metric 3: Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1987)	
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	Medium	Variability addressed by testing desorption amounts at different time intervals, but uncertainty is not addressed.	
Overall Quality Determination		High		

Formaldehyde

Environmental Releases

HERO ID: 192157 Table: 1 of 1

Study Citation:	NRC, (1981). Formaldehyde and other aldehydes. :1-340.			
HERO ID:	192157			
Conditions of Use:	Incorporation into an article			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Methodology is known and expected to be accurate but may not cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for incorporation into an article, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Published in 1981. The completed exposure or risk assessment is more than 20 years old.
Domain 3: Accessibility/ Clarity	Metric 5:	Metadata Completeness	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 4: Variability and Uncertainty	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Overall Quality Determination			Medium	

Study Citation:	OECD, (2004). Emission scenario document on water treatment chemicals.			
HERO ID:	6558582			
Conditions of Use:	Commercial Use - Water Treatment Products			
EXTRACTION				
Parameter	Data			
Description of release source:	Closed heating and cooling systems, open cooling systems, Systems within the papermaking industry, Swimming Pools			
Release or emission factors:	nan			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
Comments:	The ESD covers the use of chemicals to treat water in closed heating and cooling systems, open cooling systems, paper production and swimming pools. The models included estimate releases to water only, and do not cover the releases from container residue.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The model is free of mathematical errors and is based on scientifically sound approaches or methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from the an OECD country other than the U.S.
	Metric 3:	Applicability	Medium	Data are for chemical substances in treatment products, an in-scope occupational scenario, but not specific to formaldehyde.
	Metric 4:	Temporal Representativeness	Low	Most of the information collected from 1994-1997.
Domain 3: Accessibility/ Clarity	Metric 5:	Metadata Completeness	Medium	Model approach, equations, and choice of parameter values are transparent. However, rationale for selection of approach, equations, and parameter values is not provided.
Domain 4: Variability and Uncertainty	Metric 6:	Metadata Completeness	Medium	The model has limited characterization of the variability of parameter values. The model has limited characterization of the uncertainty in the results.
Overall Quality Determination		Medium		

Study Citation:	Radian Corp, (1991). General electric engine maintenance center AB 2588 air toxics "hot spots" health risk assessment (final report) with attachments and cover letter dated 123191.
HERO ID:	1481770
Conditions of Use:	Use of Paints/Coatings

EXTRACTION

Parameter	Data
Description of release source:	Stack emissions, engine testing, welding operations, steam space heater, steam boiler
Release quantity:	Page 16/470 reports formaldehyde release of 851 to 900 lb/year from a GE engine maintenance center. Page 19&20/470 breaks down the releases: from Steam Boiler 1.9 e-5 to 9.0e-4 lbs/hr or 0.001454 to 1.9 lbs/year. Page 21: steam space heater 0.11 lb/hr or 2.05 lbs/year; engine testing 0.09 lbs/hr or 843 lbs/year

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Model is free of mathematical errors and based on sound approaches/methods; however, choice of equations and parameters are not described.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Model can be applied to paint and coating additives in transportation equipment manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Model is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1991)
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent. Rationales for choice of approach, equations, and parameter values provided.
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	Low	Variability and uncertainty are not addressed

Overall Quality Determination**Medium**

Study Citation:	Tibaquirá, J.E., Huertas, J.I., Ospina, S., Quirama, L.F., Nino, J.E. (2018). The Effect of Using Ethanol-Gasoline Blends on the Mechanical, Energy and Environmental Performance of In-Use Vehicles. Energies 11(1):221.			
HERO ID:	4261636			
Conditions of Use:	fuels and related products			
EXTRACTION				
Parameter	Data			
Description of release source:	gasoline vs gasoline with <20% ethanol by volume, used in sedan-type vehicles (pg 3)			
Release or emission factors:	Release or emission factors			
Comments:	media: air. figure 9 provides emission factors in g/kWh as function of lambda, which is a value representing the similarity between a fuel vs. a default fuel composition (pg. 8, pg 14)Estimation method: CIMA modeling, equations/inputs in Table 2 (pg 4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Model is peer-reviewed and free of mathematical errors, based on sound approaches/methods, and uses appropriate equations and parameters.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Colombia, an OECD country.	
	Metric 3: Applicability	Uninformative	Model is not applicable and cannot be adapted to an in-scope occupational scenario (FA data only presented graphically).	
	Metric 4: Temporal Representativeness	High	Model is based on current industry conditions and based on data no more than 10 years old.	
Domain 3: Accessibility/ Clarity	Metric 5: Metadata Completeness	High	Model approach, equations, and choice of parameter values are transparent. Rationales for choice of approach, equations, and parameter values provided.	
Domain 4: Variability and Uncertainty	Metric 6: Metadata Completeness	Medium	Variability is addressed by evaluating emissions for different engines and fuel compositions. Uncertainty is not addressed	
Overall Quality Determination		Uninformative		

Study Citation:	Xiao, X., Deng, B., Zhang, P., Zang, Y., Zhu, M., Liang, H. (2012). The influence of thickness of Nitrocellulose wood lacquer on Formaldehyde emission rates. Advanced Materials Research 354-355:231-235.			
HERO ID:	5972895			
Conditions of Use:	Use as chemical substance in Paints and Coatings			
EXTRACTION				
Parameter	Data			
Description of release source:	CHL-665 Da Bao wood lacquer			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Model (double exponential decay model) appears free of mathematical errors, tested using experimental measurement of formaldehyde, and has been peer-reviewed. Methodology for formaldehyde measurement is provided.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, China.
	Metric 3:	Applicability	High	The model and included measurements can be applied to occupational scenarios
	Metric 4:	Temporal Representativeness	Medium	Not more than 20 years old (2011)
Domain 3: Accessibility/ Clarity	Metric 5:	Metadata Completeness	Medium	Model approach, equations, and choice of parameter values are transparent and clear and can be evaluated. However, the amount of formaldehyde in the wood lacquer is not specified.
Domain 4: Variability and Uncertainty	Metric 6:	Metadata Completeness	Medium	The model has limited characterization of the variability of parameter values. The model has limited characterization of the uncertainty in the results.
Overall Quality Determination		Medium		

Study Citation:	Liroy, P.J., Fan, Z., Zhang, J., Georgopoulos, P., Wang, S.W., Ohman-Strickland, P., Wu, X., Zhu, X., Harrington, J., Tang, X., Meng, Q., Jung, K.H., Kwon, J., Hernandez, M., Bonnano, L., Held, J., Neal, J., Committee, H.H. (2011). Personal and ambient exposures to air toxics in Camden, New Jersey. Research report (Health Effects Institute) (160):3-127; discussion 129-51.			
HERO ID:	1062454			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter		Data		
Description of release source:		Major sources of formaldehyde in the area includes sewage treatment facility, electric power generation, Gypsum product manufacturing (Georgia-Pacific- Domtar Gypsum), materials recovery, Mobile nonroad and mobile road sources		
Release quantity:		Based on 2002 NEI near Philadelphia: Point 50.9 tons per yr, area 13.9 tons per year, Mobile nonroad: 323.3 (tons); Mobile road: 401.5 (tons)		
Comments:		Report contains general population sampling; occupation of volunteers is not specified, EPA assumes that they best represent general population as sampling is for 24 hours/day and focus of the sampling study was general population exposures (20.2 ug/m3 in Waterfront South, NJ and 24.8 in Copewood-Davis, NJ)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	Data are from the U.S.
		Metric 3: Applicability	Uninformative	Data are for non-occupational scenario and also includes release data that cannot be attributed to an occupational scenario within scope.
		Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2011)
		Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics for extracted release data.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Low	The assessment does not focus on release estimates, lacks discussion on variability or uncertainty on that data type.
Overall Quality Determination			Uninformative	

Study Citation:	National Toxicology Program (NTP), (2016). Report on carcinogens, fourteenth edition: Formaldehyde.			
HERO ID:	5160139			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Description of release source:	"Offgassing from numerous construction and home-furnishing products, and offgassing from consumer goods... automobiles and other internal combustion engines, power plants, incinerators, refineries, forest fires, wood stoves, and cigarettes" (6/11)			
Release quantity:	"According to the U.S. Environmental Protection Agency's Toxics Release Inventory, environmental releases of formaldehyde from 716 U.S. facilities in 2014 totaled 19.8 million pounds." (6/11)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are from numerous different industries and situations, all of which are in-scope occupational scenarios.	
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (means, ranges) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.	
Overall Quality Determination		High		

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	All Uses- Emission			
EXTRACTION				
Parameter	Data			
Description of release source:	A wide range of human domestic and industrial activities is responsible for both direct and indirect releases of formaldehyde into the atmosphere from diffuse and point sources. Emission from fuel combustion is perhaps the single most important anthropogenic source of atmospheric formaldehyde, with formaldehyde being released directly or subsequently formed by oxidation of higher alkanes, hydrocarbons, or other precursors, released from combustion processes. Release of formaldehyde into the atmosphere or aquatic environment may also occur during its manufacture, or when used as an intermediate in manufacturing, and during use of products containing formaldehyde. Emissions of formaldehyde to water and soil may be expected to occur via sewage treatment facilities during manufacture of formaldehyde and formaldehyde products and during use of products containing formaldehyde, including consumer products.			
Release quantity:	Recent data from the Australian National Pollution Inventory (NPI) database for emissions of formaldehyde indicate that almost all formaldehyde is released to the atmosphere, with total emissions estimated to be 7150 tonnes for the year 2002-2003 compared with 6600 tonnes for the year 2001-2002. However, formaldehyde emissions to water and soil are significantly less than emissions to the air. Emissions data from the NPI indicate only about 1000 kg of formaldehyde was released into water and/or onto land from point sources in the reporting year 2001-2002 and only 5 kg in 2002-2003. No distinction was made between amounts released to soil and that to water.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Incorporation into Article- Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Description of release source:	Emissions of formaldehyde from the wood and paper industries are expected to occur mainly through fugitive and point source emissions of vapours from process and storage areas, and with some emissions of formaldehyde from combustion activities. The processes emitting vapours will differ with the type of industry, but may include gluing and veneering, steam heating, wood preservation treatment, and drying activities. Combustion sources include wood and paper drying, incinerating, and boiler operations.		
Release quantity:	The average emission rates were 8195 and 7061 kg/year for the 2001- 2002 and 2002-2003 reporting years, respectively, with a maximum of 51,844 kg/year (2002-2003 data) for an individual wood products activity		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data, cited as national pollution inventory, which is a governmental source on emissions.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	N/A	Values are an aggregated value of the reported emissions, no statistics (e.g., mean, range)
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources and assumptions
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the uncertainty in the results. Variability is discussed in relation to the sources of the emissions.
Overall Quality Determination		High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Other Use- Emissions from Mining			
EXTRACTION				
Parameter	Data			
Description of release source:	Emissions of formaldehyde from mining operations are expected to occur mainly via vehicle exhaust from mining equipment and transport, cleaning and site maintenance activities, power generation using fossil fuels, combustion in boilers, and blasting.			
Release quantity:	Metal ore mining activities (iron, gold, silver-lead, or nickel) contributed the highest emissions, although some facilities in this category reported no emissions of formaldehyde. The average emission rate for mining activities was 12 203 kg/year with a maximum of 401 112 kg/year for a nickel mining activity in Western Australia in the 2001-2002 reporting year. For the 2002-2003 reporting year the average emission rate was 7254 kg/year with a maximum of 363 769 kg/year for an iron mining activity in Western Australia.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data, cited as national pollution inventory, which is a governmental source on emissions.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	Values are an aggregated value of the reported emissions, no statistics (e.g., mean, range)
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources and assumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the uncertainty in the results. Variability is discussed in relation to the sources of the emissions.
Overall Quality Determination			High	

Study Citation:	OECD, (2011). Emission scenario document on coating application via spray-painting in the automotive refinishing industry.
HERO ID:	3808976
Conditions of Use:	Use of Paints/Coatings

EXTRACTION

Parameter	Data
Description of release source:	Container cleaning, equipment cleaning, coating application (overspray). Releases to air, land.
Release or emission factors:	nan
Release frequency:	250 days/yr
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple coating types.

Overall Quality Determination**High**

Study Citation:	OECD, (2009). Emission scenario documents on coating industry (paints, lacquers and varnishes).
HERO ID:	3827298
Conditions of Use:	Processing and Use: Formulation of Coatings and Use of Coatings

EXTRACTION

Parameter	Data
Description of release source:	PROC: material loading, heat-up, surface evaporation, filling, micellaneous operations, material storage, leaks, spills USE: Application losses, equipment residues, drum residues. Releases to water, air, land.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical functions and coating types

Overall Quality Determination**Medium**

Study Citation:	OECD, (2009). Emission scenario document on adhesive formulation.
HERO ID:	3827299
Conditions of Use:	Processing: Formulation of Adhesives

EXTRACTION

Parameter	Data
Description of release source:	Container cleaning, dusts and volatiles from unloading containers, vented losses during mixing, sampling, equipment cleaning, volatiles from loading containers, off-spec products. Release to water, air, land.
Release quantity:	Provides models for estimating various fugitive air releases
Release or emission factors:	Release or emission factors
Release frequency:	days/yr equal to number of bt/yr
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	Medium	Data characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and types of adhesives.

Overall Quality Determination**High**

Study Citation:	OECD, (2013). Emission scenario document on the industrial use of adhesives for substrate bonding.			
HERO ID:	3827300			
Conditions of Use:	Industrial Use of Adhesives for Substrate Bonding			
EXTRACTION				
Parameter	Data			
Description of release source:	container cleaning, unloading, equipment cleaning, application losses, curing/drying, trimming. Release to water, air, land.			
Release or emission factors:	nan			
Release frequency:	50-365 days/yr			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions, types of adhesives, and end use markets.
Overall Quality Determination			High	

Study Citation:	OECD, (2017). Emission Scenario Document (ESD) on the use of textile dyes.			
HERO ID:	3828838			
Conditions of Use:	Processing: Textile Dyeing			
EXTRACTION				
Parameter	Data			
Description of release source:	unloading, container cleaning, disposal of spent dye bath, equipment cleaning. Releases to water, air, land.			
Release or emission factors:	nan			
Release frequency:	31-295 days/yr			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment from 2015 but is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical functions
Overall Quality Determination		Medium		

Study Citation:	OECD, (2010). Emission scenario document on formulation of radiation curable coatings, inks and adhesives.			
HERO ID:	3840003			
Conditions of Use:	Adhesives and Sealants; Paint and coatings			
EXTRACTION				
Parameter	Data			
Description of release source:	Releases from equipment during formulation, releases during quality sampling of product, releases during disposal of finter waste, releases of volatile chemicals during packaging, releases during transfer for storage or mixing, releases from transport container residue			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The assessment captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The completed exposure or risk assessment is generally, more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination		High		

Study Citation:	OECD, (2010). Emission Scenario Document on Photoresist Use in Semiconductor Manufacturing.			
HERO ID:	3840005			
Conditions of Use:	Commercial Use (Electrical and electronic products (including semiconductors))			
EXTRACTION				
Parameter	Data			
Description of release source:	Container cleaning, equipment cleaning, excess photoresist (spin-off), waste developer solution, waste etching and stripping solutions. Releases to air, land and water.			
Release or emission factors:	Release or emission factors			
Release frequency:	250-360 days/yr			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple facility sizes.
Overall Quality Determination			High	

Study Citation:	OECD, (2010). Emission scenario document on chemicals used in the electronics industry.			
HERO ID:	5079083			
Conditions of Use:	Processing, Use, Disposal			
EXTRACTION				
Parameter	Data			
Description of release source:	Cleaning of components and equipment, excess materials used for joining components (adhesives, solder, wires, etc.), waste coating and packaging materials, carrier gas losses, dopant residues, filter wastes, leakage/spilling, container cleaning, disposal of old/off-spec materials, spent electroless bath materials, rinse water from plating tanks, etching vapors, drilling/routing dust, scrap board materials, spin-coating, unused film, etching wastes, solder wastes, recovery wastes.			
Release or emission factors:	Releases to water, air, land.			
Release frequency:	30-300 days/yr			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple operations, chemical functions, and facility sizes.
Overall Quality Determination		Medium		

Study Citation:	OECD, (2009). Emission scenario document on plastic additives.		
HERO ID:	5079084		
Conditions of Use:	Processing: Plastics Compounding and Converting		
EXTRACTION			
Parameter	Data		
Description of release source:	Raw material handling, compounding, converting, service life, disposal. Releases to Air, water.		
Release or emission factors:	nan		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
	Metric 3: Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment from 2011 but is based on data greater than 20 years old.
	Metric 5: Sample Size	Medium	Data characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by presenting emission factors for multiple scenarios/addtive types but uncertainty is not addressed.
Overall Quality Determination		Medium	

Study Citation:	OECD, (2011). Emission scenario document on the chemical industry.		
HERO ID:	6306753		
Conditions of Use:	Manufacture, processing, use		
EXTRACTION			
Parameter	Data		
Description of release source:	Stack Air: Reactor vents, distillation column vents, absorber units, strippers, sumps/decanter, dryers, cooling vents Fugitive Air: Valves, pump seals, compressor seals, pressure-relief valves, flanges/connections, open-ended lines, sampling connections Water: Drum cleaning, equipment cleaning, aqueous distillation streams, extraction, reaction water, absorption, solids-liquids separation, adsorption, condensation. Releases to Air, water.		
Release or emission factors:	nan		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
	Metric 3: Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment from 2011 but is based on data greater than 20 years old.
	Metric 5: Sample Size	Medium	Data characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by presenting emission factors for multiple scenarios but uncertainty is not addressed.
Overall Quality Determination		Medium	

Study Citation:	OECD, (2020). Emission scenario document on chemical additives used in automotive lubricants.
HERO ID:	6385735
Conditions of Use:	Processing and Use ((Additive chemicals used in automotive finished lubricants)

EXTRACTION

Parameter	Data
Description of release source:	PROC: unloading, container cleaning, blending, sampling, equipment cleaning, loading USE: unloading, container cleaning, disposal of spent lube oil. Releases to water, air, land.
Release quantity:	Provides models for estimating various fugitive air releases
Release or emission factors:	nan
Release frequency:	Processing: 203-360 Use: 253
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3: Applicability	Medium	Data is for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.

Overall Quality Determination**High**

Study Citation:	OECD, (2012). Emission scenario document on chemicals used in oil well production.			
HERO ID:	6387322			
Conditions of Use:	Processing: Petroleum Production			
EXTRACTION				
Parameter	Data			
Description of release source:	Container cleaning residue released to water, incineration, or land, Equipment and process storage vessels cleaning (tank bottom) residue released to water or land, Additive in oil from separation sentto refinery and released to incineration, Additive in produced water fromseparation released to deep well injection and surface water, Additive in produced water from separation released to irrigation, percolation and evaporation ponds (land).			
Release or emission factors:	nan			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation but not specific to formaldehyde.
	Metric 4:	Temporal Representativeness	Medium	ESD mainly uses data from more than 10 years back.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			High	

Study Citation:	OECD, (2009). Emission scenario document on transport and storage of chemicals.
HERO ID:	6393282
Conditions of Use:	Processing - Transportation and Storage

EXTRACTION

Parameter	Data
Description of release source:	Filling and emptying of containers, storage, pipelines, washing and cleaning, recycling and disposal of packaging
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data mostly greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical forms, containers and storage system types.

Overall Quality Determination**Medium**

Study Citation:	Organisation for Economic Co-operation and Development (OECD) (2015). Emission scenario document (ESD) on chemical vapour deposition in the semiconductor industry.			
HERO ID:	5184986			
Conditions of Use:	Use: Semiconductors (Chemical Vapor Deposition)			
EXTRACTION				
Parameter	Data			
Description of release source:	Process residue/unreacted precursor; container cleaning (at supplier site). Releases to water, air, land.			
Release or emission factors:	nan			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple abatement technologies
Overall Quality Determination		High		

Study Citation:	Preuss, P.W., Dailey, R.L., Lehman, E.S. (1985). Exposure to formaldehyde. Advances in Chemistry Series Vol. 210 :247-259.			
HERO ID:	5946647			
Conditions of Use:	Use of various products			
EXTRACTION				
Parameter	Data			
Description of release source:	Wood products, textiles and carpeting, insulation products (including subcategories for each)			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for use of various wood, textile, and insulation products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by subcategories of products, but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	RTI, (1984). A preliminary assessment of the benefits of reducing formaldehyde exposures (draft).			
HERO ID:	5901060			
Conditions of Use:	Emissions from products			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Low	The assessment is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, such as a consumer DIY scenario that is similar to a worker scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2002). Flexographic ink options: A cleaner technologies substitutes assessment. Volume 1.			
HERO ID:	10293388			
Conditions of Use:	Ink, toner, and colorant products			
EXTRACTION				
Parameter	Data			
Description of release source:	Fugitive air releases from the ink chamber and flexographic press and stack releases from the oxidizer.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for ink, toner, and colorant products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data were collected prior to the most recent NESHAPs for air releases.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Release media and release frequency provided but missing release quantity.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by giving both fugitive and stack emission factors, but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2022). Commercial use of automotive detailing products - Generic scenario for estimating occupational exposures and environmental releases (Methodology review draft).			
HERO ID:	10480464			
Conditions of Use:	Automotive detailing products			
EXTRACTION				
Parameter	Data			
Description of release source:	Container unloading, container cleaning, application and use of automotive detailing products.			
Release or emission factors:	nan			
Release frequency:	260 day/yr			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data.
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2023). Use of laboratory chemicals - Generic scenario for estimating occupational exposures and environmental releases (Revised draft generic scenario).			
HERO ID:	10480466			
Conditions of Use:	Use - Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Description of release source:	Container unloading, container cleaning, labware equipment cleaning, during laboratory analyses, waste disposal; Release media: Water, air, landfill			
Release or emission factors:	Release or emission factors			
Release frequency:	260 day/yr			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2022). Chemical repackaging - Generic scenario for estimating occupational exposures and environmental releases (revised draft).			
HERO ID:	11182966			
Conditions of Use:	Repackaging			
EXTRACTION				
Parameter	Data			
Description of release source:	Transfer losses, container cleaning, equipment cleaning, transfer losses during loading.			
Release quantity:	Provides methodology to estimate releases based on various parameters including: opening area of cleaning equipment, physical-chemical properties, air velocity, etc.			
Release or emission factors:	Release or emission factors			
Release frequency:	The number of operating days is given in a range of 174-260 days/yr with an EPA default of 260 days/yr.			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
Comments:	Media: Air, water, incineration, landfillProvides methodology to estimate total emissions for repackaging sites and process steps.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering emissions from multiple activities.
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (2021). Use of chemicals in fuels and related products - Generic scenario for estimating occupational exposures and environmental releases (Methodology review draft).			
HERO ID:	11203977			
Conditions of Use:	Fuels and Fuel Additives			
EXTRACTION				
Parameter	Data			
Description of release source:	Unloading transport containers, cleaning transport containers, equipment cleaning, fuel combustion releases			
Release quantity:	Provides models for estimating various fugitive air releases. For combustion, 100% release is assumed and remaining chemical (minus upstream losses) is released			
Release or emission factors:	Release or emission factors			
Release frequency:	365			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
Comments:	Media: air, water, incineration, or landfillEstimation methods: AP-42 emission factors, EPA/OPPT models, Mass balance			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple tank filling methods, and considering emissions from different activities.
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2014). Generic scenario draft on the use of additives in plastic compounding.			
HERO ID:	3827195			
Conditions of Use:	Reactant-Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Unloading containers, spillage, Container cleaning, dusts and fugitive emissions from compounding, equipment cleaning (pdf pg 39)			
Release quantity:	Provides models for estimating various fugitive air releases (pdf pg 47)			
Release or emission factors:	Release or emission factors			
Release frequency:	148-264 (pdf pg 63)			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Based in U.S.
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Data characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple plastic types, and additive types.
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2014). Formulation of waterborne coatings - Generic scenario for estimating occupational exposures and environmental releases -Draft.
HERO ID:	3827197
Conditions of Use:	Formulation of Coatings

EXTRACTION

Parameter	Data
Description of release source:	Unloading containers, container cleaning, dispersion and blending operations, sampling, equipment cleaning, filter wastes, loading, off-spec coating
Release quantity:	Provides models for estimating various fugitive air releases
Release or emission factors:	nan
Release frequency:	235-350
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	environmental media: water, air, land

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple coating applications, and multiple chemical functions

Overall Quality Determination	High

Study Citation:	U.S. EPA, (2000). Leather dyeing - Generic scenario for estimating occupational exposures and environmental releases (draft).			
HERO ID:	6311220			
Conditions of Use:	Leather dyeing			
EXTRACTION				
Parameter	Data			
Description of release source:	Air releases considered negligible based on low vapor pressures for most dye chemicals. Water releases expected from exhausted dyebath solution. Land releases from container residue and scrap/off-spec material.			
Release or emission factors:	nan			
Waste treatment methods and pollution control:	nan			
Comments:	Environmental media: water, land			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations and some state statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering both liquid and solid physical forms and different degrees of fixation.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2001). Manufacture and use of printing ink - Generic scenario for estimating occupational exposures and environmental releases (revised draft).
HERO ID:	6311221
Conditions of Use:	Formulation and Use of Printing Ink

EXTRACTION

Parameter	Data
Description of release source:	PROC: Packaging disposal, material transfer, ink processing, equipment cleaning USE: disposal/cleaning of ink container, cleaning printing equipment, ink drying, and disposal of paper.
Release or emission factors:	Release or emission factors
Release frequency:	PROC: 250 days/yrUSE: 250 days/yr
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses sound methods from a frequently used source, EPA, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation but is not specific to chemical.
	Metric 4: Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old (2001). The assessment captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty not addressed. Variability is addressed in different ink classes and types of additives considered.

Overall Quality Determination**High**

Study Citation:	U.S. EPA, (2003). Transportation equipment cleaning - Generic scenario for estimating occupational exposures and environmental releases (draft).
HERO ID:	6385708
Conditions of Use:	All

EXTRACTION

Parameter	Data
Description of release source:	Any water soluble heels that are compatible with the facility's treatment system and the conditions of the facility's wastewater discharge permit are usually combined with other wastewaters for treatment and discharge at the facility. Incompatible heels are segregated into drums or tanks for disposal by alternative means, which may include sale to a reclamation facility, landfill, or incineration. The TEC facility may reuse heels comprised of soaps, detergents, solvents, acids, or alkalis as tank cleaning solutions, as neutralizers for future heels, and for wastewater treatment.
Release or emission factors:	nan
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple container types and cleaning methods.

Overall Quality Determination**Medium**

Study Citation:	U.S. EPA, (2010). Manufacture and use of printing inks - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385710
Conditions of Use:	Inks, toners, and colorant products

EXTRACTION

Parameter	Data
Description of release source:	Disposal/cleaning of ink container, cleaning printing equipment, ink drying.
Release or emission factors:	Release or emission factors
Release frequency:	PROC: 250 days/yrUSE: 250 days/yr
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data.
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple printing applications, and multiple chemical functions.

Overall Quality Determination**Medium**

Study Citation:	U.S. EPA, (2001). Leather tanning - Generic scenario for estimating occupational exposures and environmental releases (draft).			
HERO ID:	6385717			
Conditions of Use:	Leather Tanning			
EXTRACTION				
Parameter	Data			
Description of release source:	All process water containing tanning agent(s) is treated and sent to POTW and/or released to the environment. Land releases are due to PMN chemical residue that remains in the shipping containers.			
Release or emission factors:	Release or emission factors			
Release frequency:	up to 350 operating days/year			
Comments:	Media: Water, land			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2004). Photographic industry - generic scenario for estimating occupational exposures environmental releases: Draft.
HERO ID:	6385718
Conditions of Use:	Incorporating into photographic film or paper, Incorporating into coating formulation, Coating of photographic film or paper, Developing photographic film or paper

EXTRACTION

Parameter	Data
Description of release source:	Releases from photographic film and paper manufacturing processes. Releases from coating processes including disposal of excess coating emulsion. Wastes generated during the photographic paper or film development process, with releases to water from film rinsing and silver recovery operations. Details for each release source are provided in GS.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are for OECD/European countries
	Metric 3: Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distributions characterized by ranges/estimations with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by sections addressing further work and limitations. Variability is not addressed.

Overall Quality Determination**Medium**

Study Citation:	U.S. EPA, (2004). Spray coatings in the furniture industry - generic scenario for estimating occupational exposures and environmental releases: Draft.
HERO ID:	6385719
Conditions of Use:	Furniture Coating Application

EXTRACTION

Parameter	Data
Description of release source:	container cleaning, equipment cleaning, coating application (overspray), volatile air emissions
Release or emission factors:	nan
Release frequency:	250 days/yr
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	media: water, air, land

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability			
Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness			
Metric 2:	Geographic Scope	High	This GS is based on U.S. data
Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and wood vs metal furniture uses

Overall Quality Determination**Medium**

Study Citation:	U.S. EPA, (1994). Application of chemicals in enhanced oil recovery: steam stimulation, steam flooding, and polymer/surfactant flooding-generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385725			
Conditions of Use:	Enhanced Oil Recovery			
EXTRACTION				
Parameter	Data			
Description of release source:	Some small amount of solid waste generated during oil separation processes after recovery, with waste packaged in 55-gallon drums. Air releases from formulations as received during handling and mixing operations. Injection fluid typically recycled and water releases considered negligible. Releases to underground oil reservoirs during operations. Container residues assumed to be recycled, cleaned, or landfilled.			
Release quantity:	Air releases dependent on physical form of formulation as powder, microbead, or liquid with equations to calculate amount in kg/site/day. Underground releases calculated as kg/site/day release.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple physical forms of chemical.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1994). Application of waterborne wood preservatives using pressure treatment-generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385737			
Conditions of Use:	Application of Wood Treatment Products			
EXTRACTION				
Parameter	Data			
Description of release source:	"soil, sawdust, woodchips, accidental releases during delivery/storage/mixing/treatment, unloading, working/breathing losses, leaks contaminated dusts, drying of treated wood"			
Release quantity:	Provides methodology to estimate releases based on various parameters including: annual solid waste output, mass fraction of chemical in wood preservative, etc.			
Release frequency:	260 days/yr			
Comments:	media: air and land			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (1991). Granular detergents manufacture - generic scenario for estimating occupational exposures environmental releases: Draft.
HERO ID:	6385740
Conditions of Use:	Granular Detergent Manufacture

EXTRACTION

Parameter	Data
Description of release source:	equipment cleaning, spillage
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control
Comments:	media: land and water

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical physical forms

Overall Quality Determination**Medium**

Study Citation:	U.S. EPA, (1994). Fabric finishing - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385741			
Conditions of Use:	Manufacture of Textiles, Apparel, and Leather			
EXTRACTION				
Parameter	Data			
Description of release source:	dumping finishing bath, drum residues			
Release quantity:	Provides method for estimating release to water based on bath size, and on-weight-bath percentage			
Comments:	environmental media: land and water			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple finishing agent types	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1996). Electrodeposition - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385753			
Conditions of Use:	Electrodeposition of paints			
EXTRACTION				
Parameter	Data			
Description of release source:	Release of paint solids to wastewater. Air releases if volatile. Landfill/incineration releases from filter inefficiencies and container residues.			
Release or emission factors:	nan			
Release frequency:	Water releases occur either continuously or on a periodic/monthly basis			
Comments:	environmental media: Air, water, incineration, landfill			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations and some state statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering continuous or periodic releases.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (1994). Water treatment disinfectants application - generic scenario for estimating occupational exposures and environmental releases.			
HERO ID:	6385754			
Conditions of Use:	Water Treatment Products			
EXTRACTION				
Parameter	Data			
Description of release source:	unreacted chemical, loading into hoppers, mixing, leaks, water treatment processes			
Release quantity:	Provides methodology to estimate releases of volatiles using solubility in water (assumes everything else volatilizes)			
Release or emission factors:	Release or emission factors			
Comments:	environmental media: air, water			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1994). Water treatment coagulants application - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385760			
Conditions of Use:	Use of Water Treatment Products			
EXTRACTION				
Parameter	Data			
Description of release source:	disposed during use, and loss during solids transfer			
Release or emission factors:	Release or emission factors			
Comments:	Report is specific coagulents used in water treatment. The function of formaldehyde in the COU- Water Treatment Products, is unknown. Therefore, general information on coagulents is extracted and evaluated.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses sound methods that are from frequently used sources, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The assessment is for an occupational scenario (use of water treatment products) within the scope of the risk evaluation but is not data specific to formaldehyde.
	Metric 4:	Temporal Representativeness	Low	More than 20 years old.
	Metric 5:	Sample Size	Medium	characterized by uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is not addressed. Variability is considered with different physical forms of the coagulents considered and different sizes of operation.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2004). Additives in plastics processing (converting) - Generic scenario for estimating occupational exposures and environmental releases - Draft.			
HERO ID:	6549571			
Conditions of Use:	Additives in Plastics Processing (Converting into Finished Products)			
EXTRACTION				
Parameter	Data			
Description of release source:	1. Container residue from plastic resin transport container released to water, incineration, or landfill.2. Dust generation from forming processes released to water or landfill.3. Fugitive air emissions from forming and molding processes released to water or air.4. Equipment cleaning and cooling water from forming and molding processes released to water, incineration, or landfill.5. Solid waste from trimming operations released to water or landfill.			
Release quantity:	Container Residue from Compounding Transport Container: Daily Release from Container Residue (kg/site-day) = Daily Use Rate (kg/site-day) x Loss FractionDust Generation from Converting Activities Released to Water or Landfill: Daily release of dust = daily use rate x loss fractionFugitive Air from Converting Activities Released to Water or Air: Daily release to water (or air) from volatilization = daily use rate x loss fractionResidual from Converting Equipment Cleaning: Daily release from equipment cleaning = daily use rate x loss fractionTrimming Waste: Daily release from trimmings = daily use rate x loss fraction			
Release or emission factors:	Release or emission factors			
Release frequency:	CEB standard assumption, 250 days per year based on 5 day work week and two weeks per year of operation shut down.			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment uses high quality data and methods that are from a frequently used source and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation. However, data are not chemical specific.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by evaluation of various sources of release, but uncertainty in release estimation is not addressed.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2021). Application of spray polyurethane foam insulation - Generic scenario for estimating occupational exposures and environmental releases			
HERO ID:	- Final. 8674805			
Conditions of Use:	Spray Polyurethane Foam Application			
EXTRACTION				
Parameter	Data			
Description of release source:	Container residues, air emissions during application, equipment cleaning, cutting/grinding wastes, spills/leaks, PPE disposal			
Release or emission factors:	nan			
Waste treatment methods and pollution control:	nan			
Comments:	environmental media: water, air, land			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering one- and two-component foams.
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2010). Generic model to estimate environmental releases from container residue for drums containing liquids: Revised draft.			
HERO ID:	8726953			
Conditions of Use:	Distribution in Commerce			
EXTRACTION				
Parameter	Data			
Description of release source:	Release from liquid remaining in a drum after unloading (rinsed or direct disposal). Rinsate from cleaning processes may be either sent to onsite wastewater treatment, used in the process, or incinerated. End-of-life recycling or disposal of drum. (page 6 of 28)			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
Comments:	Environmental Media: water, incineration, landfill			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations and some state statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple drum unloading methods and chemicals
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (1992). Generic scenario document for lube oil additives.
HERO ID:	8726954
Conditions of Use:	Lubricants

EXTRACTION

Parameter	Data
Description of release source:	water discharge/ land disposal/ Air emissions are minimal due to low vapor pressure of PMN- likely different for formaldehyde additive
Release quantity:	Additive manufactureWater 58 kg/site/yrLand 7800 kg/yrBlendingWater 0.7 kg/site/day 350 days/yrEnd useincineration 99516 kg/yrland disposal 9257 kg/yr
Release frequency:	Additive manufactureWorker exposure 250 days/yrWater 350 days/yrBlendingWorker exposure 250 days/yrWater 350 days/yrEnd use250 days/yr
Waste treatment methods and pollution control:	nan

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (EPA)
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Medium	The release data are for an occupational scenario (manufacture, blending, and use of lube oil additives) within the scope of the risk evaluation but is not specific to formaldehyde
	Metric 4: Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old. The assessment captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5: Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is not addressed. The assessment provides only limited discussion of the variability.

Overall Quality Determination**Medium**

Formaldehyde

Environmental Releases

HERO ID: 5112331 Table: 1 of 1

Study Citation:	Appleby, P. H. (1996). BUILDING RELATED ILLNESSES. British Medical Journal 313(7058):674-677.			
HERO ID:	5112331			
Conditions of Use:	Use as chemical substance in construction products, Use in cleaning products			
EXTRACTION				
Parameter	Data			
Description of release source:	Possible sources include UF foam insulation, fabrics, carpets, smoke, floor and wall coverings, adhesives, sealants, lacquer, plywood, chipboard, gypsum board, disinfectants			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Report does not specify the data used.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from United Kingdom, an OECD country.	
	Metric 3: Applicability	High	Data are for emission from construction and cleaning products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Low		

Study Citation:	Asphalt Roofing Manufacturers Association (ARMA), (2019). Comment submitted by Reed B. Hitchcock, Executive Vice President, Asphalt Roofing Manufacturers Association (ARMA) regarding initiation of prioritization of formaldehyde under the Toxic Substances Control Act.			
HERO ID:	10369851			
Conditions of Use:	Building/construction materials not covered elsewhere			
EXTRACTION				
Parameter	Data			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data not from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Baek, K. M., Kim, M. J., Seo, Y. K., Kang, B. W., Kim, J. H., Baek, S. O. (2020). Spatiotemporal variations and health implications of hazardous air pollutants in Ulsan, a multi-industrial city in Korea. Atmosphere 11(5):547.			
HERO ID:	6950643			
Conditions of Use:	disposal			
EXTRACTION				
Parameter	Data			
Description of release source:		Among multi-industrial activities in Ulsan, the petrochemical, oil refinement, and nonferrous metal industries are likely to be major sources of VOCs due to the nature of their operational processes. In addition, shipbuilding and car manufacturing industries are potential sources of VOCs. The atmospheric behavior of formaldehyde is presumed to be different from other VOCs, as not only are they produced from primary sources, such as industrial emissions or vehicle exhaust, but they are also formed in the atmosphere by photochemical oxidation under strong solar radiation and high temperatures. Seasonal concentrations of formaldehyde also substantially increased during the summer, possibly due to secondary formation by photochemical reactions.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S.,
	Metric 3:	Applicability	Low	The report is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	The report is no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:		CalEPA, (2012). Air Toxics Hot Spots Program Risk Assessment Guidelines: Technical support document for exposure assessment and stochastic analysis.		
HERO ID:		10217809		
Conditions of Use:		Commercial Use / Chemical substances in automotive and fuel products		
EXTRACTION				
Parameter		Data		
Description of release source:		Cars and trucks release at least forty different toxic air contaminants, including, but not limited to, diesel particulate, benzene, formaldehyde, 1,3-butadiene and acetaldehyde. Levels of these pollutants are generally concentrated within 500feet of freeways and very busy roadways.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	Use of formaldehyde in fuel is a COU.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old
	Metric 5:	Sample Size	N/A	The information is qualitative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not addresses variability and uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	Carteret, M., Pauwels, J.F., Hanoune, B. (2012). Emission factors of gaseous pollutants from recent kerosene space heaters and fuels available in France in 2010. Indoor Air 22(4):299-308.			
HERO ID:	1290538			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from France, an OECD country.
	Metric 3:	Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2010)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by emission factors for multiple fuel types but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Chen, C.C., Kuo, W.C., Chiang, C.M., Liu, K.S., Nieh, K. (2013). A study on the impact of different application ratios of ultra-low emission green building materials on human health in indoor environments. Applied Mechanics and Materials 271-272:126-130.			
HERO ID:	5965144			
Conditions of Use:	Building/construction materials not covered elsewhere			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2012)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Clunie, J. C., Roberts, E. C. (1987). The sorption and desorption of formaldehyde by fabrics. Part2: Cotton, viscose, nylon 6,6 and polyester. Textile Chemist and Colorist 19(9):73-75.			
HERO ID:	5946077			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Description of release source:		Formaldehyde is desorbed from cotton, viscose, nylon 6,6, and polyester. (1/3)		
Release or emission factors:		Release or emission factors		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for the desorption of formaldehyde by cotton fabrics, which is similar to the in-scope occupational scenario commercial use of fabrics.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (ranges, graphs, slopes) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by testing four fabrics. Uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Clunie, J. C., Roberts, E. C. (1987). The sorption and desorption of formaldehyde by fabrics. Part 1: Cotton fabrics. Textile Chemist and Colorist 19(6):15-18.			
HERO ID:	5948670			
Conditions of Use:	Incorporation into articles			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde is desorbed from cotton fabrics			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	Data are for the desorption of formaldehyde by cotton fabrics, which is similar to the in-scope occupational scenario commercial use of fabrics.	
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by discussing limitations of the study and the effects on results. Variability is not addressed.	
Overall Quality Determination		High		

Study Citation:	Cook, R., Phillips, S., Houyoux, M., Dolwick, P., Mason, R., Yanca, C., Zawacki, M., Davidson, K., Michaels, H., Harvey, C., Somers, J., Luecken, D. (2011). Air quality impacts of increased use of ethanol under the United States’ Energy Independence and Security Act. Atmospheric Environment 45(40):7714-7724.			
HERO ID:	1056185			
Conditions of Use:	Unknown			
EXTRACTION				
Parameter	Data			
Release quantity:	RFS1: 140,156 (tons); RFS2: 140,330 (tons)			
Release or emission factors:	Release or emission factors			
Comments:	Multi-scale Air Quality Model			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Uninformative	Condition of use is unknown.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by emissions under RFS1 and RFS2 being compared but uncertainty is not addressed.
Overall Quality Determination		Uninformative		

Study Citation:	Correia, V. M., Judd, S. J., Stephenson, T. (1994). Characterisation of textile wastewaters: A review. Environmental Technology 15(10):917-929.			
HERO ID:	6110946			
Conditions of Use:	Textile finishing			
EXTRACTION				
Parameter	Data			
Description of release source:	For cotton fabric finishing, sources of wastewater are: desizing, scour and wash, mercerize and wash, bleach and wash, dye and wash, print and wash, apply finish.			
Waste treatment methods and pollution control:	Formaldehyde is expected to be present in wastewater from the dyeing process. Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Information is qualitative
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 5936928 Table: 1 of 1

Study Citation:	Crnogorac, O., Miljkovic, J., Hespodarik, A. (1995). Correlation between destructive and nondestructive methods for determination of formaldehyde emission from plywood. Drevarsky Vyskum 40(1):17-25.			
HERO ID:	5936928			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from Serbia, a non-OECD country and Slovakia, an OECD country.	
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range (in graph form) with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Low		

Study Citation:	Di, Y., Cheung, C.S., Huang, Z. (2009). Experimental investigation on regulated and unregulated emissions of a diesel engine fueled with ultra-low sulfur diesel fuel blended with biodiesel from waste cooking oil. Science of the Total Environment 407(2):835-846.			
HERO ID:	857752			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Description of release source:	Vehicle exhaust			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3:	Applicability	High	Data are for fuels and fuel additives, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2008)
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing emissions at different engine loads but uncertainty is not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 5950772 Table: 1 of 1

Study Citation:	Ding, W., Li, W., Gao, Q., Han, C., Zhang, S., Li, J. (2013). The effects of sealing treatment and wood species on formaldehyde emission of plywood. BioResources 8(2):2568-2582.			
HERO ID:	5950772			
Conditions of Use:	Adhesives and sealant chemicals in: Plastic and resin manufacturing; Wood product manufacturing; All other basic organic chemical manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Emissions from plywood			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The release data methodology is known or expected to be accurate. It discusses releases from individual products, not a site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors may impact releases relative to the U.S.
	Metric 3:	Applicability	High	The release data are for an occupational scenario within the scope
	Metric 4:	Temporal Representativeness	High	The operations, equipment, and worker activities associated with the data indicate that the data should to be representative of current operations, equipment, and activities. The releasedata were collected after the most recent federal regulatory action or update and are no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Release data include all associated metadata, including release media; process, unit operation, or activity that is the source of the release, but not release frequency.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The release data study addresses variability in the determinants of
Overall Quality Determination			High	

Study Citation:	Dow Chemical, (1988). [Redacted] Airborne formaldehyde from aqueous solutions.			
HERO ID:	10602429			
Conditions of Use:	General			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The report is general emission from an aqueous solution of formaldehyde, useful for occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is from 1988, more than 20 years old.
	Metric 5:	Sample Size	Low	Uncertain the sample size of measured headspace analysis.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Though the model is presented - other data sources are not clear
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report does discuss variability in exposure scenarios but not with respect to measured data. Uncertainty in model is discussed used is characterized but not uncertainty in measured data.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 1167915 Table: 1 of 1

Study Citation:	Dunn, W., Toy, H. D., Wright, A. J., Hedley, W. H., Holmes, L., Barrett, G. J. (1983). Detailed Industrial Hygiene Survey Formaldehyde Production, E. I. DuPont DeNemours and Company, Linden, New Jersey, Report No. CT-114-20b. NIOSH(068-03-3025):068-03.
HERO ID:	1167915
Conditions of Use:	Manufacture

EXTRACTION

Parameter	Data
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The data are for an occupational scenario (formaldehyde manufacture) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1982 more than 20years old
	Metric 5: Sample Size	N/A	Qualitative information
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Clear that information provided was from site visit
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Qualitative information

Overall Quality Determination	High

Formaldehyde

Environmental Releases

HERO ID: 1958980 Table: 1 of 1

Study Citation:	Elia, V. J., Messmer, R. A. (1992). Evaluation of methods for estimating formaldehyde released from resin-containing paper and wood product dusts. American Industrial Hygiene Association Journal 53(10):632-638.			
HERO ID:	1958980			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Description of release source: Raw wood, UF resin, UF paperboard, UF paper				
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1992)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing emission factors for different formaldehyde-containing resins but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Formaldehyde Institute, (1984). Letter from Formaldehyde Institute to USEPA regarding comments on ANPR for urea-formaldehyde resins.			
HERO ID:	6574573			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Description of release source:	Cured and uncured resins can release free formaldehyde			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Data sources in the report are not specified
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for processing an in-scope occupational scenario
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Data sources are not fully transparent
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium		

Study Citation:	FRM Risk, (2019). [Redacted] Industrial hygiene air contaminant assessment report.			
HERO ID:	10602489			
Conditions of Use:	”blending operations”			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde gas is liberated during blending processes in which paraformaldehyde supersacks are emptied into a hopper to transfer paraformaldehyde into blend tank via vacuum pump. Paraformaldehyde is a white crystalline powder of polymerized formaldehyde that can emit formaldehyde gas. (pg 5)			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for blending operations, which could be applicable to multiple COUs but not specific.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	description of release source
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 5950827 Table: 1 of 1

Study Citation:	Graves, G. (1999). Urea-formaldehyde resins: Yesterday, today, and tomorrow. :3-10.			
HERO ID:	5950827			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Release or emission factors:	nan			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for processing as a reactant, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Hawthorne, A.R., Gammage, R.B. (1982). Formaldehyde release from simulated wall panels insulated with urea-formaldehyde foam insulation. Journal of the Air Pollution Control Association 32(11):1126-1131.			
HERO ID:	5957355			
Conditions of Use:	Use of wall panels with urea-formaldehyde foam insulation			
EXTRACTION				
Parameter	Data			
Description of release source:	Formaldehyde emissions may arise both from excess formaldehyde in the original urea-formaldehyde resin, some of which may still be present just after foaming, and from a continuing generation and release due to hydrolysis of the UFFI. The acid catalyst used to complete the polymerization of the UFFI provides an acidic environment, which tends to enhance hydrolytic decomposition and produce continuous formaldehyde release.			
Comments:	Source provides data on formaldehyde in chamber and wall cavities with and without air flow. These concentrations can be translated into emission rates using the chamber / cavity volumes and equation provided in the study. Data evaluated as monitoring data.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Sampling or analytical methodology is an approved OSHA or NIOSH method or is well described and found to be equivalent to approved OSHA or NIOSH methods.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Low	The data are for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, such as a consumer DIY scenario that is similar to a worker scenario.
	Metric 4:	Temporal Representativeness	Low	Metadata on the operations, equipment, and worker activities associated with the data show that the data agree representative of outdated operations, equipment, and activities rather than current operations, equipment, and worker activities. The data were collected before the most recent PEL establishment or update or are more than 20 years old if no PEL is established.
	Metric 5:	Sample Size	N/A	concentrations can be translated into emission rates
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Description of sources of potential environmental releases
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	limited discussion-Description of sources of potential environmental releases
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 1316234 Table: 1 of 1

Study Citation:	Hazleton Laboratories, (1982). Development document for effluent limitations, guidelines and standards for the pulp, paper, and paperboard, and the builders paper and board mills (final report) (epa 440/1-82/025).			
HERO ID:	1316234			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is greater than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Hunsucker, J.H., Sankey, C.F., Eckler, P.E., Tomasino, C., Livengood, C. (1982). Reduced formaldehyde release with nitro alcohols. Textile Research Journal 52(2):133-140.			
HERO ID:	5965784			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Description of release source:	Free formaldehyde is released from durable-press formaldehyde finished fabrics. (1/8)			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for textile finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by using different resins and wash conditions in the methods. Uncertainty isn't addressed.
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 5901065 Table: 1 of 1

Study Citation:	ICFI, (1984). Formaldehyde emissions from building products: cost-effectiveness of reduction strategies. Chapter II: formaldehyde-emitting wood products and alternatives for controlling emissions.			
HERO ID:	5901065			
Conditions of Use:	emission			
EXTRACTION				
Parameter	Data			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		High		

Study Citation:	IT Corporation, (1996). Air dispersion modeling report in support of permit applications for acrylate (including ethyl acrylate) incinerator units, Clear Lake Plant, Pasadena TX, w/cvr ltr dtd 7/29/96.			
HERO ID:	4442078			
Conditions of Use:	disposal			
EXTRACTION				
Parameter	Data			
Description of release source:	The Clear Lake Plant of Hoechst Celanese Chemical Group currently operates a chemical manufacturing plant in Texas. The article presents air dispersion modeling results for its proposed new units. The expansion will result in fugitive emissions from 2 units, along with fugitive and stack emissions from one unit. The total project sources include 2 incinerator slacks, one cooling tower, and 3 fugitive sources. Formaldehyde was expected to be one of the pollutants.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	data are from the United States	
	Metric 3: Applicability	High	report is for an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Kaiser, E.W., Andino, J.M., Siegl, W.O., Hammerle, R.H., Butler, J.W. (1991). Hydrocarbon and aldehyde emissions from an engine fueled with ethyl-t-butyl ether. Journal of the Air and Waste Management Association 41(2):195-197.			
HERO ID:	1248190			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Description of release source:	Automobile engines			
Release quantity:	64 to 220 ppm in engine exhaust			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	scientific journal article	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1991)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by testing engine emissions at different RPMs but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation: Katovic, D., Soljagic, I., Orji, G., Piljac, I. (1996). Polarography determination of free formaldehyde on treated cotton fabrics. Croatica Chemica Acta 69(1):1-8.	
HERO ID: 5944049	
Conditions of Use: Fabric Finishing	
EXTRACTION	
Parameter	Data
Description of release source:	treated fabric
Release quantity:	Not really environmental release data - tested free formaldehyde release from fabric via extraction processes (pg 3-7)
Comments:	AATCC Test Method 112-1982 (pg 3)
EVALUATION	
Domain	Metric
Domain 1: Reliability	
Metric 1:	Methodology
	Medium
	Report uses high quality data/techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
	Low
Metric 3:	Applicability
	High
Metric 4:	Temporal Representativeness
	Low
	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size
	Low
	Sample distribution is presented graphically.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	Medium
	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	Medium
	Variability addressed by evaluating at different temperatures but uncertainty is not addressed.
Overall Quality Determination	
Low	

Formaldehyde

Environmental Releases

HERO ID: 5943864 Table: 1 of 1

Study Citation:	Knowles, L. (1993). Evolution of formaldehyde control through the use of wet scavengers, dry scavengers, and dual resin systems in an operating board plant. :243-253.			
HERO ID:	5943864			
Conditions of Use:	Building materials- Engineered Wood Products			
EXTRACTION				
Parameter	Data			
Waste treatment methods and pollution control: nan				
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The report is based on operations at the site who it appears publish the work, no associated information indicates flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The report includes information on different approaches to reduce formaldehyde emissions that the site has employed over the years. This appears to be general information that can be used for the wood composite products within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	More than 20 years ago. New emission standards may have caused new approaches for reducing formaldehyde emissions
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents their approaches and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 491238 Table: 1 of 1

Study Citation:	Ladou, J. (2006). Printed circuit board industry. International Journal of Hygiene and Environmental Health 209(3):211-219.			
HERO ID:	491238			
Conditions of Use:	Use of electrical and electronic products			
EXTRACTION				
Parameter	Data			
Description of release source:	When heated, chemicals used in the electroless copper bath can generate formaldehyde vapors. most electroless copper baths contain significant concentrations of formaldehyde that result in air emissions.			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for electrical and electronic products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2005)
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		Medium		

Study Citation:	Malin, N. (1994). Carpeting, Indoor Air Quality, and the Environment. Environmental Building News 3(6):1.			
HERO ID:	5708617			
Conditions of Use:	Use- Floor Coverings & Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Description of release source:	Article discusses issues with indoor air quality from carpets which potentially could be from carpets or adhesives used in carpets. The article mentions formaldehyde emissions is tested by carpet lines, that it can be absorbed into carpets from other indoor or outdoor sources, and has been found to be emitted from vinyl backings			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data	
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Information is more than 20 years old.	
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	This metric is not applicable to the data being extracted	
Overall Quality Determination		Medium		

Study Citation:	Marsal, A., Cuadros, S., Cuadros, R.M., Font, J., Manich, A.M. (2018). Dyestuffs and formaldehyde content in split leather treated with formaldehyde resins. Dyes and Pigments 158:50-59.			
HERO ID:	5959225			
Conditions of Use:	Finishing agents in textile, apparel, and leather manufacturing (leather dyes)			
EXTRACTION				
Parameter	Data			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Spain, an OECD country.
	Metric 3:	Applicability	High	Data are for fabric finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Discussion of waste treatment options.
Overall Quality Determination		High		

Study Citation:	Mcdonald, A.G., Gifford, J.S., Steward, D., Dare, P.H., Riley, S., Simpson, I. (2004). Air emission from timber drying: high temperature drying and re-drying of CCA treated timber. Holz als Roh- und Werkstoff 62(4):291-302.		
HERO ID:	1155306		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Description of release source:	Green radiata pine timber and CCA treated timber (drying operations).		
Release or emission factors:	Release or emission factors		
Comments:	Air concentrations over different duration as well as the total amount released per volume of wood are shown on table 4 page 6/12. The air concentrations could be also used to estimate worker exposure.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for Building/construction materials (wood and wood engineered products), an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2004)
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium	

Study Citation:	Michanicki, A. (1997). Recovery of fibers and particles from wood-based products. :115-119.			
HERO ID:	1965315			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	MDF made with fibers from secondary particles in combination with fresh fibers have lower formaldehyde emissions than MDF exclusively made with fresh fibers.			
Release quantity:	Figure 3 shows reduction of formaldehyde release by the addition of urea to the impregnation liquor or the glue. Perforator value at ~ 10 mg/100g down to 2 and 4 mg/100g with 1.5% urea in liquor and glue.			
Comments:	MDF is medium density fiberboard.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Unclear if source is peer reviewed but likely appears high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is from Britain, an OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to manufacture of wood products.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1997)
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report addresses variability by evaluating different additives but does not address uncertainty.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 5471613 Table: 1 of 1

Study Citation:	Mihlan, G.J. (1983). Preliminary control technology survey on Datel Intersil Corporation, Mansfield, Massachusetts.			
HERO ID:	5471613			
Conditions of Use:	Process Aid- Electroless Copper Plating			
EXTRACTION				
Parameter	Data			
Description of release source:	manufacturing of printed circuit boards			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data and/or techniques
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 8728027 Table: 1 of 1

Study Citation:	Monsanto Research Corp. (1984). A survey of health hazard control systems for formaldehyde production facilities.			
HERO ID:	8728027			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	Leakage from a formaldehyde production unit. Fugitive emissions during loading and unloading procedures.			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - description of release source and pollution control.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - description of release source and pollution control.
Overall Quality Determination		High		

Study Citation:	Mølhav, L. (1980). The effect of a chemical surface-treatment on formaldehyde emission from particleboards. <i>Holzforschung und Holzverwertung</i> 32(6):137-138.
HERO ID:	22889
Conditions of Use:	Installation/Demolition of Building Materials

EXTRACTION

Parameter	Data
Description of release source:	Emissions from particleboard
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Danish study, an OECD country.
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data on type of resin used for particleboard is unclear.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.

Overall Quality Determination	Medium

Study Citation:	Neuschutz, H. (1977). Process for the purification of industrial effluent.			
HERO ID:	6115384			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Waste treatment methods and pollution control:		Waste treatment methods and pollution control		
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The patent only contains references to other patents.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of water treatment products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (2003). Niosh health hazard evaluation report- Bemis.			
HERO ID:	8684536			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Thermal sealing and cutting of plastic packaging bags.			
Release frequency:	Bag department operations occur 5 days/week 8 hours/day.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	N/A - qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - qualitative information
Overall Quality Determination			High	

Study Citation:	OECD, (2015). Emission scenario document on use of adhesives.			
HERO ID:	3833136			
Conditions of Use:	Use of Adhesives			
EXTRACTION				
Parameter	Data			
Description of release source:	1. Container residues from adhesive transport container (release to water, incineration, or land)2. Open surface losses of volatile chemicals during container cleaning (release to air)3. Transfer operation losses of volatile chemicals (release to air)4. Equipment cleaning wastes (release to water, incineration, or land)5. Open surface losses of volatile chemicals during equipment cleaning (release to air)6. Overspray particulates/mists captured within spray area (release to water, air, incineration or land, depending onthe control technology utilized)7. Evaporative losses during drying or curing (release to air or incineration)8. Overspray not captured by emission controls and vented to outside air (release to air)			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	OECD report authored by EPA, and it is generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	Medium	The report is for an occupational scenario (use of adhesives) within the scope of the risk evaluation, but information is general for the use scenario and not necessarily specific to formaldehyde.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old (2015).
	Metric 5:	Sample Size	N/A	No sample data were extracted.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	This report aggregates all of the information such that it is not possible to differentiate what processes and application techniques apply to Formaldehyde.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	OECD, (2011). Resource compendium of PRTR release estimation techniques, part 4: Summary of techniques for releases from products, version 1.0.			
HERO ID:	7348917			
Conditions of Use:	Building/ construction materials (wood and engineered wood products)			
EXTRACTION				
Parameter	Data			
Description of release source:				
Released from adhesives in wooden furniture to air [PDF Pg. 52]Released from finishes in insulating materials to air [PDF Pg. 52]Released from wooden furniture into soil when used in open air. [PDF Pg. 89]				
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Document is from the OECD country.	
	Metric 3: Applicability	High	Data is for Building/ construction materials (wood and engineered wood products), an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability, but uncertainty in the results.	
Overall Quality Determination		High		

Study Citation:	OECD, (2011). Resource compendium of PRTR release estimation techniques, part 4: Summary of techniques for releases from products, version 1.0.			
HERO ID:	7348917			
Conditions of Use:	Floor coverings			
EXTRACTION				
Parameter	Data			
Description of release source:	Released from carpet finishes into air. [PDF Pg. 52]Released from carpets into water during washing. [PDF Pg. 92]			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Document is from the OECD country.	
	Metric 3: Applicability	High	Data is for floor coverings, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion does not address variability, but uncertainty in the results.	
Overall Quality Determination		High		

Study Citation:	OECD, (2018). Economic valuation in formaldehyde regulation.			
HERO ID:	7681892			
Conditions of Use:	Disposal			
EXTRACTION				
Parameter	Data			
Description of release source:	Anthropogenic sources of formaldehyde in the environment include direct sources, such as on-site industrial emissions, transport fuel combustion and other combustion processes from power plants and incineration (WHO, 2010[2]).			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for disposal, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		High		

Study Citation:	Paredes, J. J., Shaler, S. M., Edgar, R., Cole, B. (2010). Selected volatile organic compound emissions and performance of oriented strandboard from extracted southern pine. Wood and Fiber Science 42(4):429-438.			
HERO ID:	1117964			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Emission from oriented strandboard during pressing operations.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials (wood and wood-engineered products, an in-scope occupational scenario. (Received February 2010)
	Metric 4:	Temporal Representativeness	Medium	
	Metric 5:	Sample Size	N/A	Not applicable - no sampling.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sampling.
Overall Quality Determination			High	

Study Citation:	Pond, R.L. (1999). Biofiltration to reduce VOC and HAP emissions in the board industry. Tappi Journal 82(8):137-140.			
HERO ID:	1178712			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Hard board mill press exhaust			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for building/construction materials (wood and wood engineered products), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1999)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination			Medium	

Study Citation:	Roffael, E. (2006). Volatile organic compounds and formaldehyde in nature, wood and wood based panels. Holz als Roh- und Werkstoff 64(2):144-149.			
HERO ID:	5963834			
Conditions of Use:	Use as chemical substance in wood products			
EXTRACTION				
Parameter	Data			
Description of release source:	Emission from untreated wood and wood products treated with formaldehyde-based resins			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	Data are for use in wood products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by chamber and perforator sampling methods. Variability addressed by various wood types and change over time.
Overall Quality Determination		Medium		

Study Citation:	Rosenfeld, P. E., Feng, H., L.G. (2011). The petroleum industry. :57-71.			
HERO ID:	6108171			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Description of release source:	Release within petroleum industry arises from leakage, venting, and the evaporation of raw materials and finished products. The operations within a typical refinery emit a wide variety of criteria pollutants and toxic chemicals from fuel combustion devices. Oil and gas field operations as well as gas processing plants are also significant sources of emissions. As such, air emissions consist of point, fugitive, and area sources. Fugitive emissions are the emissions from equipment leaks, such as from valves, storage tanks, and various support equipment. According to the EPA, over 50% of all VOC and toxic air emissions from refineries are fugitive emissions.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		High		

Formaldehyde

Environmental Releases

HERO ID: 5041238 Table: 1 of 1

Study Citation:	Rovira, J., Domingo, J.L. (2019). Human health risks due to exposure to inorganic and organic chemicals from textiles: A review. Environmental Research 168:62-69.			
HERO ID:	5041238			
Conditions of Use:	Textile finishing			
EXTRACTION				
Parameter	Data			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty in regards to environmental releases.
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 5937111 Table: 1 of 1

Study Citation:	Ruffing, T.C., Shi, W.W., Brown, N.R., Smith, P.M. (2011). Review of United States and international formaldehyde emission regulations for interior wood composite panels. Wood and Fiber Science 43(1):21-31.			
HERO ID:	5937111			
Conditions of Use:	Use as chemical substance in wood products			
EXTRACTION				
Parameter	Data			
Description of release source:	Interior composite wood panels using urea-formaldehyde resin; free formaldehyde is initial emission			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for use in wood products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			High	

Study Citation:	Schuetzle, D., Siegl, W.O., Jensen, T.E., Dearth, M.A., Kaiser, E.W., Gorse, R., Kreucher, W., Kulik, E. (1994). The Relationship between Gasoline Composition and Vehicle Hydrocarbon Emissions: A Review of Current Studies and Future Research Needs. Environmental Health Perspectives 102(SUPPL. 4):3.			
HERO ID:	1518425			
Conditions of Use:	Use in Fuels (Vechicle Exhaust)			
EXTRACTION				
Parameter	Data			
Description of release source:	Hydrocarbon emissions increase rapidly when the fuel and air mixture becomes fuel rich. "Single-cyclinder engine studies demonstrated that the total engine-out HC emissions increased as the average molecular weight of the fuel increased. Reduction in T90 also resulted in the reduction of 1,3-butadiene, formaldehyde and acetaldehyde (Table4). The lower formaldehyde and acetaldehyde emissions may be the result of the reduced concentration of the heavier isoparaffins and alkylaro-matics...Replacement of olefins with paraffins and/or aromatics [as well as addition of MTBE] should result in an increase in total HC emissions..."MTBE may be a primary fuel precursor for formaledhyde.			
Comments:	Partial combustion of the isoparaffins and alkyl aromatics would result in an increased formation of methyl and ethyl radicals. These radicals can undergo further reactions(especially under lean con-ditions) to form formaldehyde and acetaldehyde. Primary fuel precursor is MTBE			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses sound methods that are not from a frequently used source and associated information does notindicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	U.S. Data	
	Metric 3: Applicability	Low	The report is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	More than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability is well characterized(study discusses a number of variations in fuel types) but only limited discussion on uncertainty on relationship dependencies	
Overall Quality Determination		Medium		

Study Citation:	Shinohara, N., Fujii, M., Yamasaki, A., Yanagisawa, Y. (2007). Passive flux sampler for measurement of formaldehyde emission rates. Atmospheric Environment 41(19):4018-4028.			
HERO ID:	5958934			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD Country.
	Metric 3:	Applicability	Medium	Data are for a testing method to detect emissions from furniture, which is similar to the in-scope occupational scenario use of furniture products.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (averages, ranges, graphs) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by determining the upper and lower limits of the testing procedure and testing the precision. Variability is addressed by testing different materials with the apparatus.
Overall Quality Determination			Medium	

Study Citation:	SIA, (2020). SIA comments on the draft scope of the risk evaluation for formaldehyde.			
HERO ID:	10384684			
Conditions of Use:	electroless copper plating			
EXTRACTION				
Parameter	Data			
Waste treatment methods and pollution control: Waste treatment methods and pollution control				
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 3421076 Table: 1 of 1

Study Citation:	Silveira, C. C., Amorim, Costa, D. S., Mansur, H. S., Mansur, P., A.A. (2016). Evaluation of formaldehyde release from ASTM C6 coating of non-oriented electrical steel. I E E E Transactions on Magnetics 52(5):2002104.			
HERO ID:	3421076			
Conditions of Use:	Use of metal products			
EXTRACTION				
Parameter	Data			
Description of release source:	Resin varnishes on non-oriented grain electrical steel			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Brazil, a non-OECD country.
	Metric 3:	Applicability	High	Data are for use in coatings, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed by margin of error on measurements. Variability addressed by different temperatures and varnishes.
Overall Quality Determination			High	

Formaldehyde

Environmental Releases

HERO ID: 4678382 Table: 1 of 1

Study Citation:	Suzuki, A., Sugiyama, N., Hayasaka, T., Nozaki, A. (2005). A study on the emission of chemical substances and mitigation technique from housing equipment. :2237-2242.			
HERO ID:	4678382			
Conditions of Use:	Use as chemical substance for furniture			
EXTRACTION				
Parameter	Data			
Description of release source:	Furniture products			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3:	Applicability	High	Data are for use in furniture products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).
HERO ID:	1256822
Conditions of Use:	Domestic Manufacture

EXTRACTION	
Parameter	Data
Description of release source:	Formaldehyde productionProcess Emissions– Silver Catalyst Process – The primary source of formaldehyde process emissions is the purging of gases from the secondary absorber. The product fractionator is another possible source of formaldehyde process emissions. However, most producers report that gases from the fractionator are fed to the absorber before venting. Formaldehyde emissions also occur during plant startup. Formaldehyde plants are normally operated at design conditions to achieve highest yields and are shut down when product inventories are filled. The silver catalyst process operates above the upper explosive limit of methanol. Thus, plant startup procedures must be handled carefully. Unstable conditions are encountered, and explosions can occur in the methanol vaporizer and the reactor. Various startup procedures are used in the industry. During startup, the output from the reactor may be vented until stable operation is achieved and an acceptable yield ratio is obtained. The flow is then switched into the absorber. Most formaldehyde producers report that startup vents go through the absorber before venting to the atmosphere. Total startup time is usually 1 to 2 hours. The reactor feed rate varies as the startup proceeds. Initially, the reactor produces mainly carbon dioxide and water vapor. As the temperature rises, the formaldehyde yield increases, thereby increasing the amount of formaldehyde in the vented gas. Startup emissions, when venting through the absorber, are reported to be 0.1 kg/Mg. Metal Oxide Catalyst Process– The metal oxide catalyst process operates below the explosive limit of methanol with an excess of air resulting in stable conditions during startup. Thus, venting of the reactor during startup is not required as it was for the silver catalyst process, and there are no intermittent startup emissions. Formaldehyde process emissions result from venting gases from the product absorber. The emission composition and flow rates are affected by the percent of absorber gas recycled. By recycling a portion of the oxygen-lean vent gas, the oxygen concentration in the reactor feed mixture can be reduced, making it possible for the concentration of methanol to be increased without forming an explosive mixture. This reduces the volume of reaction gases and thus reduces the emission rate of formaldehyde from the absorber.Storage Emissions– Formaldehyde emissions result from storing formaldehyde product. Formaldehyde storage emissions were estimated based on an average of four tanks per plant, a tank size of 190 cubic meters, 45 turnovers per year, and a bulk liquid temperature of 54°C. The tanks were assumed to be fixed-roof, half full, and subject to a diurnal temperature variation of 11.1°C.Handling Emissions- Emission factors from the handling of formaldehyde product were calculated assuming submerged fill-pipe loading into trucks and tank cars.Fugitive Emissions– Fugitive emissions of formaldehyde and other volatile organics result from leaks in process valves, pumps, compressors, and pressure relief valves. The rate of fugitive emissions of formaldehyde from these sources was calculated from the number of pumps, valves, compressors, and relief valves in formaldehyde service, the estimated formaldehyde concentration in streams in contact with these sources, and emission factors for fugitive sources.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (formaldehyde manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	The provided emission factors did not include associated statistics.
Domain 3: Accessibility/ Clarity				

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Formaldehyde

Environmental Releases

HERO ID: 1256822 Table: 1 of 19

...continued from previous page

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Domestic Manufacture			
		EVALUATION		
Domain	Metric	Rating	Comments	
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Resin Manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	Urea-formaldehyde and Melamine-formaldehyde resin productionFormaldehyde emissions from the polymerization process occur while water is being removed from the reactor under vacuum and during the cleaning of the reactor kettles between batches. Fugitive gaseous emissions may occur from relief valves, pumps, valves, and flanges. Potential formaldehyde emission sources in spray drying operations are belt driers, continuous drum dryers, and continuous screen dryers that are vented to the atmosphere. Urea-formaldehyde and M-F production plants may vary in configuration and level of control. The level of control on formaldehyde storage emissions should be equivalent to that for formaldehyde production. The reader is encouraged to contact plant personnel to confirm the existence of emitting operations and control technology at a particular facility prior to estimating its emissions.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	The provided emission factors were presented as a range, but did not include any additional statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Resin Manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	PHENOL-FORMALDEHYDE RESIN PRODUCTION Formaldehyde emissions from the production of resols and novolaks may result from the storage of formaldehyde before it is charged to the reactor and from the distillation and dehydration of the reaction mixture. Carbon adsorption or liquid extraction is used to control emissions from these operations. Fugitive gaseous emissions may occur at the condenser, vacuum line, sample ports, and vents of both processes. Intermittent formaldehyde emissions occur at safety blow-off valves. Formaldehyde emissions also may result from washing reactor kettles. Water washing of some resols during product preparation may produce formaldehyde emissions. Phenol-formaldehyde production plants may vary in configuration.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	The provided emission factors were presented as a range, but did not include any additional statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Resin Manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	POLYACETAL RESIN PRODUCTIONFormaldehyde emissions may result from the storage of aqueous formaldehyde solution prior to feed preparation. The major source of process and fugitive emissions is the feed preparation step.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	The provided emission factors were presented as a range, but did not include any additional statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Resin Manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	PENTAERYTHRITOL PRODUCTION Formaldehyde may be emitted from formaldehyde storage, from the evaporator, and from the drier vents.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	The provided emission factors were presented as a range, but did not include any additional statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Plastic Manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	PHTHALIC ANHYDRIDE PRODUCTIONThe main process waste gas from the phthalic anhydride condensers, may contain a small amount of formaldehyde			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	The provided emission factors did not include any statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant process aid			
EXTRACTION				
Parameter	Data			
Description of release source:	SOLID UREA AND UREAFORM PROCESSINGFormaldehyde is emitted during the urea solids production process, specifically related to fluidized bed prilling and drum granulation operations. Uncontrolled emission rates from prill towers may be affected by factors such as product grade being produced (agricultural or feed grade), air flow rate through the tower, type of tower bed, and ambient temperature and humidity. Uncontrolled emissions per unit of production are usually lower for feed-grade prills than for agricultural-grade prills due to lower airflows. Emission rates from drum granulators may be affected by parameters such as rotation rate of the drum, product size, recycle rate of seed material, bed temperature, solution spray pressure, and airflow rates through the drum.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (process aid) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	The provided emission factors did not include any statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant wood products			
EXTRACTION				
Parameter	Data			
Release quantity:	Furniture ManufacturingIn the absence of furniture plant formaldehyde emissions data, the available range of particleboard manufacturing formaldehyde emissions data may be used to predict a worst-case formaldehyde emissions estimate for furniture manufacturing. This estimate is possible because both industries use similar U-F adhesive resins and both utilize board pressing operations at elevated temperatures and pressures.However, in furniture plants it is possible that a smaller percent of the excess formaldehyde in the adhesive resin is emitted than in particleboard plants. Formaldehyde emissions from furniture plants are probably lower because: (1) presses in furniture plants operate at much lower temperatures, (2) furniture presses have somewhat shorter cycle times than those in particleboard plants, and (3) the physical configuration of furniture pieces is different than that of particleboards. (In a furniture piece, a veneer barrier protects the major glue surface from direct exposure to air, while no such continuous barrier inhibits formaldehyde evaporation during the particleboard pressing cycle.)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (wood products manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Some of the emission factors were provided as a range but did not include any statistical data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	External combustion - Industrial processes			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	The provided emission factors did not include any statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 1256822 Table: 10 of 19

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Mobile sources			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	The provided range datat for the emission factors but did not include any other statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	External combustion - boilers			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	The provided emission factors did not include any statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 1256822 Table: 12 of 19

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	combustion Incineration			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	The provided range datat for the emission factors but did not include any other statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Resin Manufacture			
EXTRACTION				
Parameter	Data			
Description of release source:	HEXAMETHYLENETETRAMINE PRODUCTION Formaldehyde emission sources include off-gases from the reactor, waste water from the centrifuge wash bleed line, and the drier vent.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	The provided emission factors did not include associated statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Resin Manufacture			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	EPA Locating and Estimating document	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	Low	The provided emission factors did not include associated statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation: U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).	
HERO ID: 1256822	
Conditions of Use: Reactant construction material	
EXTRACTION	
Parameter	Data
Description of release source:	InsulationDuring UFFI, formaldehyde is released during foaming due to excess formaldehyde in the U-F resins and continues to be emitted long after hardening due to hydrolytic decomposition of the UFFI.
EVALUATION	
Domain	Metric
Domain 1: Reliability	Rating
Metric 1:	Methodology
	High EPA Locating and Estimating document
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Metric 3:	Applicability
	High US
Metric 4:	Temporal Representativeness
Metric 5:	Sample Size
	High The report is for an occupational scenario (construction materials) within the scope of the risk evaluation.
	Low 1991 - Prior to the PEL (1992) and more than 20 years old.
	N/A qualitative information provided
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	High Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	N/A Qualitative information provided
Overall Quality Determination	High

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	combustion - oil refinery			
EXTRACTION				
Parameter	Data			
Description of release source:	Combustion Oil RefiningFormaldehyde is emitted with combustion products from refinery process heaters, boilers, and internal combustion compressor engines. These combustion sources are located throughout the refinery. Process vent streams from catalytic cracking and fluid coking operations also contain formaldehyde. These streams are discharged from boilers used to burn CO-rich waste gas streams. In catalytic cracking, the CO-rich waste stream results from the partial air oxidation of catalyst coke deposits, while in fluid coking, the CO stream results from the partial oxidation of the coke burned to provide process heat.There is no corresponding process vent stream from the delayed coking operation. Refinery unit operations include valves, pumps, flanges, and other hardware, all of which emit fugitive hydrocarbons. These hydrocarbons are not, however, expected to contain large amounts of formaldehyde.Emissions from external combustion sources (boilers and process heaters) and internal combustion engines are discussed in the section of this report entitled COMBUSTION SOURCES.			
Release or emission factors:	Release or emission factors			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	The provided emission factors did not include any statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 1256822 Table: 17 of 19

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Plastics Manufacture			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (plastics manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	some of the emission factors included range data, but no other statistics were provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).
HERO ID:	1256822
Conditions of Use:	Reactant wood products

EXTRACTION	
Parameter	Data
Description of release source:	Pressed-wood Manufacturing Emissions from pressed-wood products result as compounds in the resin used to bind the chips evaporate when heated. These emissions usually exit through exhaust fans mounted on the roof above the presses. The type of resin used and, thus, the compounds present in its formulation vary depending upon the type of panel being manufactured. The U-F resins are primarily used in the production of particleboard and medium-density fiberboard. These panels typically contain 8 to 9 percent (w/w) resin. The U-F resin is used in applications where the final product will not be subject to weathering. The P-F resins are used in the production of particleboard, waferboard (WB), and oriented strand board (OSB). Structural particleboard made with P-F resins contains approximately 7 percent (w/w) resin, and WB and OSB contain approximately 2 percent (w/w) resin. The P-F resins are more resistant to moisture than U-F resins. The National Council of the Paper Industry for Air and Stream Improvement (NCASI) published two technical bulletins in 1986 that investigated the release of formaldehyde from press vents in the wood panelboard industry. One NCASI study concluded that three major factors affect the release of formaldehyde from press vents: (1) the excess formaldehyde content of the resin, (2) the amount of resin used, and (3) the press temperature. These factors are discussed below. Excess formaldehyde is the amount of formaldehyde in the resin in excess of the amount required for stoichiometric reaction with the urea or phenol in the resin. The emission rates have been shown to increase in proportion to the increase in the free formaldehyde content of the resin. The excess or free formaldehyde contents of resins are often held proprietary by resin manufacturers. NCASI showed that where such information was available, the data indicated that 5 to 15 percent of the excess formaldehyde in the panelboard was emitted during the pressing and board cooling operations. One method to determine the potential of resins to emit formaldehyde during particleboard manufacture would be to use the excess formaldehyde content of the resin (calculated on the basis of the amount of formaldehyde in excess of the amount needed to react stoichiometrically with the other reactive constituents in the resins). However, resin manufacturers will not divulge sufficient information about their resins to allow these calculations to be made. The NCASI study showed that the emission rate of formaldehyde increased in proportion to the amount of resin used in the panelboard and the press temperature. The NCASI study also showed that the formaldehyde emissions from particleboard press vents are related to the amount of excess formaldehyde in the unpressed boards loaded into the press. It would appear that formaldehyde emission rates could be reduced by using less excess formaldehyde in the resin. The industry has already decreased the amount of excess formaldehyde in resins in order to reduce the emissions of formaldehyde from the finished product into the living or work space. This reduction of excess formaldehyde in the resin also resulted in longer press times and, hence, reduced production rates. In an effort to eliminate the potential for formaldehyde emissions, methylene diphenyl diisocyanate (MDI) resins have been used by some manufacturers. The MDI resins produce a higher-strength panel than do the U-F or P-F resins. Therefore, manufacturers are able to use less MDI resin to meet the industry's product standards. However, MDI resins are much more expensive than U-F or P-F resins, and panels produced with MDI resins tend to stick to the presses. Two approaches have been used to prevent the panels from sticking. One is to spray the presses lightly with an antisticking agent between press cycles. Another approach is to use U-F or P-F resins to bind the material on the two outer surfaces of the panel. The core of the panel is bound with the MDI resin. This reduces the amount of formaldehyde available to volatilize, and the panel retains the structural strength provided by the MDI resin. In addition to press vents, wood furnish dryers are also sources of formaldehyde emissions. In a study by NCASI designed to determine the emission rates of formaldehyde and other compounds emitted from wood furnish dryers, a range of typical emission factors were developed for use in preparing emission estimates for air discharge permits. The study indicates that the concentration of formaldehyde in the dryer exhaust is a function of the dryer inlet temperature. The formaldehyde emission rate at dryer inlet temperatures below 900°F was less than 0.085 lb/ton of product. At inlet temperatures above 1000°F, the formaldehyde emission rates ranged from 0.01 to 1.1 lb/ton of product.
Release or emission factors:	Release or emission factors
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability				
Metric 1:	Methodology	High	EPA Locating and Estimating document	
Domain 2: Representativeness				
Metric 2:	Geographic Scope	High	US	

Continued on next page ...

Formaldehyde

Environmental Releases

HERO ID: 1256822 Table: 18 of 19

...continued from previous page

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant wood products			
		EVALUATION		
Domain		Metric	Rating	Comments
	Metric 3:	Applicability	High	The report is for an occupational scenario (wood products manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Some of the emission factors were provided as a range but did not include any statistical data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination			Medium	

Formaldehyde

Environmental Releases

HERO ID: 1256822 Table: 19 of 19

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	internal combustion - stationary sources			
EXTRACTION				
Parameter	Data			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Low	The provided emission factors did not include any statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The provided emission factors did not include information about variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2003). Estimating 2003 building-related construction and demolition materials amounts.			
HERO ID:	6388382			
Conditions of Use:	construction and demolition materials			
EXTRACTION				
Parameter	Data			
Description of release source:	Building related C&D materials			
Release quantity:	52% of the building-related C&D materials were discarded in 2003. Much of this material goes to specifically designated C&D landfills. Table 3-1 provides the amounts of C&D materials disposed and recovered by different states (pg 27 of 60).			
Release frequency:	The units destroyed through intentional demolitions or disasters, such as fires or weather-related incidents between 2003 and 2005 averaged 270,000 per year (pg 15 of 60). 240,000 residential demolitions per year (pg 37 of 60).			
Waste treatment methods and pollution control:	nan			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses high quality data as it is published by EPA
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results.
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (1995). AP-42: Chapter 8 - Inorganic chemical industry.			
HERO ID:	7315933			
Conditions of Use:	Processing as a reactant: Intermediate in: Pesticide, fertilizer, and other agricultural chemical manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	Urea: Formaldehyde may be emitted. The chromotropic method of measuring formaldehyde cannot distinguish between formaldehyde and methylenediurea. Report also includes release emission factors for particulate.Normal Superphosphate: Formaldehyde emissions have been recorded; report does not associate the emission with a process unit or operation.			
Release or emission factors:	Release or emission factors			
Waste treatment methods and pollution control:	Waste treatment methods and pollution control			
Comments:	Chapter 8 contains 13 subsections, a word search for 'formaldehyde only returned hits in Section 8.2 Urea, 8.5.1 Normal Superphosphates ,8.5.2 Triple Super-phosphates. Only these subsections were reviewed for extraction and evaluation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data that are from frequently used sources (EPA) and are generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	Report is for an occupational scenario (fertilizer manufacturing), which is in scope but most of the information is not specific to formaldehyde
	Metric 4:	Temporal Representativeness	Low	More than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is not addressed. Report provides only a limited discussion of variability in different process operations.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (n.d.). AP-42: Chapter 5 - Petroleum industry.			
HERO ID:	9102566			
Conditions of Use:	Processing aids, specific to petroleum production in all other basic chemical manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:	The major emission sources in the natural gas processing industry are compressor engines, acid gaswastes, fugitive emissions from leaking process equipment and if present, glycol dehydrator vent streams.			
Comments:	Only the SO2 emissions from gas sweetening operations were discussed, no mention of formaldehyde, VOCs or hydrocarbons in general.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report is from a frequently used source (EPA) and are generally accepted by the scientific community.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	U.S. data	
	Metric 3: Applicability	Low	The report is for an occupational scenario (natural gas processing) but is not specific to formaldehyde and only similar to scenarios within the scope of the risk evaluations (Processing aids, specific to petroleum production in all other basic chemical manufacturing)	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old(1995). The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A- qualitative information	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A- qualitative information	
Overall Quality Determination		Medium		

Formaldehyde

Environmental Releases

HERO ID: 1010207 Table: 1 of 1

Study Citation:	Vaart, D.v., Marchand, E.G., Bagely-Pride, A. (1994). Thermal and catalytic incineration of volatile organic compounds. Critical Reviews in Environmental Science and Technology 24(3):203-236.
HERO ID:	1010207
Conditions of Use:	Disposal

EXTRACTION

Parameter	Data
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	High	data are from the United States
	Metric 3: Applicability	Medium	The report is for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	report is greater than 20 years old
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination	High

Study Citation:	Wan, H., Wang, X.M., Barry, A., Shen, J. (2014). Recycling wood composite panels: Characterizing recycled materials. BioResources 9(4):7554-7565.
HERO ID:	3072990
Conditions of Use:	Recycling

EXTRACTION

Parameter	Data
Waste treatment methods and pollution control:	Waste treatment methods and pollution control

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Source is peer reviewed so likely high quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data is a combined study between US and Canada
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old (2015)
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Clear but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability in recycling processes is discussed; uncertainty is discussed as they test different approaches.

Overall Quality Determination	High

Formaldehyde

Environmental Releases

HERO ID: 5945936 Table: 1 of 1

Study Citation:	Waters, G. D. (1993). Current industry practices for controlling formaldehyde emissions - The history and motivation. :201-205.			
HERO ID:	5945936			
Conditions of Use:	Processing: Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Description of release source:		Formaldehyde can come from the resin systems used, but it has been found that formaldehyde is also released from the wood during the hot pressing of composites.		
Waste treatment methods and pollution control:		nan		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	The article mentions methods to reduce formaldehyde emissions. No scope for variability and uncertainty.
Overall Quality Determination			High	

Study Citation:	Akbar-Khanzadeh, F., Pulido, E.V. (2003). Using respirators and goggles to control exposure to air pollutants in an anatomy laboratory. American Journal of Industrial Medicine 43(3):326-331.			
HERO ID:	1313879			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Chemical concentration:	~35%			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2003)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Arnold, S.M., Fontaine, D.D., Hwang, H., Krygsman, A., Miller, P.R., Woods, W.B., Shah, H.C. (2011). The use of Henry’s Law to estimate formaldehyde inhalation exposure concentrations. Human and Ecological Risk Assessment 17(3):745-751.			
HERO ID:	5953154			
Conditions of Use:	Use (Biocide)			
EXTRACTION				
Parameter	Data			
Life cycle description:	Biocides are necessary ingredients in professional and consumer products to control microbial growth and extend product shelf-life. They are designed to slowly release formaldehyde to kill any microbes within the product.			
Chemical concentration:	A range of partial vapor pressures, 0.00077 mmHg to 0.0074 mmHg, corresponding to solution concentrations ranging from 0.01% to 0.10% for application temperatures of 25° C and 0.0016 mmHg to 0.016 mmHg for 35°C is proposed. This approach is applicable to a wide range of aqueous-based consumer and professional applications.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			High	

Study Citation:	Bello, A. (2008). Assessment of exposures to cleaning product ingredients used in common cleaning tasks.			
HERO ID:	9551179			
Conditions of Use:	Cleaning and personal care products			
EXTRACTION				
Parameter	Data			
Process description:	A cleaning "task" was defined as a cleaning activity that requires application of one single product type. Common cleaning tasks performed in the daily bases included patient room cleaning,bathroom cleaning and floor cleaning. Patient room cleaning and bathroom cleaning involved several tasks such as mirror cleaning, toilet bowl cleaning, counter cleaning and floor cleaning.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	Data are for cleaning and personal care products, an in-scope occupational scenario; however, data is not specifically for formaldehyde.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	N/A	N/A - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - process description.	
Overall Quality Determination		High		

Study Citation:		Cook, C. K., Page, E. H. (2000). Health hazard evaluation report, HETA 99–0137–2810: World Color Press, Effingham, Illinois, September 2000.			
HERO ID:		8016661			
Conditions of Use:		Use of ink, toner, and colorant products			
EXTRACTION					
Parameter		Data			
Process description:		The printing operation at WCP is an automated lithography (off-set) process that prints, dries, cuts, folds, and assembles magazines into a crude form called signatures. The 12 high-speed printing presses in operation are manned by printing press operators. Four types of colored inks (black, blue, red, and yellow) are printed on wide-web rolls of bleached paper. The chemical composition of inks varies, but most include a complex mixture of pigments, petroleum distillates, and resins (including epoxy and phenolic resins). Some magazine covers require a varnished finish that is applied by catalytic coating units on presses #219 and #228. This varnish coating contains 2-butoxyethanol. After printing and coating, the ink is dried by gas-fired dryer ovens operating at 350°F. Signatures are then cut, folded, assembled, and prepared for binding. Local exhaust ventilation (LEV) is present at catalytic units and dryer ovens of each press. Numerous roof exhaust fans are present throughout the plant. During the printing operation, workers routinely use blanket wash solutions and wetting agents (also called fountain solutions) as solvent cleaners to remove ink from printing press equipment. These solvents are manually applied by workers using shop rags while wearing nitrile rubber gloves for hand protection. Press equipment is partially cleaned or wiped down about 2-3 times each shift. A more thorough cleaning on each press is done a few times each week, with cleaning sessions lasting about an hour. Some cleaning tasks require three workers several hours to accomplish. Some printing presses have an auto-blanket wash system that is capable of cleaning during operation. Blanket wash solutions are combustible liquids (flashpoint greater than 100°F) made of petroleum naphtha. Wetting agents (flashpoint less than 100°F) are made of alcohol or an alcohol substitute. Over the course of a workday, solvent-saturated shop rags are accumulated and stored in metal orplastic containers. An anti-static silicon solution is also handled by workers during printing. The anti-static solution is manually applied to press rollers several times each shift to achieve a certain print quality.			
EVALUATION					
Domain		Metric		Rating	Comments
Domain 1: Reliability		Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness		Metric 2:	Geographic Scope	High	The data are from the United States.
		Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
		Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
		Metric 5:	Sample Size	N/A	N/A - process description
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	N/A	N/A - process description
Overall Quality Determination				High	

Study Citation:	Dunn, D. W., Johnson, M. L., Holmes, L., Hedley, W. H., Barrett, G. J., Mckinnnery, W. N. (1983). Detailed industrial hygiene survey formaldehyde production, Celanese Chemical Company, Inc., Bishop, Texas.			
HERO ID:	1144185			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Process description:	Detailed process description given on PDF Pg. 22; diagram on PDF Pg. 23.			
Throughput:	1,500*10^6 (lb/yr)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.		
HERO ID:	6302987		
Conditions of Use:	Domestic Manufacturing		
EXTRACTION			
Parameter	Data		
Process description:	At an industrial scale, formaldehyde is manufactured by catalytic oxidation of methanol via either a silver or metal-oxide catalyst process. Production capacity is split almost equally between production processes which use the silver catalyst process and those which use oxide manufacturing processes. In the metaloxide process, methanol is oxidised with excess air in the presence of a modified ironmolybdenum-vanadium oxide catalyst at 250-400 °C and atmospheric pressure (methanol conversion of 98-99%) (IARC11, 2006) (pg.9)		
Throughput:	The world production capacity of Formalin is 40 million tonnes per year of which Europe represents around 25% with a production capacity of 9.5 million tonnes per year (Merchant Research and consulting, 2012, quoted in RPA/TNO, 2013).Formaldehyde is registered under REACH in quantities >1 million tonnes per year. The total formaldehyde production in Europe (EU28 + Norway + Switzerland) is around 3.2 million tonnes as 100% pure formaldehyde, which is equivalent to 8.6 million tonnes as 37% water solution. (pg. 9)		
Chemical concentration:	Formaldehyde is commonly not produced in pure form as it is not stable. Formal or Formalin is usually produced instead with 30-50% of formaldehyde. (pg. 9)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from the EU, and locality-specific factors(e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The assessment captures operations, equipment, and worker activities expected to be representative of current conditions. EPA has no reason to believe exposures have changed.The completed exposure or risk assessment is from 2019.
	Metric 5: Sample Size	N/A	N/A- Qual.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		High	

Study Citation:	ECHA, (2019). Worker exposure to formaldehyde and formaldehyde releasers.		
HERO ID:	6302987		
Conditions of Use:	Manufacture		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	According to an industry report (Formacare, 2015), formaldehyde is used at industrial and professional level as:1. Starting material for the production of FA-based resins such as:• condensed resins (62% of total FA consumption) including:◦ Urea-Formaldehyde (UF) resin◦ Melamine-Formaldehyde (MF) resin◦ Phenol-Formaldehyde (PF) resins• Polyacetal resins (polyoxymethylene – POM): 8% of total FA consumptionPolyols: 9% of total FA consumption Polyurethanes (MDI): 6% of total formaldehyde consumptions2. Other uses, accounting for 15% of total FA consumption in the EU include:• Use as an intermediate in the chemical synthesis of: ◦ methylene dianiline (MDA)◦ diphenylmethane diisocyanate (MDI)◦ hexamethylenetetraamine (HTMA - hexamine)◦ trimethylol propane neopentylglycol◦ pentaerythritol (for production of alkyd resins and neopolyol esters)◦ butanediol (BDO) acetylenic agents• Use as reagent and bactericidal agent used in healthcare applications such as tissue preservation, embalming fluids in autopsy rooms and pathology departments, disinfectant in operating rooms, vaccines, animal medicines, etc .• Use as preservative, biocidal and cleaning agent in food applications• Biocidal use in germicides, bactericides and fungicides as well as an ingredient in fertilizers in agriculture and non-agricultural sector.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (European Union or OECD reports) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from the EU, and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The assessment captures operations, equipment, and worker activities expected to be representative of current conditions. EPA has no reason to believe exposures have changed.The completed exposure or risk assessment is from 2019.
	Metric 5: Sample Size	N/A	N/A- production volume percents
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The assessment does not address uncertainty. Variability is not applicable.
Overall Quality Determination		Medium	

Study Citation:	Gosselin, N.H., Brunet, R.C., Carrier, G. (2003). Comparative occupational exposures to formaldehyde released from inhaled wood product dusts versus that in vapor form. Applied Occupational and Environmental Hygiene 18(5):384-393.			
HERO ID:	1313865			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances in furnishing products: woodworking exposure			
Chemical concentration:	Plywood 0.004 ug/mg; MDF board 1.4 ug/mg; Particleboard - pre-press 2-3 ug/mg; Particleboard - post press 0.6-2 ug/mg			
Comments:	This study presents a model to estimate the absorption of formaldehyde as a vapor and via woodworking dust particles.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	Sampling or analytical methodology is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - an OECD member
	Metric 3:	Applicability	High	The data are for woodworking, an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The study was published in 2003 after the most recent PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Low	generally single values are provided which one assumes is an mean value
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	very little metadata are provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The study does not address variability or uncertainty in the models input data
Overall Quality Determination			Low	

Study Citation:	Kinnes, G. M., Echt, A. S., Shults, R. A. (1996). Health hazard evaluation report 91–0153-2581 Unocal Corporation Kenai, Alaska June 1996.
HERO ID:	8048799
Conditions of Use:	reactant: Intermediate in fertilizer and other agricultural chemical manufacture.

EXTRACTION

Parameter	Data
Process description:	Urea is manufactured from liquid ammonia and gaseous carbon dioxide (CO₂) at elevated pressures and temperatures; both reactants are typically obtained from an ammonia-synthesis plant. Urea plants are usually located adjacent to ammonia production facilities which conveniently furnish not only the ammonia but also the CO₂, because CO₂ is a by-product of ammonia production and purification. Plants #1 and #4 at the Kenai facility are ammonia-synthesis plants that supply the reactants to the urea producing plants. The remaining plant (Plant #3) generates power for the entire Kenai facility. The ammonia and CO₂ are fed to a high pressure reactor at temperatures of about 200 degrees Celsius (°C) where ammonium carbamate is formed as an intermediate compound, which is simultaneously dehydrated to form urea. Although, the reaction to form the ammonium carbamate is complete at elevated pressures, the reaction to form the urea is incomplete under all practical conditions. Because an excess of ammonia (typically a 4:1 ratio) is fed to the reactor, and because the reactions are reversible, ammonia and CO₂ exit the reactor along with the ammonium carbamate and urea. The ammonia, CO₂, and ammonium carbamate are then recycled back into the reaction process. Purification of the ammonia, CO₂, and ammonium carbamate in the liquid stream from the reactor achieves a urea solution of about 72%. After the reaction process and the removal of the by-products for recycling, the urea in solution is crystallized, centrifuged, dried, melted, and finished by either prilling or granulation. Of the two plants that produce the urea, one produces urea in the prill form while the other produces granular urea. Worldwide, prilling is the most widely used method of solidifying urea, but the use of granulation is increasing rapidly. Urea prilling is the more economical method for finishing, but the prills have low strength and are generally too small for use in blending with granular materials such as diammonium phosphate. Also, the prilling operation is a serious polluter, the abatement of which is costly because of the large volume of dust-laden air that must be treated. For these reasons, there is a strong trend toward granulation of urea. Although prilling is still the most widely used method worldwide, granulation is now the leading method of finishing urea in the United States. In prilling, molten urea that is almost anhydrous is forced through spray heads or spinner buckets at the top of a tower to produce droplets that fall through a countercurrent stream of air in which they solidify to form prills. The prills are collected at the base of the prill tower by a rotating rake and dumped onto a conveyor that feeds the prill bucket elevator. The prills are then elevated to the prill screens where undersized and oversized prills are removed. The undersized and oversized prills are collected and returned to the crystal melt tanks for reprocessing. The final product is then transported to a storage building by a series of conveyors. The granular urea is produced in Plant #5. In this process, granules are formed by the successive spraying and drying (layering) of concentrated urea solution on recycled granules in a rotating drum. Special design of the drum and sprays, together with the control of air flow, results in hard granules of particle sizes favorable for blending and other use. Spraying occurs primarily in the first third of the granulator; the remaining portion is used mainly as a rotary cooler. The cooled granules discharge from the drum and are screened into oversize, undersize, and product size. The oversized granules are crushed and returned to the front of the granulator as recycle along with the undersized to form seed. As the recycled urea seed passes through the granulator, the sprayed molten urea impinges on them and the granules are grown. The final product is then transported to a storage building. The finished granules and prills are stored in separate warehouses while awaiting shipment. Most of the urea fertilizer is transported from the Kenai plant by ocean freighter. The urea storage warehouses are equipped with overhead conveyor systems to distribute the finished urea in the warehouse and subfloor conveyor systems to transport the product to the wharf for loading. The conveyors are located in the center and run the length of both warehouses. The floors of the warehouses are equipped with a series of grates that open to the subfloor conveyor system. The urea falls from the overhead conveyor onto the warehouse floor forming large mounds of the finished product. The urea then falls through the opened grates onto the subfloor conveyor that transports it to the wharf where it is loaded into the holds of a freighter. Both the conveyors and the grates are controlled so that the warehouses are filled evenly. Two large loaders are used in the warehouses to aid the loading operations by moving the urea over the floor grates and dislodging urea that has caked together. During both the prilling and granulation processes, UF-85 is added to the molten urea prior to finishing. Formaldehyde, such as in the UF-85, has been widely used in the production of urea since the mid- 1970's as a conditioning agent to harden the product, reduce dust generation during handling, and provide anti-caking properties in storage. Approximately 95% of the domestic urea fertilizer producers condition their urea with a formaldehyde-based additive (ureaforms) and virtually all solid urea producers employ some type of conditioning agent to improve product handling. The Kenai facility produces approximately 1 million tons of urea and 1 million tons of ammonia per year. Plant #2 was built in 1968 and produces from 1250 to 1450 tons of the prill urea per day. The granular urea is produced in Plant #5 which became operational in 1978. Plant #5 typically produces from 1700 to 1800 tons of the granular urea per day.
Throughput:	
Number of sites:	1 facility with 5 plants (#2 and #5 are used to produce urea fertilizer.
Chemical concentration:	The UF-85 is a liquid mixture containing 60% formaldehyde, 15% water, and 25% urea.

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Study Citation:	Kinnes, G. M., Echt, A. S., Shults, R. A. (1996). Health hazard evaluation report 91–0153-2581 Unocal Corporation Kenai, Alaska June 1996.				
HERO ID:	8048799				
Conditions of Use:	reactant: Intermediate in fertilizer and other agricultural chemical manufacture.				
Domain	Metric		EVALUATION Rating		Comments
Domain	Metric		EVALUATION Rating		Comments
Domain 1: Reliability					
	Metric 1:	Methodology	High	NIOSH study	
Domain 2: Representativeness					
	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	High	The assessment is for an occupational scenario (fertilizer manufacture) within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	1996 more than 20 years old	
	Metric 5:	Sample Size	N/A	qualitative information provided	
Domain 3: Accessibility/ Clarity					
	Metric 6:	Metadata Completeness	High	Information presented derived from NIOSH Site visit.	
Domain 4: Variability and Uncertainty					
	Metric 7:	Metadata Completeness	N/A	qualitative information provided	
Overall Quality Determination			High		

Study Citation:	Kitwattanavong, M., Prueksasit, T., Morknoy, D., Tunsaringkarn, T., Siriwong, W. (2013). Health risk assessment of petrol station workers in the inner city of Bangkok, Thailand, to the exposure to BTEX and carbonyl compounds by inhalation. Human and Ecological Risk Assessment 19(6):1424-1439.			
HERO ID:	2858419			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	12.2 million L gasohol/day (Thailand) in 2010			
Life cycle description:	Chemical substances in products not described by other codes.			
Number of sites:	Gasohol was sold at 4,323 stations			
Chemical concentration:	Presently, gasohol (e.g., E10, or 1:9 (v/v) ratio of ethanol:gasoline) is the most popular fuel in Thailand because, due to its government subsidy, it is lower in price than gasoline.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country.
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The data were published in 2013 based on data from 2010, after the most recent PEL (1992) and approximately 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			Medium	

Study Citation:	Lee, E. G., Magrm, R., Kusti, M., Kashon, M. L., Guffey, S., Costas, M. M., Boykin, C. J., Harper, M. (2017). Comparison between active (pumped) and passive (diffusive) sampling methods for formaldehyde in pathology and histology laboratories. Journal of Occupational and Environmental Hygiene 14(1):31-39.				
HERO ID:	4453119				
Conditions of Use:	Chemical substances in products not described by other codes:Laboratory Chemicals (e.g., specimen preservation, medical samples, mortuary science)				
EXTRACTION					
Parameter	Data				
Chemical concentration:	20% buffered formalin solution (20 mL/l formaldehyde) p.4				
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (NIOSH).	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3:	Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	High	The assessment captures operations, equipment, and worker activities expected to be representative of current conditions. EPA has no reason to believe exposures have changed.	
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.	
Overall Quality Determination			High		

Study Citation:	Levy, L. S., Lee, W. R. (1994). Aliphatic chemicals. :139-190.			
HERO ID:	664424			
Conditions of Use:	Processing as a Reactant			
EXTRACTION				
Parameter	Data			
Process description:	Methanol is successively oxidized to formaldehyde and then to formic acid.			
Chemical concentration:	Formaldehyde is generally available as a 37 per cent aqueous solution, formalin, commercial grades of which might contain up to about 10 per cent of methyl alcohol, or in solid form as paraformaldehyde (CH2O)n, or trioxane, (CH2O)3.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for processing as an intermediate in resins, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by addressing conflicting study results. Variability is not addressed.	
Overall Quality Determination		High		

Study Citation:	Milton, D.K., Walters, M.D., Hammond, K., Evans, J.S. (1996). Worker exposure to endotoxin, phenolic compounds, and formaldehyde in a fiberglass insulation manufacturing plant. American Industrial Hygiene Association Journal 57(10):889-896.				
HERO ID:	1314170				
Conditions of Use:	Multiple				
EXTRACTION					
Parameter	Data				
Process description:		The manufacturing process involves six basic steps:III,II) melting glass; spinning molten glass into fibers; cooling and coating the fibers with binder; forming the fibers into a blanket or pad; curing the binder; and packing the insulation for consumer use.			
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.	
	Metric 3:	Applicability	High	Data are for plasticizer, additive and impurity in adhesives, sealants and lubricants, an in-scope occupational scenario.	
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1999)	
	Metric 5:	Sample Size	N/A	Not applicable - process description.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - process description.	
Overall Quality Determination			High		

Study Citation:	National Toxicology Program (NTP), (2016). Report on carcinogens, fourteenth edition: Formaldehyde.			
HERO ID:	5160139			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	”Annual production of formaldehyde in the United States increased from about 0.9 million metric tons (1 million tons) in 1960 to 4.5 million metric tons (5 million tons) in 2006.” (6/11)			
Process description:	Formaldehyde is produced by catalytic oxidation of methanol via a silver or metal-oxide catalyst process. (6/11)			
Number of sites:	”In 2009, formaldehyde was produced by 12 companies and their subsidiaries at 39 U.S. manufacturing plants, and paraformaldehyde and trioxane each were produced at one U.S. manufacturing plant. Formaldehyde was available from 36 U.S. suppliers, paraformaldehyde from 25, and trioxane from 11. Internationally, formaldehyde was available from 152 suppliers in 25 countries, paraformaldehyde from 59 in 15 countries, and trioxane from 21 in 9 countries.” (6/11)			
Chemical concentration:	”Commercially, formaldehyde is most often available as 30% to 50% (by weight) aqueous solutions of the hydrated form, which is commonly referred to as formalin.” (6/11)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are from numerous different industries and situations, all of which are in-scope occupational scenarios.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on current industry conditions but data is between 10 and 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1976). Health hazard evaluation determination: corhart refractories.			
HERO ID:	8687978			
Conditions of Use:	Plastic and rubber products			
EXTRACTION				
Parameter	Data			
Process description:	The no-bake mold department is one of three areas in this plant that produce sand molds into which molten silica and alumina are poured to produce the refractory product sold by Corhart to the glass industry. Dry sand at approximately 90°F. is mixed with binders in an auger type mixer and dropped about four feet into the forms which shape the molds. In about five minutes the mold hardens due to the plasticizing of t he phenol-formaldehyde resin. The molds are then separated from the forms, in some cases fitted with a top or core, and transported from the area. Until they are removed from the area, however, these fresh molds continue to off-gas into the atmosphere. Approximately sixteen men are involved in this operation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic and rubber products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The assessment does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1983). Preliminary survey report: Control technology for formaldehyde emissions at Baker Furniture Company, Mocksville, North Carolina.
HERO ID:	8728029
Conditions of Use:	Adhesive and sealant chemicals in wood product manufacturing

EXTRACTION	
Parameter	Data
Life cycle description:	Formaldehyde is used in formaldehyde resin glue that is used as an adhesive for the production of fiber and particle boards. The formaldehyde is then emitted during hot pressing operations.
Process description:	The simplest veneered panel consists of three plies, a face and a back veneer glued to each side of a core. Additional plies may be added to make a panel which is stronger and more stable dimensionally. An established way to achieve a high rate of production is to reduce the glue-curing time by heating the glue while pressure is being applied to the panels. One way to do this is to heat the metal plates which apply the pressure, generally referred to as "hot-press II process. Another way is to generate heat in the glue-line with radio-frequency (R/F) radiation in much the same way that food is cooked in a microwave oven. In this "R/F-press" process, the hydraulic press only applies pressure. "cold-press" processes, those for which pressure is applied while the boards—and glue—are maintained between 60 and 100F, require much longer periods of time for the glue to cure. For most applications, the glue which currently provides the best performance for the least cost is a urea/formaldehyde (U/F) resin adhesive. The core may be a sheet of veneer, particleboard ("chip-core") or fiberboard, or a piece of edge-glued solid-wood "lumber-core". Almost all particleboard and fiberboard are made with formaldehyde resin binders, and a formaldehyde resin glue may be used to assemble lumber-core. To improve the appearance of a panel, the core may be "banded" with solid wood edges prior to veneering. Here again, the adhesive may contain formaldehyde. A variety of hardwoods and softwoods, including oak, walnut, poplar, and pine, are used for veneer stock. Some plastic laminates are being used for certain products; usually these panels are cold-pressed. The veneers are received in flitch form, thin strips bundled together as they were cut from the log. The veneer flitches are pressed, trimmed, and joined into sheets, which are then cut to the proper size for the panel being produced. Core stock is received already cut into pieces of the appropriate nominal size and banded, if desired. This plant does not have facilities for manufacturing lumber-core. About 70% of the flat panels produced use chip-core, and about half of this quantity is banded. The remainder is lumber-core; very little fiberboard is used. Five-ply panels, from all types of cores, make up most of the total production. Large curved panels are not made here, the only other veneering involves small parts and frames. Hot-press veneering is accomplished mostly on a Wemhoner feed-through press. Heat and pressure are applied for from less than 2 to over 3 minutes, depending on the panels being processed. Two workers are assigned to the Wemhoner: a loader and an unloader. The process is highly automated. A steam-heated, two-level shuttle press is still used, but mostly for flattening sheets of veneer. It is used for pressing panels only when the feed-through press is not being used. The panels are prepared for pressing by the glue-spreader crew. Two or three people are assigned to the glue spreader. The appropriate layers are passed through the glue spreader, and the stack of panels is built-up like a pile of sandwiches. The stack is moved to the loading end of a press on roller conveyors.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesive and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.

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Study Citation:		NIOSH, (1983). Preliminary survey report: Control technology for formaldehyde emissions at Baker Furniture Company, Mocksville, North Carolina.		
HERO ID:		8728029		
Conditions of Use:		Adhesive and sealant chemicals in wood product manufacturing		
Domain		Metric	EVALUATION	
			Rating	Comments
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	NIOSH, (1973). Industrial hygiene survey of Owens Corning Fiberglas, Kansas City, Kansas.			
HERO ID:	8728044			
Conditions of Use:	Construction (including roofing materials)			
EXTRACTION				
Parameter	Data			
Process description:	In the centrifugal forming processes (aerocor and standardinsulation) glass batch is fed into the furnace where boro-silicateglass is formed at temperatures of approximately 2500°F. The molten glass next flows into a smaller refractory container known as a forehearth where the temperature is held at approximately 2200°F. The molten glass flows from the forehearth by gravity into spinners where centrifugal force is used to force the glass through small holes in the periphery of the spinner thus fanning primary fibers. Upon leaving the spinners, each glass fiber is met by a high velocity burner flame which further attenuates the fibers. A phenol-formaldehyde binder (containing ammonia) also is sprayed onto the fibers at this time. The fibers, coated with binder, are collected on a conveyer thus forming a continuous blanket. The blanket next passes through a curing oven {400-500°F) causing the phenol-formaldehyde binder to polymerize. If a high density product is desired, the blankets also may be compressed during curing. After curing, the blankets are cut and trimmed and eithercompression packaged or taken to another area for further fabrication (aerocor fabrication).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for construction (including roofing materials), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - Process Description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The assessment does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	OECD, (2011). Emission scenario document on coating application via spray-painting in the automotive refinishing industry.			
HERO ID:	3808976			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	”54,633,000 total gallons automotive refinish coatings/yr 99,747 - 1,097,457 gallons coating/yr (depending on coating type)”			
Life cycle description:	Automotive Coating Application			
Process description:	Repair/replace automotive surface, initial wash (water/detergent and/or solvent), sanding (dry or wet), mixing of primer coatings, spray paint (multiple layers of primer), curing/drying each layer, sanding (dry or wet), solvent wipe-down, mixing of each coating (basecoat and clearcoat), spray paint (multiple layes of basecoat and clearcoat), curing/drying each layer			
Throughput:	Op days: 250 days/yr. 0.25-12 gal coating/site-day, depending on number of jobs Also provides method for adjsutng the use rate based on the type of coating product used			
Number of sites:	32,296			
Chemical concentration:	15-25%			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (min, max, mean) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple coating types.
Overall Quality Determination			High	

Study Citation:	OECD, (2009). Emission scenario documents on coating industry (paints, lacquers and varnishes).		
HERO ID:	3827298		
Conditions of Use:	Processing and Use		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	3.2 million tonnes coating/yr (by US sales, 2001)		
Life cycle description:	Formulation of Coatings and Use of Coatings		
Process description:	PROC: Dispersion, milling, finishing, filling USE: Application via roller/brush, air spray systems, airless and air-assisted airless spray systems, electrostatic spray, electrodeposition/electrocoating and autodeposition, dip coating, flow and curtain coating, roll coating, and supercritical carbon dioxide coating systems		
Throughput:	0.62-9.0 l/vehicle (auto refinishing Table 5.3); 1.1-5.1 g coating/can (metal can coating sites Table 6.3)		
Number of sites:	60,330 automotive application sites in EU; 33 metal coating application sites in UK		
Chemical concentration:	Provides conc. estimates based on the chemical function, not chemical specific.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical functions and coating types
Overall Quality Determination		Medium	

Study Citation:	OECD, (2009). Emission scenario document on adhesive formulation.			
HERO ID:	3827299			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	15.8-4,990 million kg adhesive/yr			
Life cycle description:	Formulation of Adhesives			
Process description:	Unloading raw materials from containers into mixing vessel, mixing, packaging/on-site storage			
Throughput:	Batch Size: 4000 kg or 1,000 gallons of adhesive/bt. Op days & Bt per day: Equal to the number of batches. Provides methodology for estimating throughput based on the amount of adhesive produced, and the concentration of the chemical in the adhesive.			
Number of sites:	Provides methodology for estimating number of sites based on chemical PV, the adhesive use rate, and the concentration of the chemical in the adhesive formulation			
Chemical concentration:	Provides conc. estimates based on chemical function, not chemical specific.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This ESD was developed by EPA based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and types of adhesives.	
Overall Quality Determination		High		

Study Citation:	OECD, (2013). Emission scenario document on the industrial use of adhesives for substrate bonding.			
HERO ID:	3827300			
Conditions of Use:	Industrial Use of Adhesives for Substrate Bonding			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	1,500 - 9,100,000 kg adhesive/site-yr			
Life cycle description:	Industrial Use of Adhesives for Substrate Bonding			
Process description:	Unloading, dilute and mix (optional), application (roll, spray, curtain, bead/syringe), drying/curing, product finishing			
Throughput:	Op days: 50-365 days/yr. Provides methodology for estimating throughput based on the amount of adhesived used, and the concentration of the chemical in the formulation			
Number of sites:	541-22,294			
Chemical concentration:	Provides conc. estimates based on chemical function and adhesive type, not chemical specific.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions, types of adhesives, and end use markets.
Overall Quality Determination			High	

Study Citation:	OECD, (2017). Emission Scenario Document (ESD) on the use of textile dyes.			
HERO ID:	3828838			
Conditions of Use:	Processing: Textile Dyeing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Textile Dyes			
Process description:	Dye formulation received, unloaded, dyeing of fiber, yarn, or fabric, disposal			
Throughput:	Op days: 31-295 days/yr. Provides methodology for estimating throughput based on the amount of textile dyed and concentration of chemical in the dye.			
Number of sites:	Provides methodology to estimate number of sites based on chemical production volume, use rate, and operating days			
Chemical concentration:	Provides conc. estimates based on the chemical function, not chemical specific.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment from 2015 but is based on data which is mostly greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical functions
Overall Quality Determination		Medium		

Study Citation:	OECD, (2010). Emission scenario document on formulation of radiation curable coatings, inks and adhesives.			
HERO ID:	3840003			
Conditions of Use:	Adhesives and Sealants; Paint and coatings			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	211 million lbs of rad-cur materials produced in 2005			
Process description:	Describes formulation process, application process, typical formulations.			
Number of sites:	715 (appears to be total number of sites from Table 3-2)			
Chemical concentration:	depends on function, no specific to formaldehyde			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The assessment is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The assessment captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The completed exposure or risk assessment is generally, more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.	
Overall Quality Determination		High		

Study Citation:	OECD, (2010). Emission Scenario Document on Photoresist Use in Semiconductor Manufacturing.			
HERO ID:	3840005			
Conditions of Use:	Commercial Use (Electrical and electronic products (including semiconductors))			
EXTRACTION				
Parameter	Data			
Life cycle description:	Semiconductors (Photoresist)			
Process description:	Photoresist received in bottles, bottle change-out, filter, application (spin-coat), soft-bake, image application, hard bake, developing, etching, stripping			
Throughput:	Op days: 250-360 days/yr. 10-36 kg photoresist/site-day.			
Number of sites:	Provides methodology to estimate number of sites based on chemical production volume, use rate, and operating days			
Chemical concentration:	20-40%			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation but is not specific to Formaldehyde.
	Metric 4:	Temporal Representativeness	Medium	The completed exposure or risk assessment is generally, more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	OECD, (2010). Emission scenario document on chemicals used in the electronics industry.		
HERO ID:	5079083		
Conditions of Use:	Processing and Use		
EXTRACTION			
Parameter	Data		
Life cycle description:	Electronics		
Process description:	Provides process descriptions for manufacture of components and associated processes (e.g., laminates, photo-lithography, etching, solvents, spin coating, vapor deposition, soldering, cleaning), assembly and associated processes, service life, and recovery		
Throughput:	Op days: 30-300 days/yr		
Number of sites:	18,000 sites in EU		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple operations, chemical functions, and facility sizes.
Overall Quality Determination		Medium	

Study Citation:	OECD, (2009). Emission scenario document on plastic additives.			
HERO ID:	5079084			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Provides % of polymers used for various end-use applications			
Life cycle description:	Plastics Compounding and Converting			
Process description:	”Provides descriptions for a variety of closed, partially open, and open compoundind and converting processing. Including the following compounding processes: tumbling, ball blending, gravity mixers, paddle mixers, intensive vortex mixers, banbury mixers, two roll mills, and extruder mixing. And the following converting processes: extrusion, injection molding, compression molding, extrusion blow molding, injection blow molding, film extrusion, extrusion coating, thermoforming, calendering, hand lay up, spray techniques, and filament winding. ESD also provides a break down of the % and volume of polymers used in each process in the UK.”			
Throughput:	Provides methodology for estimating throughput of polymers and additives			
Number of sites:	4000 sites in UK			
Chemical concentration:	Provides conc. estimates based on additive function in various plastics, not chemical specific.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
	Metric 3:	Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment from 2009 but is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering prevalence of various processing methods, additive functions, and plastics.
Overall Quality Determination			Medium	

Study Citation:	OECD, (2011). Emission scenario document on the chemical industry.			
HERO ID:	6306753			
Conditions of Use:	Manufacture, processing, use			
EXTRACTION				
Parameter	Data			
Life cycle description:	Manufacture, Formulation of processing aids, processing as a reactant, use of processing aids			
Process description:	General synthesis process consists of reaction, handling/transportation, isolation, handling/transportation, purification, handling/transportation, then either reaction to make another chemical or on to the next life cycle stage			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
	Metric 3:	Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment from 2011 but is based on data greater than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted (process description only)
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted (process description only)
Overall Quality Determination		Medium		

Study Citation:	OECD, (2020). Emission scenario document on chemical additives used in automotive lubricants.			
HERO ID:	6385735			
Conditions of Use:	Processing and Use (Additive chemicals used in automotive finished lubricants)			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	6.3 billion kg lubricants/yr			
Life cycle description:	Formulation and Use of Automotive Lubricants			
Process description:	"Processing: Unloading raw materials, blending, intermediate storage Use: Unloading lube oil, removing spent oil and replacing with new oil, disposing/recycling of used oil"			
Throughput:	Op days: Processing: 203-360 days/yr Use: 253 days/yr. Provides methodology for estimating throughput based on the amount of lubricant produced, and the concentration of the chemical in the lube oil			
Number of sites:	Provides methodology for estimating number of sites based on chemical PV, the use rate, and the concentration of the chemical in the lubricant			
Chemical concentration:	Provides conc. estimates based on chemical function, not chemical specific.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This ESD was developed by EPA based on U.S. data
	Metric 3:	Applicability	Medium	Data is for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.
Overall Quality Determination			High	

Study Citation:	OECD, (2012). Emission scenario document on chemicals used in oil well production.			
HERO ID:	6387322			
Conditions of Use:	Processing: Petroleum Production			
EXTRACTION				
Parameter		Data		
Production, import, or use volume:		4.95 million barrels of oil per day in 2007 and 58.61 billion cubic feet of natural gas per day in 2008 (EIA, 2009).		
Process description:		A description for each of the four steps in traditional oil extraction from an oil well is provided in Sections 1.1 to 1.4 (i.e., Exploration, Well Development, Petroleum Production, Site Abandonment).		
Number of sites:		More than 500,000 production wells in the United States and approximately 4,000 oil and natural gas platforms in U.S. waters (API, 2008).The report presents an equation to calculate number of sites based on annual production, daily use rate, and number of operating days.		
Comments:		Chemicals used in petroleum production are often mixed with other additives on site and dilutedwith water prior to injection...“injection concentrations” presented in Table 3-3 and in Table 3-4.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
		Metric 3: Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation but not specific to formaldehyde.
		Metric 4: Temporal Representativeness	Medium	Data from more than 10 years ago but less than 20 years ago.
		Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	High	The assessment addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			High	

Study Citation:	OECD, (2009). Emission scenario document on transport and storage of chemicals.		
HERO ID:	6393282		
Conditions of Use:	Processing - Transportation and Storage		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	UK: 11 million tonnes shipped via rail tankers 30 million tonnes shipped via pipelines		
Process description:	On-site storage of chemicals, filling of containers, transport to distributors/downstream users/consumers, containers with residual chemical transported to recycling/cleaning or disposal site, empty/cleaned containers returned to distributor or production site.		
Number of sites:	Container cleaning sites in UK: 40 for road tankers; 8 for steel drums; 8 for plastics drums; 6 for fibre drums; 13 for IBCs; 7 for hazardous waste containers		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	This ESD was not developed by EPA, but another OECD-member country.
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data mostly greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical forms, containers and storage system types.
Overall Quality Determination		Medium	

Study Citation:	Oie, S., Kamiya, A. (2002). Assessment of and intervention for the misuse of aldehyde disinfectants in Japan. Infection Control and Hospital Epidemiology 23(2):98-99.
HERO ID:	5946165
Conditions of Use:	Use

EXTRACTION

Parameter	Data
Life cycle description:	Disinfectants in Hospitals
Process description:	Rooms are fumigated with formaldehyde to disinfect them. The formaldehyde is generated by adding potassium permanganate to formalin. Formaldehyde is also used in vapor cabinets to disinfect cystoscopes, arthroscopes, and echographic probes.
Number of sites:	6 hospitals use formaldehyde to fumigate rooms, and 18 use formaldehyde in vapor cabinets.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3: Applicability	Uninformative	Data are for use as a disinfectant, which is not in-scope or similar to an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination

Uninformative

Study Citation:	Organisation for Economic Co-operation and Development (OECD) (2015). Emission scenario document (ESD) on chemical vapour deposition in the semiconductor industry.			
HERO ID:	5184986			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	25-1,000 kg precursor/site-yr			
Life cycle description:	Semiconductors (Chemical Vapor Deposition)			
Process description:	CVD precursors shipped to end users in cylinder, bubbler/canister, or isotrailer, container attached to gas delivery system, deposition/reaction, unreacte precursors to abatement systems			
Throughput:	Op days: 250-360 days/yr. Provides methodology for estimating throughput based on the precursor use rate and operating days/yr			
Number of sites:	Provides methodology to estimate number of sites based on chemical production volume, precursor use rate, and operating days			
Chemical concentration:	100%			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This ESD was developed by EPA based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple site sizes	
Overall Quality Determination		High		

Study Citation:	OSHA (1992). Occupational exposure to formaldehyde. Federal Register 57(102):22290-22328.		
HERO ID:	1314358		
Conditions of Use:	Multiple		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	Formaldehyde is a major industrial chemical, ranked 24th in production volume in the United States. In 1985, 5.7 billion pounds of 37 percent formaldehyde (by weight) was produced. Formaldehyde has four basic uses: As an intermediate in the production of resins; as an intermediate in the production of industrial chemicals; as a bactericide or fungicide; and as a component in the formulation of end-use consumer items. The manufacture of three types of resins: urea-formaldehyde, phenolformaldehyde, and melamine formaldehyde, accounts for about 59 percent of total consumption. An additional seven percent is consumed in the production of thermoplastic acetal resins. About one-third is used in the synthesis of high volume chemical derivatives, including pentaerythritol, hexamethylenetetramine, and butanediol. Two percent is used in textile treating and small amounts of formaldehyde are present as preservatives or bactericides in consumer and industrial products, such as cosmetics, shampoos and glues. Some products prepared from formaldehyde contain unreacted formaldehyde residues which may be released from the product over its useful life. One example is urea-formaldehyde resin. Urea-formaldehyde resin is a generic name that actually represents an entire class of related formulations. Over 60 percent of ureaformaldehyde resin production in 1977 was consumed by particleboard and plywood manufacturing, where the resin is used as a glue. Urea-formaldehyde resins are also used in decorative laminates, textiles, paper, and foundry sand molds. Formaldehyde resins are used to treat textiles to impart wrinkle-resistance to clothing. About 60-85 percent of all apparel fabric is finished with formaldehyde-containing resins. As apparel manufacture is the sixth largest industry sector in the United States, this use is the major source of widespread exposure to formaldehyde because of the large number of workers potentially exposed. Formaldehyde destroys bacteria, fungi, molds, and yeast. Its commercial importance as a fungicide is probably its greatest use as a disinfectant. Because of its bactericidal properties, formaldehyde is used in numerous cosmetic preparations. Formaldehyde’s uses can lead to widespread exposure in downstream industries. For example, when formaldehyde is present in disinfectants, preservatives, and embalming fluid, worker exposure can occur. Although formaldehyde changes into other chemicals when urea-formaldehyde resins and concentrates are produced, decay may occur, causing workers in numerous industries including wood products and apparel manufacture to be exposed to airborne formaldehyde when it off gasses from products’ manufactured with these resins.		
Life cycle description:	All lifecycle processes and uses		
Number of sites:	Table 1 (page 22300 or pdf pg 154/268) provides details concerning the number of establishments for different levels of exposure for 35 different industrial sectors.		
Comments:	This is the notice that sets the most recent PEL		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	As an FRN the information provided is based on high-quality data, techniques, and sound methods that are from frequently used sources and are generally accepted by the scientific community, and associated information though dated, does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The assessment is for all occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The data are more than 20 years old.
	Metric 5: Sample Size	N/A	No samples
Domain 3: Accessibility/ Clarity			
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Study Citation:		OSHA (1992). Occupational exposure to formaldehyde. Federal Register 57(102):22290-22328.		
HERO ID:		1314358		
Conditions of Use:		Multiple		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	High	The FRN clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	N/A	No statistics
Overall Quality Determination			High	

Study Citation:	Rodriguez, Manuel, M., Aristeguieta, C. (2009). Evaluation of employees’ chemical exposures while blending and repackaging glass beads for road markings.			
HERO ID:	8684530			
Conditions of Use:	Paints and coatings			
EXTRACTION				
Parameter	Data			
Process description:	Employees blend and repackage the beads in smaller paper sacks or boxes for distribution to state transportation departments and other customers. The glass beads are applied over wet paint sprayed on road surfaces to make street markings reflective to automobile headlights. The beads vary in size from 0.2–1.2 mm and have a silane coating. The repackaging process begins with lifting a Super Sack with a forklift over a metal bin, then cutting the bottom of the container with a knife to empty the beads into the bin (Figure 1). The metal bin is lifted by a forklift, and the glass beads are poured into hoppers. From the hoppers the beads are gravity fed into smaller cardboard boxes or paper sacks that are shipped to customers (Figure 2).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for paints and coatings, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	N/A	N/A - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The assessment does not address variability or uncertainty.	
Overall Quality Determination		High		

Study Citation:	Ruhe, R. L., Arnold, S. J., Anastas, M. (1986). Health Hazard Evaluation Report HETA-1984-379-495-1687 Metal Container Corporation, Columbus, Ohio.
HERO ID:	8684538
Conditions of Use:	Metal products not covered elsewhere

EXTRACTION	
Parameter	Data
Process description:	The cans are formed from coiled aluminum sheet by the so-called draw and wall- iron method in which a "cup" is formed in a special press and forced through a redraw die and "3 wall ironing rings". In this step the can is drawn tp full length and thickness. The hemispherical shape of the bottom is also formed . After the tops of the cans are trimmed to obtain burr- free edges they are washed and treated (acid and alkali wash) in preparation for the application of inner and outer coatings. There are four washing/treating machines located on the upper deck. cans from the washing operation are conveyed to one of four machines in which a water- based coating (called base coat) is applied from a system of rollers. As the cans leave the basecoat application rollers they are moved by a continuous "pin" conveyor, with each can being held on a 5-in. spindle or "pin" from the inside, to oneof four "FECO" pin-ovens in which the basecoat (either white or clear during the visit) is cured.The FECO ovens are divided into two sections . In the first section the basecoat is cured at 400°F in an indirect natural .gas- fired curing section. Air (for both combustion and ventilation) is supplied to the curing section and exhausted to the outside through a 30-foot stack. The cans exit the curing section and enter the cooling section, where filtered ambient-temperature air is blown and exhausted to a stack. The FECO ovens were designed for negative pressure operation.The basecoated cans exit the FECO oven through a chute and are conveyed to the decoration or "deco" machines where brand name and other information is printed. Inks of various colors are applied by a system of rollers in four deco machines, which have, the capability of applying up to four colors simultaneously. The cans are then conveyed by pin conveyor to FECO ovens, where the ink is cured in the same fashion as the basecoat. Following the ink cure, five machines on the first floor are used toapply an epoxy inner liner; the solution is sprayed from stationarynozzles. The cans are positioned by a rotating star-shaped wheel(turret) . The spray from the nozzles is intermittent and issynchronized so that it occurs only when a can is in place. The cansare then conveyed -to one of four curing ovens by one of four conveyors, each having horizontal and vertical runs. As in the case of FECO ovens, the inner spray "DESPATCH" curing ovens have two sections, one for curing and the other one for cooling. The cans exiting the DESPATCH oven are conveyed to a machine which forms a neck and a flange into the top portion where the end will be applied after the can is filled. After being tested for leaks, the cans are palletized and the pallets are strapped with 112 in. wide plastic film before shipping. The plant operates continuously with two 12-hour shifts per day. At maximum capacity, four lines may be in operation simultaneously; with each line producing 500,000 cans per shift.
Throughput:	The Metal Container Corporation manufactures two-piece aluminum beverage containers at the rate of 4,000,000/day.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for metal products not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	N/A	process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.

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Formaldehyde

General Engineering Assessment

HERO ID: 8684538 Table: 1 of 1

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Study Citation:	Ruhe, R. L., Arnold, S. J., Anastas, M. (1986). Health Hazard Evaluation Report HETA-1984-379-495-1687 Metal Container Corporation, Columbus, Ohio.		
HERO ID:	8684538		
Conditions of Use:	Metal products not covered elsewhere		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Science Applications International Corporation, (1996). Generic scenario for automobile spray coating: Draft report.			
HERO ID:	6311222			
Conditions of Use:	Automotive Coating Application			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Auto OEM: 166,00 cars painted/yrAutorefinish: 70-2,000 L paints.yr			
Process description:	Pretreatment (wash) of car body, E-coat (dip), oven/cure, primer (spray), oven/cure, basecoat (spray), oven/cure, clearcoat (Spray), oven/cure			
Number of sites:	Auto OEM: 61 sitesAutorefinish: 1000's of sites			
Comments:	operating days: "Auto OEM: 250 days/yrAutorefinish: 170 days/yr"			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering OEM and refinish applications.	
Overall Quality Determination		Medium		

Study Citation:	Sylvain, D. C. (1999). Health hazard evaluation report 97-0113-2720, U. S. Fish and Wildlife Service, Hadley, Massachusetts, January 1999.			
HERO ID:	8016870			
Conditions of Use:	Disinfectants			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Formalin used in hatcheries contains 37% formaldehyde, 6-15% methanol, and “inert ingredients.” (6/20)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from a frequently used source.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	Medium	The assessment is for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The assessment provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2002). Flexographic ink options: A cleaner technologies substitutes assessment. Volume 1.			
HERO ID:	10293388			
Conditions of Use:	Ink, toner, and colorant products.			
EXTRACTION				
Parameter	Data			
Process description:	Flexography is a process used primarily for printing on paper, corrugated paperboard, and flexible plastic materials. Flexography uses a soft, flexible printing plate that is mounted on a rotary cylinder. Flexographic presses are equipped with anywhere from one to as many as twelve color stations. Examples of items printed with flexography include comics, newspapers, appliance boxes, and many grocery store packages - including cereal boxes, shampoo and soda bottle labels, frozen food and bread bags, and milk cartons.Solvent-based inks are widely used in many flexographic printing processes. They were the first printing inks to be available commercially. Historically they have been very popular because they dry quickly, perform well, and allow printers a wide choice of products. Solvent-based inks are generally considered to be the industry standard for ease of use and quality of printing.Solvents are important in delivering the ink to the substrate. The solvent allows the ink to flow through the printing mechanism, and then evaporates so that the ink forms a solid coating on the substrate. Typically, inks are manufactured and transported in a concentrated form, and the printer must add solvent to the ink to attain the desired viscosity. A solvent must display several important characteristics. It must adequately disperse or dissolve the solid components of the ink, but must not react with the ink or with any part of the press. It must dry quickly and thoroughly, and have low odor. Finally, it is desirable for the solvent to have minimal flammability and toxicity concerns.			
Number of sites:	550 firms manufacture printing inks in the U.S.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for ink, toner, and colorant products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Data is from 2002.	
	Metric 5: Sample Size	Low	Sample distribution is described qualitatively (number of sites).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2022). Commercial use of automotive detailing products - Generic scenario for estimating occupational exposures and environmental releases (Methodology review draft).			
HERO ID:	10480464			
Conditions of Use:	Automotive detailing products			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Provides methodology to estimate annual use rate based on number of cars, product used per car, and density of product.			
Process description:	Receive detailing products, dilute with water, application to vehicle through washing, polishing, and/or wiping.			
Throughput:	1 to 16 ounces of automotive detailing product per car.			
Number of sites:	Provides methodology to estimate number of sites based on chemical production volume, annual throughput - 147,152 total establishments.			
Chemical concentration:	Provides conc. estimates based on the chemical function, not chemical specific.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data.
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering different chemical functions.
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (2023). Use of laboratory chemicals - Generic scenario for estimating occupational exposures and environmental releases (Revised draft generic scenario).			
HERO ID:	10480466			
Conditions of Use:	Use - Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Provides methodology to estimate annual use rate.			
Life cycle description:	Laboratory Chemicals			
Process description:	Receive chemicals, weigh or measure chemical, add chemical to labware, dilute/add other laboratory chemicals, add sample, run analytical testing, dispose of sample and laboratory chemical waste			
Throughput:	260 days/yr; 255 grams reagent/site-day (average); 2,000 mL reagent/site-day (average); Table 3-2 gives daily throughput for laboratory stock solutions			
Number of sites:	Provides methodology to estimate number of sites based on chemical production volume, annual throughput - 40,639 total establishments			
Chemical concentration:	'Provides conc. estimates based on the chemical function, not chemical specific.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering different chemical functions
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2022). Chemical repackaging - Generic scenario for estimating occupational exposures and environmental releases (revised draft).		
HERO ID:	11182966		
Conditions of Use:	Repackaging		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	Table B-1 presents data on repackaging rate in kg chemical/site-yr.		
Process description:	"Pre-manufacture notices (PMN) submitted from 2010 to 2020 under EPA’s New Chemicals Program indicated imported and repackaged chemicals can be solids or liquids and may be neat or in solutions/mixtures and contained in various packaging types. After they arrive at the repackaging site, repackaging operations occur where the chemical is transferred from the transport container it was imported in to a new one of a different size in order to meet the customer’s needs (JACO, 2021). Chemicals may also be transferred from original containers to intermediate storage containers before packaging into smaller containers (Cooke, 2013; NIOSH, 2009). Chemicals are expected to be received at repackaging sites in drums or larger bulk containers (supersacks, totes, tank trucks, etc.) (Cooke, 2013; NIOSH, 2009). The chemical of interest may be received in its final formulation and transferred directly from these large containers into smaller containers, charged to a temporary storage tank, or it may be charged to a mixing tank and diluted or mixed with other chemicals before it is repackaged. Once the chemical has been formulated to desired specifications, it can be repackaged. Workers may be potentially exposed during the unloading of chemicals from the original transport containers into temporary storage or new transport containers. Releases of chemicals may also occur during this stage, from open container surfaces (e.g., if the chemical is volatile), transfer operations (e.g., if the chemical is volatile or a powder), and original transport container disposal.Repackaging operations for liquid chemicals typically involve pouring or pumping the product from the original containers or mixing /storage tanks into the new containers. A study conducted by the Health and Safety Laboratory in the U.K. investigated two chemical repackaging sites (Cooke, 2013). At both of these sites the chemical was delivered to the site by road tanker and pumped into dedicated storage tanks. One of the sites, a hydrazine supplier, pumped the hydrazine into a mixing vessel where it was diluted with water and packaged into smaller containers for sale to customers. At the other site, trichloroethylene was pumped from storage tanks into a closed loop system where workers using a hydraulic lance connected to a semi-automated filling system transferred the chemical into new containers (Cooke, 2013). The usual process for repackaging solid chemicals differs from the processes for liquids. A NIOSH Health Hazard Evaluation Report (HHE) from 2009 investigated a repackaging facility that was transferring bulk shipments of silane-coated glass beads ranging between 0.2 – 1.2mm in diameter. At this facility, 2,200 lb supersacks of the product are lifted with a forklift over a metal bin, then cutting the bottom of the container with a knife to empty the beads into the bin. The metal bin is then lifted by a forklift, and the glass beads are poured into hoppers. From the hoppers the beads are gravity fed into smaller cardboard boxes or paper sacks that are shipped to customers (NIOSH, 2009). Workers may be potentially exposed during the transfer of chemicals from temporary storage into new transport containers. Releases of chemicals may also occur during this stage from open container surfaces (e.g., if the chemical is volatile), transfer operations (e.g., if the chemical is volatile or a powder), and cleaning any equipment that was used in during the process."		
Throughput:	The number of operating days is given in a range of 174-260 days/yr with an EPA default of 260 days/yr.		
Number of sites:	Table 1-2 presents the number of repackaging sites based on 2019 U.S. Census data.		
Chemical concentration:	A fraction of completed IRERs from 2010-2020 were reviewed, 21 submissions contained information on chemical repackaging. In these submissions, chemicals were repackaged at concentrations ranging from 1% to 100%, with a 50th percentile of 93%, a 95th percentile of 100%, and a mode of 100%.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High This GS is based on U.S. data.
	Metric 3:	Applicability	Medium Data are for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
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Study Citation:	U.S. EPA, (2022). Chemical repackaging - Generic scenario for estimating occupational exposures and environmental releases (revised draft).			
HERO ID:	11182966			
Conditions of Use:	Repackaging			
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete use amounts provided).
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple repackaging facilities.
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (2021). Use of chemicals in fuels and related products - Generic scenario for estimating occupational exposures and environmental releases (Methodology review draft).			
HERO ID:	11203977			
Conditions of Use:	Fuels and Fuel Additives			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	95.3 billion gallons of gasoline were sold in 2018.			
Process description:	Chemicals in fuels and related products are expected to be received at use sites (i.e., fueling stations) via tank trucks, rail cars, tankers, barges, and pipelines. The fuels are then transferred from these transport containers to on-site storage tanks, typically through pipes and hoses. At the use site, fuels are dispensed from storage tanks to vehicles or other equipment. Storage tanks for fuel are typically underground, and fuel is pumped upwards through tubes and nozzles. During combustion, fuel is burned to provide energy to an engine. In a typical internal combustion engine, fuel is mixed with air in a chamber. This mixture is ignited with a spark and energy from the burning fuel is used to power the vehicle or machine. Exhaust gases leave through a tailpipe or vent.			
Throughput:	365 days/yrProvides methodology for estimating throughput based on use rates and operating days/yr.			
Number of sites:	Up to 505,698 sites (Table 1-2)			
Chemical concentration:	Table 1-1 provides concentration ranges (with example chemicals) of typical fuel additives.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple fuel and additive types.
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2014). Generic scenario draft on the use of additives in plastic compounding.			
HERO ID:	3827195			
Conditions of Use:	Reactant-Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Plastics Compounding			
Process description:	Polymer pellets/resins received, blending/compounding into masterbatch, extrusion/shaping, packaging (pdf pg 22)			
Number of sites:	'Provides methodology for estimating number of sites based on chemical PV, the amount of plastic produced, and the concentration of the chemical additive in the plastic (pdf pg 36)			
Chemical concentration:	'Provides conc. estimates based on additive function in various plastics, not chemical specific. (pdf pg 30)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data.	
	Metric 3: Applicability	Medium	Specific to a process, but not the chemical being reviewed.	
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple plastic and additive types.	
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2014). Formulation of waterborne coatings - Generic scenario for estimating occupational exposures and environmental releases -Draft.			
HERO ID:	3827197			
Conditions of Use:	Formulation of Coatings			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	1.6-16 million kg coatings/site-yr			
Process description:	Unloading solid/liquid components from tank cars, totes, drums, or sacks and from filter replacement → pre-mixer (pigment dispersion), grinder (pigment dispersion), blending tank, filter, packaging			
Throughput:	Provides methodology for estimating throughput based on the amount of coatings produced, and the concentration of the chemical in the coating			
Chemical concentration:	Provides conc. estimates based on chemical function and coating type, not chemical specific.			
Comments:	operating days: 235-350 days/yr			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple coating applications, and multiple chemical functions	
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (2004). Use of additives in foamed plastics – Generic scenario for estimating occupational exposures and environmental releases – Draft.			
HERO ID:	6304171			
Conditions of Use:	Flexible and Rigid Polyurethane Foam Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	”2,365 million lbs polurethan foam/yr6,442 million lbs polysytrene/yr”			
Process description:	Converters mix plastic resins with additives, shaping/molding			
Number of sites:	566 total polystyrene sites, 610 total polyurethane foam sites			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple foam types.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2000). Leather dyeing - Generic scenario for estimating occupational exposures and environmental releases (draft).			
HERO ID:	6311220			
Conditions of Use:	Leather dyeing			
EXTRACTION				
Parameter	Data			
Process description:	Leather is generally dyed in wooden drums or rotating vessels. A dye bath is prepared by adding a dye stuff to the dyeing equipment; surfactants and other auxiliaries may also be added. The bath temperature may range from 0 to 60C. The leather is brought into the drum or rotating vessel, and the leather is dyed by gentle agitation for approximately 10 minutes. There are also semicontinuous processes ((multimac) dyeing machine) for leather dyeing.			
Throughput:	A batch consists of between 450 and 900 kg of leather with a typical value of 680 kg. This batch size corresponds to between 40 and 80 grain leather sides, and between 100 and 200 suede leather sides, based on a weight of 11kg/side of grain leather and 4.5 kg/side of suede leather. The amount of formulated dyestuff used per batch is 6.8 kg for the grain leather sides, and 20 kg for the suede leather sides. Calculation for use rate per batch.annual amount of active colorant in the dyestuff solution used ranges from 200-2,500 kg/tannery, with an average use rate of 1,000 kg/tanneryThe total number of hides dyed at each facility typically averages 1,000 sides/day			
Number of sites:	315 tanneries in the United States, and 80% perform dyeing operations. Number of sites calculated based on PV and should not exceed 252 tanneries.			
Chemical concentration:	Amount of active chemical in the formulated dyestuff (% active chemical of interest) is typically 50% for powdered dyes and 15% for liquid dyes (most dyes used in leather dyeing are acid dyes)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations and some state statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering both liquid and solid physical forms and different leather types.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2001). Manufacture and use of printing ink - Generic scenario for estimating occupational exposures and environmental releases (revised draft).		
HERO ID:	6311221		
Conditions of Use:	Formulation and Use of Printing Ink		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	11.9-373.8 million kg/yr (depending on the class of ink)(pdf pg. 28)		
Process description:	PROC: Vehicle consisting of resin, solvent, drying agents, and resin plasticizing oils is prepared, pigment blended into vehicle, fed to dispersing mill, raw ink let down with additional solvent and other additives, packaged for sale.USE: Provides descriptions for lithography, gravure, flexography, letterpress, digital printing, and screen printing.		
Throughput:	Average Annual formulation rate: 2 million kg/yr-site, Average Annual use rate: 0.002 million kg/yr-site. (Different rates are given based on ink class) (pdf pg. 28)		
Number of sites:	PROC: 13-239 (depending on printing application)USE: 454-18,622 (depending on printing application)(pdf pg. 28)		
Chemical concentration:	Provides conc. estimates based on chemical function, not chemical specific. (pdf pg. 29)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses sound methods from a frequently used source, EPA, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation but is not specific to chemical.
	Metric 4: Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old (2001). The assessment captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty not addressed. Variability is addressed in different ink classes and types of additives considered.
Overall Quality Determination		High	

Study Citation:	U.S. EPA, (2003). Transportation equipment cleaning - Generic scenario for estimating occupational exposures and environmental releases (draft).			
HERO ID:	6385708			
Conditions of Use:	All			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	EPA estimates 500,000 IBCs are cleaned annually in the United States. Of this amount, EPA believes 225,000 IBCs are cleaned by Transportation Equipment Cleaning facilities. The remaining 275,000 IBCs are cleaned by drum reconditioning facilities.			
Process description:	Cleaning process generally include reviewing manifests, draining the tank heel, rinsing, washing or using material-specific cleaning methods, rinsing a second time, and drying. Cleaning processes vary between facilities depending on the available cleaning equipment and the commodities last transported in the tanks to be cleaned.			
Throughput:	"IBCs are portable plastic and metal containers with 450 liters (199 gallons) to 3,000 liters (793 gallons) capacity. Cleaning time for tank barges typically ranges from four to eight hours. On average, tank trucks, IBCs, or intermodal tank containers requires two hours for cleaning."			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple container types and cleaning methods.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2010). Manufacture and use of printing inks - generic scenario for estimating occupational exposures and environmental releases: Draft.		
HERO ID:	6385710		
Conditions of Use:	Ink, toner, and colorant products		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	11.9-373.8 million kg ink/yr (depending on printing application).		
Process description:	USE: Provides descriptions for lithography, gravure, flexography, letterpress, digital printing, and screen printing.		
Throughput:	Provides methodology for estimating throughput based on the amount of ink produced, and the concentration of the chemical in the ink for both PROC and USE. PROC: 250 days/yrUSE: 250 days/yr.		
Number of sites:	USE: 454-18,622 (depending on printing application)		
Chemical concentration:	Provides conc. estimates based on chemical function, not chemical specific.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple printing applications, and multiple chemical functions
Overall Quality Determination		Medium	

Study Citation:	U.S. EPA, (2001). Leather tanning - Generic scenario for estimating occupational exposures and environmental releases (draft).			
HERO ID:	6385717			
Conditions of Use:	Leather Tanning			
EXTRACTION				
Parameter	Data			
Life cycle description:	Pg. 15/29: formaldehyde is used as a tanning agent in the chrome tanning process that is frequently used to tan leather in the U.S.			
Process description:	”The first steps of the process are referred to as beamhouse operations, which include trimming, soaking, fleshing, and unhairing. These operations take place for both chrome and vegetable tanning. Next, tanyard processes take place,which include bating, pickling, tanning, wringing, and splitting. Lastly, finishing processes include conditioning, staking, dry milling, buffing, spray finishing, and plating. Process flow diagram and additional details provided in GS document. ”			
Number of sites:	up to 315 sites			
Comments:	operating days: up to 350 operating days/year			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample is a single value with unknown statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2004). Photographic industry - generic scenario for estimating occupational exposures environmental releases: Draft.			
HERO ID:	6385718			
Conditions of Use:	Incorporating into photographic film or paper, Incorporating into coating formulation, Coating of photographic film or paper, Developing photographic film or paper			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	In 2002, the United States consumed 31 million pounds of cellulose ester film and sheet. In 1998 the United States produced approximately 619 thousand tons of polyester film (only 25% of polyester film consumed in the US is used in photographic industry).			
Process description:	Provides process descriptions for manufacture of photographic film and paper, formulation of photographic coating material, incorporation of coating onto the paper/film, and developing the paper/film after light exposure			
Chemical concentration:	Impurities are often added to the coating formulation to impart various photographic properties. These additives are often incorporated into the emulsion in very small concentrations, often the ppm or ppb range.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distributions characterized by ranges/estimations with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by sections addressing further work and limitations. Variability is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2004). Spray coatings in the furniture industry - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385719			
Conditions of Use:	Furniture Coating Application			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	”Metal: 5,000-446,600 L coating/yrWood: 4,326-4,372 L coating/yr”			
Process description:	”Metal furniture: Metal cleaning, coating unloaded, coating mixing, coating application (spray booth, manual or automatic), flash-off, drying oven Wood furniture: coating unloaded, coating mixing, coating application (spray booth, manual or automatic), flash-off, drying oven, sanding and other finishing operations”			
Throughput:	”Metal: 20-1,786 L coating/dayWood: 17.3-17.4 L coating/day”			
Number of sites:	152-8,176			
Chemical concentration:	Provides conc. estimates based on chemical function, not chemical specific.			
Comments:	Operating days/yr: 250 days/yr			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering various chemical functions and wood vs metal furniture uses
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1994). Application of chemicals in enhanced oil recovery: steam stimulation, steam flooding, and polymer/surfactant flooding-generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385725			
Conditions of Use:	Enhanced Oil Recovery			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Enhanced oil recovery accounts for 10% of domestically produced oil (1992) with approximately 761,000 barrels/day produced			
Process description:	Polymer or surfactant formulated in enclosed continuously stirred tank reactor onsite, transferred to storage tank, then pumped into well with injection fluid using metered pumps. Steam stimulation involve steam injection followed by a waiting period before pumping. Steam flooding involves continuous steam injection.			
Throughput:	Successful enhanced oil recovery operation is considered one that recovers 20% as much oil as fluid injected (e.g., 20 barrels of oil per 100 barrels of injection fluid used). Default production rate of 5,300 barrels/site/day.			
Number of sites:	117 active enhanced oil recovery sites use steam stimulation and 26 active sites use a form of polymer flooding (1992)			
Chemical concentration:	Crosslinked polymers injected at concentrations of 1000 to 5000 ppm. Surfactants used at concentrations as low as 0.1% by weight			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distributions characterized by ranges/estimations with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple physical forms of chemical.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (1994). Application of waterborne wood preservatives using pressure treatment-generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385737			
Conditions of Use:	Application of Wood Treatment Products			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	20-40,000,000 board ft/yr			
Process description:	Treatment product received in dedicated tankers, transferred to concentrate tanks, diluted with water, transferred to work tanks, used to treat wood in treatment cylinder			
Number of sites:	400 plants			
Chemical concentration:	0.4-2.5 lb chemical/ft3 wood			
Comments:	operating days: 260 days/yr			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple facility sizes.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1991). Granular detergents manufacture - generic scenario for estimating occupational exposures environmental releases: Draft.			
HERO ID:	6385740			
Conditions of Use:	Granular Detergent Manufacture			
EXTRACTION				
Parameter	Data			
Process description:	Raw material receipt and storage, paste making (surfactant), adding additives, mixing and pumping, spray drying, cooling/screening/mixing, packaging			
Throughput:	300,000-500,000 kg detergent/site-day			
Number of sites:	Provides estimate for estimating number of sites assumed 300 days/yr of operation, chemical PV, and conc of chem in detergent			
Chemical concentration:	Provides conc. estimates based on function of chemical in product			
Comments:	Operating Days: "if known number of sites, provides method for estimate operating days using chemical PV, site daily throughput of detergent, and conc. of chem in detergent If number of sites is unknown, assumes 300 days/yr"			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple chemical functions
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (1994). Fabric finishing - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385741			
Conditions of Use:	Manufacture of Textiles, Apparel, and Leather			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	73 million kg finishing agents/yr			
Process description:	Fabric immersed in an aqueous finishing formulation then squeezed between metal rolls to remove excess pagging solution and to aid in the even distribution of the finishing agent, fabric dried by passing over a series of heated metal rolls, fabric cured by passing through a long oven.			
Throughput:	3,520-50,000 kg cloth/site-day			
Number of sites:	1,100 total finishing plants			
Chemical concentration:	Provides conc. estimates based on chemical function, not chemical specific.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple finishing agent types	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1996). Electrodeposition - generic scenario for estimating occupational exposures and environmental releases: Draft.			
HERO ID:	6385753			
Conditions of Use:	Electrodeposition of paints			
EXTRACTION				
Parameter	Data			
Process description:	”The process consists of pre-treatment of the article to be painted, painting of the article,and rinsing of the product. Example of specific steps include degreasing article, rinsing article, electrodeposition of article in dip tank with liquid formulation, recycling dip tank liquid, water rinsing article with recycling of rinsate, and drying/baking article. ”			
Throughput:	Dip times range from just seconds to 3 minutes for large pieces			
Number of sites:	Number of sites calculated for automobile and appliance manufacture separately based on PV, transfer efficiency, use rates, and product throughputs			
Chemical concentration:	Approximate composition of paint used for electrodeposition is: 84% deionized water, 0.6% surfactants, 0.3% defoamers, 2.0% crosslinkers, 4% solvents, 2% pigments, 1 % grind vehicle, and 6.1 % main vehicle. Solids composition typically ranges from 5.5% to 15%.			
Comments:	operating days: assume 250 days/yr			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality information/data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	Medium	Sample distributions characterized by ranges/estimations and some state statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering both automotive and appliance applications and different chemical functions.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1994). Water treatment disinfectants application - generic scenario for estimating occupational exposures and environmental releases.			
HERO ID:	6385754			
Conditions of Use:	Water Treatment Products			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	2,186 million lbs disinfectant/yr			
Throughput:	Provies estimates for dosage rates for various disinfectants			
Number of sites:	”59,000 total public water treatment sites15,438 WWT sites”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	This GS is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple facility sizes.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1994). Water treatment coagulants application - generic scenario for estimating occupational exposures and environmental releases: Draft.		
HERO ID:	6385760		
Conditions of Use:	Use of Water Treatment Products		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	12.9 billion lbs/yr of water treatment chemicals sold in 1988. 54% to treat municipal, utility, and institutional water. 34% to treat industrial water, 12% by residential and commercial markets. (pdf pg. 1)		
Process description:	Dry coagulants are fed gravimetrically or volumetrically to a mixing tank, slurry is decanted or pumped to point of application. Liquid coagulents are mixed in a tank with diluting water then pumped to point of application. (pdf pg. 3)		
Throughput:	180 gal per capita (pdf pg. 1)		
Number of sites:	59,000 public water treatment plants (pdf pg. 1)		
Chemical concentration:	concentrations are given for typical coagulents (formaldehyde was not listed)		
Comments:	Report is specific coagulents used in water treatment. The function of formaldehyde in the COU- Water Treatment Products, is unknown. Therefore, general information on coagulents is extracted and evaluated.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses sound methods that are from frequently used sources, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Medium	The assessment is for an occupational scenario (use of water treatment products) within the scope of the risk evaluation but is not data specific to formaldehyde.
	Metric 4: Temporal Representativeness	Low	More than 20 years old.
	Metric 5: Sample Size	Medium	characterized by uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is not addressed. Variability is considered with different physical forms of the coagulents considered and different sizes of operation.
Overall Quality Determination		Medium	

Study Citation:	U.S. EPA, (2004). Additives in plastics processing (converting) - Generic scenario for estimating occupational exposures and environmental releases - Draft.
HERO ID:	6549571
Conditions of Use:	Additives in Plastics Processing (Converting into Finished Products)

EXTRACTION

Parameter	Data
Production, import, or use volume:	Table 2 presents the types of thermoplastic resins, common uses, and 2003 production volume.
Life cycle description:	The plastic manufacturing industry can be divided into four sections: polymer manufacturing, compounding, converting, and “in-house” manufacturing. This generic scenario will address converting operations. Polymer manufacturing will not be included in this scenario. Compounders produce masterbatches of plastic resins with specific properties by blending the polymer (resin), additives, fillers, and reinforcements. Converters receive the masterbatch of plastic resin from compounders and form finished plastic products. Compounding and converting may take place at the same facility (“in-house” manufacturing) or at separate facilities. This scenario assumes that compounding and converting take place at separate facilities; therefore, in-house manufacturing is not covered in this scenario.
Process description:	Various plastic processing operation descriptions are provided in Table 5, and a Process Diagram is provided on PDF pg. 10. More generally, polymer resin is received at the compounding sites from the resin manufacturer in the form of pellets. A compounding site blends the resin and additives to produce a masterbatch. The converting site then processes the masterbatch by shaping the plastic into the desired form for the final plastic product. The blending and forming may take place at the same facility (“in house” manufacturing) or separate facilities. As a conservative estimate, it is assumed that the compounding of the plastic resin and the converting of the resin into plastic products take place at separate facilities. Therefore, in-house manufacturing is not covered in this scenario. After shaping, finishing operations such as filing, grinding, sanding, polishing, painting, bonding, coating, engraving etc. are performed to complete the finished plastic product. This scenario covers the converting of plastic resins into finished products.
Throughput:	Daily use rate = amount of resin / # converting sites / days of operation x fraction of additive x fraction of chemical in additive
Number of sites:	Overall, there were 12,191 Plastic Product Manufacturing establishments in 2001. Table 1 provides Number of Establishments for subcategories of NAICS 3261 Plastic Product Manufacturing.
Chemical concentration:	Default values used to represent the weight fraction of various additives in plastic resin range from 0.001 - 0.5. These values are provided in Table 2 and Table 3.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment uses high quality data that are from a frequently used source are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	Medium	The assessment is for an occupational scenario within the scope of the risk evaluation. However, data is not chemical specific.
	Metric 4: Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity			

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Study Citation:	U.S. EPA, (2004). Additives in plastics processing (converting) - Generic scenario for estimating occupational exposures and environmental releases - Draft.			
HERO ID:	6549571			
Conditions of Use:	Additives in Plastics Processing (Converting into Finished Products)			
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	Medium	Variability is addressed by evaluation of various plastic processing operations, as well as various additive fractions. However, uncertainty associated with data are not characterized.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2021). Application of spray polyurethane foam insulation - Generic scenario for estimating occupational exposures and environmental releases			
HERO ID:	- Final. 8674805			
Conditions of Use:	Spray Polyurethane Foam Application			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	365 million lbs of 2-component spray foam/yr and 55 million lbs of 1-component spray foam/yr			
Process description:	pre-spraying activities, SPF application, trimming, cleanup, chemical transfers, maintenance activities			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering one- and two-component foams.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2010). Generic model to estimate environmental releases from container residue for drums containing liquids: Revised draft.			
HERO ID:	8726953			
Conditions of Use:	Distribution in Commerce			
EXTRACTION				
Parameter	Data			
Process description:	Empty drums may be sent to drum reconditioner after several uses; drums require cleaning for both reuse/recycling and reconditioning. Cleaning may be done manually or in an automated system with water or solvent, and may include presteaming. Reclamation may also involve furnace processes for steel drums. (page 6 of 28)			
Throughput:	Model only applies to liquids shipped in drums ranging from 20 to 100 gallons, with the default drum size set at 55 gallons (page 5 of 28)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality information/data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	This GS is based on U.S. data	
	Metric 3: Applicability	Medium	Data are for multiple in-scope occupational scenarios; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	Medium	Sample distributions characterized by ranges/estimations with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple drum types.	
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (1992). Generic scenario document for lube oil additives.		
HERO ID:	8726954		
Conditions of Use:	Formaldehyde is not specifically noted, but it can be an additive to lube oil, so the general discussion is relevant.		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	Production1000000kg PMN/yr		
Process description:	The nature of the production process varies among additives. PMN produced at 100% concentration then diluted to between 90 - 50%in mineral oil to facilitate handling. More detailed description on page 6-11		
Throughput:	1,000,000 kg PMN/yr		
Number of sites:	Lube additive manufacture 2Lube additive blending 2end use pure lube 4,000end use general automotive 57,629		
Chemical concentration:	Additive Manufacture PMN dilution 50-90% in mineral oilBlending 1% kg PMN/kg lubeEnd use 1.2 %		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods thatare from a frequently used source
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario(lubricants); however, data is general and not specific to a chemical.
	Metric 4: Temporal Representativeness	Low	The completed exposure or risk assessment is more than 20 years old. The assessment-captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5: Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by considering multiple additive types.
Overall Quality Determination		Medium	

Study Citation:	[Redacted] (2013). [Redacted] Exposure screening assessment for XXX (formaldehyde, epichlorohydrin).			
HERO ID:	10605379			
Conditions of Use:	Textile/Fiber Finishing			
EXTRACTION				
Parameter	Data			
Process description:	The yarn product(actual descriptor is redacted) is coated by a spinning and winding process. An additional coating may or may not be applied then sent to RFL dipping . The RFL condensate as purchased contains some formaldehyde that maynot have completely reacted but during the curing step the three components (Resorcinol, formaldehyde, and latex) are reacted to completion and bound to the fiber.(pg 3 of 14) Section 3.1 provides a description of the treatment process.			
Chemical concentration:	Formaldehyde concentration in the final product is 0.3 wt% (pg 5 of 14).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Due to redactions, data sources in the report are not fully specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country (Japan) other than the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	Low	No statistics associated with concentration data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Report provides results and assumptions, but the underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	[Redacted] (2014). [Redacted] Formaldehyde exposure risk assessment for XXX.			
HERO ID:	10605383			
Conditions of Use:	Textile finishing			
EXTRACTION				
Parameter	Data			
Chemical concentration:	reported to be 41 ppm and max expected to be 75 ppm(pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	Data are for textile finishing, and in-scope occupational scenario
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	[Redacted] (2012). [Redacted] Prop 65 exposure risk assessment for formaldehyde and acetaldehyde in XXX.			
HERO ID:	10605387			
Conditions of Use:	Unknown			
EXTRACTION				
Parameter	Data			
Chemical concentration:	8E-05 (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Uninformative	No indication which COU this data is applicable for.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Uninformative		

Study Citation:	[Redacted] (2014). [Redacted] Prop 65 exposure risk assessment for formaldehyde in XXX.			
HERO ID:	10605388			
Conditions of Use:	Formulating semiconductor industry cleaning agents			
EXTRACTION				
Parameter		Data		
Chemical concentration:		2 ppm in one ingredient, 2% * 2 ppm = 40 ppb in product (pg 2-3)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for processing into formulation, which is applicable to multiple COUs
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	[Redacted] (2012). [Redacted] Screening level exposure and risk assessment of formaldehyde in XXX.			
HERO ID:	10605391			
Conditions of Use:	coating application			
EXTRACTION				
Parameter	Data			
Throughput:	Processing rate = max 15 m/min for 8 hr workday generating 7200 m, assuming 1 m widthAmount of processed in workday =15 m/min x 1 m width x 8 hr/day x 60 min/hr = 7200 m²Maximum coating product weight basis = 5 gsm = 5 g/m² or 0.5 mg/cm²Resulting mass of coating processed in a workday = 36000 g (7200*5) resulting product applied per minute = 36000/480min/(1000L/mL) = 0.075 L/min assuming a density of 1 g/mL (pg 3)			
Chemical concentration:	Maximum composition of formaldehyde in coating is 0.08% (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Report does not specify the data sources for the data extracted.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	Data are for coating application, in-scope
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Formaldehyde

General Engineering Assessment

HERO ID: 10608176 Table: 1 of 1

Study Citation:	[Redacted] (2014). [Redacted] Prop 65 exposure risk assessment for XXX (formaldehyde, antimony trioxide).			
HERO ID:	10608176			
Conditions of Use:	Fabric finishing			
EXTRACTION				
Parameter	Data			
Throughput:	Amount of processed per day = 1.4E+05 cm² (based on each worker sewing 8 garments per day) (4060 g in mass using assumed destiny of 0.029 g/cm2)			
Chemical concentration:	4 ppm (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	Data are for fabric finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Abou-Elela, S.I., Haleem, H.A., Abou-Taleb, E., Lbrahim, H.S. (2007). Application of cleaner production technology in chemical industry: A near zero emission. Journal of Cleaner Production 15(18):1852-1858.			
HERO ID:	5971179			
Conditions of Use:	Plastic material and resin manufacturing (plasticizer)			
EXTRACTION				
Parameter	Data			
Process description:	PFD in Fig. 1, pg 2			
Throughput:	30,000 ton liquid/year (poly sulfonated naphthalene formaldehyde super plasticizer for concrete) (pg 1)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from Egypt, a non-OECD country	
	Metric 3: Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario	
	Metric 4: Temporal Representativeness	Medium	Assessment is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	N/A	process description/throughput data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	process description/throughput data	
Overall Quality Determination		Medium		

Study Citation:	ACA, (2019). Comment submitted by Raleigh Davis, Assistant Director and Riaz Zaman, Counsel, Government Affairs, American Coatings Association (ACA) regarding the proposed 20 high priority candidates for chemical risk evaluation.			
HERO ID:	10369850			
Conditions of Use:	Processing, incorporation into product, paints and coatings			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Formaldehyde is present in trace amounts in most raw materials used in paints, coatings, sealants and adhesives. Formaldehyde is in synthetic latex resins. Some raw materials can be manufactured with very low formaldehyde concentration, at less then 10 ppm, but it cannot be entirely eliminated. Formaldehyde will be present in amounts between 5-200 ppm for every pound of dispersion of synthetic latex polymers. Formaldehyde is also found in fluorescent pigments at concentrations below 50 ppm. Based on identified concentrations in raw materials, some formulators speculate certain final products could have concentrations in the range of 0.1–1% (1,000 ppm to 10,000 ppm) in final products. Formulators of these specialty products expect actual concentration is significantly less. (page 5 of 7)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	From the knowledge of the American Coatings Association
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	From USA
	Metric 3:	Applicability	High	Relevant for Processing COUs
	Metric 4:	Temporal Representativeness	High	From 2019
	Metric 5:	Sample Size	Medium	The Association’s membership represents 90% of the paint and coatings industry, including downstream users (or processors) of chemicals, as well as chemical manufacturers (information was assumedly gathered from this large membership pool)
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination		High		

Study Citation:	ACC, (2020). Comment submitted by Kimberly Wise White, American Chemistry Council (ACC) Formaldehyde TSCA Risk Evaluation Consortium regarding the draft formaldehyde TSCA risk evaluation scoping document.			
HERO ID:	10370215			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Process description:	Phenol-Formaldehyde (PF) Resins [PDF Pg. 9]A thermoset polymer manufactured by condensation of formaldehyde and phenol. PF resins are resistant to moisture and solvents and can withstand temperatures up to 200°C. They also have good electrical resistance and are noncombustible. PF resins are used in the building and construction industry for applications including insulation binder, wood-based products, and laminates. Other end uses include automobile applications (e.g., friction materials) and foundry binders.Methylene Diphenyl Diisocyanate (MDI) [PDF Pg. 9]Produced by reacting formaldehyde with aniline hydrochloride. The initial reaction yields diphenylmethane diamine, which reacts with additional formaldehyde to form trimmers, tetramers and higher oligomers. MDI is used in the production of polyurethane foams for use as insulation materials in construction and automotive applications. Foam applications can include appliances (e.g., refrigerators, freezers, and air conditioners), packaging for electronics, and transportation.Pentaerythritol (Penta) [PDF Pg. 10]Produced by reacting excess formaldehyde with acetaldehyde in an alkaline medium to produce a white crystalline powder. It is used in the production of alkyd resins, which are found in paints and product finishes for automobiles. It is also used to make polyol esters, an important ingredient of engine lubricants in heavy dutyapplications (e.g., airplane turbines and automobiles).Hexamethylenetetramine (HTMA) [PDF Pg. 10]A crystalline powder with a fused heterocyclic structure. HMTA is produced by reacting aqueous formaldehyde with ammonia. HTMA is primarily used as a crosslinking agent to cure resins which are used in foundry resins, friction materials, and other applications. It is also used in applications, such as rubber accelerators, explosives, and pharmaceuticals.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for processing as a reactant, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	N/A	N/A - Process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - Process description.	
Overall Quality Determination		High		

Study Citation:	Agency for Toxic Substances and Disease Registry (ATSDR) (2010). Addendum to the toxicological profile for formaldehyde.		
HERO ID:	5160116		
Conditions of Use:	Multiple COUs		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	Production volume of formaldehyde (37% by weight basis) in the United States in 1990, 1995, and 2000 were reported to be 7.5, 8.7, and 10.3 billion pounds, respectively (IARC 2006). From 1995 to 2000, formaldehyde production averaged an annual growth rate of 1.8% per year and was predicted to grow at a rate of 1.0% per year through 2004 (CMR 2001). The estimated total annual formaldehyde capacities in 1998 and 2001 were 11.3 and 12.5 billion pounds, respectively (C&EN 1998; CMR 2001). The annual growth rate of formaldehyde production from 2001 to 2006 was 0.9% per year, and was predicted to grow at a rate of 1.0% per year through 2010 (CMR 2007). The total annual capacity of formaldehyde production (37% solution basis) in the United States in 2007 was 11.9 billion pounds (SRI 2007). Table 4-1 shows capacity and production volumes for selected years between 1960 and 2007. AS of 2007, 3 manufacturers of FA were responsible for over 50% of the annual capacity for the US: Georgia-Pacific Chemicals LLC; Celanese Ltd. and Hexion Specialty Chemicals, Inc. Capacities and PV from 1960 to 2007 are in Table 4-1: Capacities start at 2,449 and go up to 11,900 from 1960 to 2007 with PVs going from 1,870 to 10,251 from 1960 to 2000. Table 4-2 provides each state with the number of facilities and min/max amount on site in pounds. 1999 import and export volumes were 82 and 21 million lbs respectively, and in 2000 they were 62 and 18 million lbs respectively. 2005 they were 21 and 27 million lbs respectively and in 2006 they were 22 and 31 million lbs respectively. FA consumption in the United States in 2005 and 2006 was reported as 10.24 and 10.50 billion pounds, respectively, and it is projected to be 10.93 billion pounds in 2010 (CMR 2007). Formaldehyde consumption in 1999 and 2000 was reported as 9.6 and 9.8 billion pounds, respectively (CMR 2001; IARC 2006). This was a slight decrease from the 11.3 and 11.6 billion pounds demand reported for formaldehyde in 1994 and 1995 (C&EN 1995). In 2001, it was reported that the fastest growing formaldehyde market, at about 5% per year, in the United States is in the production of acetylenic chemicals (butanediol), MDI, and acetal resins. Table 4-3 provides percentage distribution of FA production according to uses in the US with most recent in 2007 at 17% PF resins, 22% UF resins, 13% acetal resins, 9% Acetylenics (butanediol), 3% melamine resins, 10% in MDI, 5% pentaerythritol, 3% Hexamethylenetetramine, 3% fertilizer and 15% miscellaneous.		
Life cycle description:	The most extensive use of formaldehyde is in the manufacture of urea-formaldehyde, phenol-formaldehyde, melamine-formaldehyde resins, and polyacetal resins. Formaldehyde-based resins are used as adhesives and as impregnating resins in the manufacture of particle board, fiber board, plywood, furniture, and other wood products. Plywood is the largest market for phenol-formaldehyde resins, and particle board is the largest for urea-formaldehyde resins. These resins are also used for the production of curable moulding materials (appliances, electric controls, telephones, wiring services) and as raw materials for surface coatings and controlled release nitrogen fertilizers. Additionally, they are used in the textile, leather, rubber, and cement industries. Further uses are as binders for foundry sand, stonewool, and glasswool mats in insulating materials, abrasive paper, and brake linings. Polyacetal plastics produced by polymerization of formaldehyde are incorporated into automobiles to reduce weight and fuel consumption. They are also used in the manufacture of functional components of audio and video electronics equipment.		
Process description:	Because methanol is manufactured from synthesis gas, usually produced from methane, there have been extensive efforts to develop a one-step process that makes formaldehyde directly from methanol by partial oxidation. Although a successful commercial process has not been developed, a wide range of catalysts and oxidation conditions have been studied. Following World War II, approximately 20% of the production volume in the United States was manufactured by vapor phase, non-catalytic oxidation of propane and butanes. This nonselective oxidation process produces a variety of coproducts that require a costly and complex separation system, and therefore, the methanol process is preferred. Formaldehyde is also produced in solid form as its cyclic trimer, trioxane, and as its polymer, paraformaldehyde. As a readily available source of formaldehyde for certain applications, paraformaldehyde is prepared commercially by the concentration of aqueous formaldehyde solutions under vacuum in the presence of small amounts of formic acid and metal formates. Trioxane is prepared commercially by strong acid-catalyzed condensation of formaldehyde in a continuous process. Available information indicates that paraformaldehyde is produced in the United States by three companies and trioxane is produced by two companies.		
Number of sites:	Source of number of facilities that produce, process or use FA on Table 4-2 is from TRI data.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Contains high quality data from reputable sources.
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Study Citation:	Agency for Toxic Substances and Disease Registry (ATSDR) (2010). Addendum to the toxicological profile for formaldehyde.			
HERO ID:	5160116			
Conditions of Use:	Multiple COUs			
Domain	Metric	EVALUATION		Comments
		Rating		
Domain 2: Representativeness				
	Metric 2: Geographic Scope	High		Data is for US.
	Metric 3: Applicability	High		Data is applicable to multiple COUs.
	Metric 4: Temporal Representativeness	Medium		Most recent data is from 2007 but also contains data that is over 20 years old.
	Metric 5: Sample Size	Medium		Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity				
	Metric 6: Metadata Completeness	High		Provides data sources, results. Includes process description, production, import and use volumes, number of sites, and life cycle descriptions.
Domain 4: Variability and Uncertainty				
	Metric 7: Metadata Completeness	Medium		Addresses variability by looking at multiple different COUs. Does not address uncertainty.
Overall Quality Determination		High		

Study Citation:	Ahman, M., Alexandersson, R., Ekholm, U., Bergström, B., Dahlqvist, M., Ulfvarson, U. (1991). Impeded lung function in moulders and coremakers handling furan resin sand. International Archives of Occupational and Environmental Health 63(3):175-180.			
HERO ID:	1314424			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Process description:	Cold-setting furan resins is used as binding agents for sand in moulding and coremaking in foundries. "Furan resin bindersbased either on urea-formaldehyde resin containing 50 %-95 % furfuryl alcohol or on a phenol-fortified resin containing 50 % furfuryl alcohol were used. Toluene-sulphonic acid (PTS) or a mixture of PTS and phosphoric acid was used as a hardener Themoulding sand contained some quartz." Formaldehyde is emitted from the furan resin.			
Throughput:	1,000 tons of furan resin sand is used in Swedish foundries every year			
Number of sites:	6			
Comments:	There are 4 different core and moulding methods, all of which use organic binders with formaldehyde resin (cold-setting furan, cold-box, shell moulding, and hot-box). This data source is associated with cold-setting furan resin.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Journal article
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data pertain to a COU
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1991)
	Metric 5:	Sample Size	Medium	A figure that is difficult to read contains TWA data for all sampled workers.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by sampling multiple facilities but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Ahrenholz, S. H. (1988). Health Hazard Evaluation Report HETA 87-266-1860, U.S. Department of the Treasury, Bureau of Engraving and Printing, Washington, D.C, January 1988.			
HERO ID:	1318521			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Process description:	The Bureau of Engraving and Printing is responsible for the production of all United States currency. The printing of the currency involves single pass intaglio printing. The notes are printed on a special currency paper that contains a melamine-formaldehyde resin to impart wet strength to the finished product. Two inks are used, black and green, with green applied first, and then after about a 48 hour curing period the black or face is applied. The inks cure by oxidative polymerization. The inks are composed of three primary parts: the vehicle containing resins and solvents; the color which contains metal pigments or oxides; and ink driers (metal soaps) which may contain cobalt, lead, or manganese compounds-for example lead octoate. None of the aldehydes identified by the bureau are listed as an ink constituent by any of the ink manufacturers.Loads of currency are brought into the mechanical examination areas from vaults after a 24 to 48 hour holding period after printing has been completed. The loads, two stacks of 10,000-32 subject sheets, are manually opened and separated on a vibrating table, and shingled out onto the currency feeder as needed to maintain a continuous flow of the sheets through the mechanical examining unit and past the examiners. During this process the sheets are cut and trimmed to two 16 subject sheets and defective sheets are removed. The examining units have four examiners who examine the face (front) and backs of the currency sheets. This is the first opportunity for separation of the individual sheets after the currency has been printed. The loads are locked down tightly during storage and must be broken apart manually after removal of the locking strap. The temperature and relative humidity was closely regulated in both the printing and mechanical examining areas. Temperatures were maintained around 72 to 74 Fahrenheit and the relative humidity was held between 45 and 55%.			
Throughput:	Regular production currency examination ranges from 35 to 40 thousand 32 subject sheets per work shift.			
Number of sites:	1			
Comments:	The source of the formaldehyde is most likely due to the presence of a melamine-formaldehyde resin used in the currency paper. The work conducted by the bureau concerning aldehyde levels associated with the various test currency samples demonstrated little variation in formaldehyde concentrations among regular production currency, test currency printed with the test inks, blind embossed currency paper (no ink but run through the press), and unprocessed blank currency paper.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data and/or sound methods thatare from frequently used sources (NIOSH HHEs) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The report is for an occupational scenario (printing operation) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	1987 - more than 20 years old.	
	Metric 5: Sample Size	N/A	qualitative information provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Information provided was derived from NIOSH site visit.	
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Study Citation:	Ahrenholz, S. H. (1988). Health Hazard Evaluation Report HETA 87-266-1860, U.S. Department of the Treasury, Bureau of Engraving and Printing, Washington, D.C, January 1988.		
HERO ID:	1318521		
Conditions of Use:	Multiple		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	qualitative information provided
Overall Quality Determination		High	

Study Citation: Ahrenholz, S. H. (1987). Health Hazard Evaluation Report HETA-86-0125-1853 Empire-Detroit Steel Division, Mansfield, Ohio. :24.	
HERO ID: 8197551	
Conditions of Use: Processing aids, not otherwise listed	
EXTRACTION	
Parameter	Data
Process description:	Coils of steel come into the rolling mill staging area from the pickling lines west of the rolling mill area. Steel enters the five-stand tandem mill with gauges of .080-.250 inch and, under the extreme roll pressures applied by the mills is cold reduced into longer thinner sheets of steel with gauges of .011-.101 inches. The reversing mill also cold reduces the steel as well as tempering the steel. Lighter gauges are generally run on the tandem mill and heavier gauges on the reversing mill. A coolant is applied to the coil steel from coolant nozzles aimed at the steel as it enters the rolls of each mill stand. A continuous flow of coolant cascades over the sheet during mill operation. The action of the rolls on the mill, the movement of the steel coil, and the spray of the coolant from the coolant supply nozzles result in generation of a continuous mist during mill operation. The gauge reduction being taken on the steel, the gauge of the feed stock, and the mill speeds affect the build up of heat in the mills and the amount of mist and vapors coming off of the mills. The work stations for the mills are located at control panels along the east side of the tandem mill and the west side of the reversing mill. Workers generally stand back from the tandem mills during their operation except to make adjustments, check controls, and at the start and end of a coil pass through the mill. (3/24)
EVALUATION	
Domain	Metric
Domain 1: Reliability	
Metric 1:	Methodology
	High
	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Metric 3:	Applicability
	High
	Data are from the U.S.
	Medium
	Data are for processing aids not otherwise listed, which may be in the scope of the scenario.
Metric 4:	Temporal Representativeness
	Low
	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size
	N/A
	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	High
	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	N/A
	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination	High

Study Citation:	Alexandersson, R., Hedenstierna, G. (1988). Respiratory hazards associated with exposure to formaldehyde and solvents in acid-curing paints. Archives of Environmental Health 43(3):222-227.			
HERO ID:	31634			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Construction, paint, electrical, and metal products: Manufacture of clothes closets (acid hardening lacquers)			
Process description:	Conveyor moves to surface finishing through treatment stations which grind, apply fillers, dry, intermediate grinding, top painting and drying.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden - OECD Member	
	Metric 3: Applicability	High	The data are for surface coating using acid hardening lacquer which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 2010, after the most recent PEL (1992) but 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumption	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:		Almaguer, D. (1988). Health Hazard Evaluation Report HETA 87-307-1917, Downing Displays, Inc., Cincinnati, Ohio, August 1988.		
HERO ID:		1316871		
Conditions of Use:		Multiple		
EXTRACTION				
Parameter		Data		
Process description:		In the Unlimited Department, display boards for sales promotions are assembled. Metal channeling is cut to size and metal slivers are cleaned from the surface with 1,1,1-trichloroethane while wearingprotective gloves. Adhesive is purchased in 55 gallon drums and dispensed into paint roller pans as needed. The adhesive is applied to the cardboard backing using paint rollers. When the adhesive isnot being used the paint roller pans are placed in a plexiglass cabinet to prevent the adhesive from drying out.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses sound methods from frequently used source, NIOSH study.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1987 - prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information derived from NIOSH site visit
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information
Overall Quality Determination			High	

Study Citation:	Almaguer, D., Boiano, J. M. (1986). Health Hazard Evaluation Report HETA-1985-0018-1759 American Crystal Sugar Company, Moorhead, Minnesota.
HERO ID:	8684542
Conditions of Use:	Agricultural chemicals in agriculture, forestry, fishing, and hunting

EXTRACTION	
Parameter	Data
Process description:	Beet sugar production, as indicated above, is a seasonal operation. In the early to late fall the beets are harvested and transported by truck to the plant where they are either stockpiled on the ground or dumped directly from the trucks into wet hoppers. Beets enter the factory via a water flume and go through several debris removing devices prior to washing. After cleaning, the /, beets are sliced into pieces called "cassettes". The cassettes are conveyed into the bottom of a large inclined cylindrical vessel called the diffuser. Hot water, flowing across the cassettes, is used to extract the sugar via osmosis. The sugar solution leaves the diffuser in the form of "raw juice". The processed cassettes (beet pulp), now devoid of most of the sugar, are dried in a large coal fired rotary drying drum, then are made into pellets for use as livestock feed.After leaving the diffusers, the raw juice is mixed with milk of lime and carbon dioxide (CO2) .(produced in the lime kiln from the oxidation of CaC03 using coke as a fuel source) in carbonation vessels to precipitate impurities and non-sugars from the juice. The juice is filtered several times to remove solidified impurities. The "thin juice" as it is now called is piped into evaporators, which thicken the mixture by evaporating excess water. The steam required for the evaporation process is provided by coal-fired boilers. The resulting thickened juice is boiled in vacuum pans and seeded with sugar crystals to initiate the crystallization process. The mixture is then transferred to centrifugals where the sugar crystals are separated from the remaining syrup (beet morasses). After drying, the sugar crystals are sorted by crystal size through screens, and stored in bulk bins (concrete silos or Weibul bins) prior to being bagged or bulk loaded into railroad cars.
Throughput:	Produces 595 tons of sugar are produced each day of the 180 day campaign period

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	Data are from the U.S.
		Metric 3: Applicability	Uninformative	Data are for sugar production, which is outside of the scope of the risk evaluation. EPA has determined that the use of formaldehyde in sugar refining would be regulated under the FIFRA program.
		Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
		Metric 5: Sample Size	N/A	N/A - process description.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	N/A	N/A - process description.

Overall Quality Determination **Uninformative**

Study Citation:	Almaguer, D., Klein, M. (1991). HETA 89-170-2100 February 1991 Northwest Vocational School , Cincinnati, Ohio.				
HERO ID:	8143964				
Conditions of Use:	Chemical Substances in Treatment/Care Products- Personal care products				
EXTRACTION					
Parameter		Data			
Number of sites:		1			
Chemical concentration:		Formalin - 37% formaldehyde			
		EVALUATION			
Domain		Metric		Rating	Comments
Domain 1: Reliability					
	Metric 1:	Methodology		High	NIOSH Study
Domain 2: Representativeness					
	Metric 2:	Geographic Scope		High	US
	Metric 3:	Applicability		High	The report is for an occupational scenario (classroom exposure) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness		Low	
	Metric 5:	Sample Size		N/A	
Domain 3: Accessibility/ Clarity					
	Metric 6:	Metadata Completeness		High	Information provided was from a NIOSH site visit.
Domain 4: Variability and Uncertainty					
	Metric 7:	Metadata Completeness		N/A	Typical formalin concentration
Overall Quality Determination				High	

Study Citation:	Almaguer, D., Klein, M., Klinecicz, S. (1990). Health Hazard Evaluation Report No. HETA-87-387-2050, Ithaca College, Ithaca, New York. :87-387.			
HERO ID:	4440693			
Conditions of Use:	Chemical substances in products not described by other codes.: laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Process description:	Monkey cadavers preserved in formalin are used for identification of anatomical parts. By the college policy, primate specimens are rinsed in Caro-Safe before teachers or students are allowed to work with the primates. Caro-Safe is a holding fluid containing ethylene glycol. Holding fluids are solutions used to store or rinse preserved materials. The reason for rinsing or treating formalin fixed specimens with holding fluids is to remove any excess formalin.			
Number of sites:	1			
Chemical concentration:	Formalin is a solution of formaldehyde gas in water and generally contains 37% formaldehyde gas of the equivalent of 37 grams of gas in 100 ml of water.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses sound methods from NIOSH HHEs	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	1987 - more than 20 years old	
	Metric 5: Sample Size	N/A	qualitative information provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Information provided was derived from NIOSH site visit.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	qualitative information provided	
Overall Quality Determination		High		

Study Citation:	Almgren, G., Bruze, M. (1988). Dermatositis in workers exposed to resins based on phenol and formaldehyde. :18-26.			
HERO ID:	1317040			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: Phenol-Formaldehyde resin production.			
Process description:	Decorative laminate built of several layers of paper sheets impregnated with PFR (phenol and formaldehyde resin) and resol resins based on phenol and formaldehyde. The outer layer paper was impregnated with melamine-formaldehyde resins. In varnishing machines, paper from rolls were passed through a resin bath which was filled from a closed system. The impregnated paper was then moved through a drying zone and subsequently cut into sheets of appropriate size. Next the impregnated sheets of paper were stacked to the desired laminate thickness, a step done manually, followed by curing which took place in a press at a certain temperature and pressure for a specified time. Finally the post-lamination processing of the product involved sawing, cutting and inspection steps.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden - an OECD member	
	Metric 3: Applicability	High	The data are for formaldehyde resin products which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The data were published in 1987, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Alonso, M.V., Oliet, M., Rodriguez, F., Astarloa, G., Echeverria, J.M. (2004). Use of a methylolated softwood ammonium lignosulfonate as partial substitute of phenol in resol resins manufacture. Journal of Applied Polymer Science 94(2):643-650.			
HERO ID:	2865748			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Specific information about Formaldehyde is not available. Only information about production volume in the article is that "total consumption for phenolic resins in the world amounted to more than 2.9 million tons in 2001."			
Chemical concentration:	Free formaldehyde concentration ranged between 0.7 wt% to 2.1 wt%.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Report is between 10 and 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Andersen, M.E., Gentry, P.R., Swenberg, J.A., Mundt, K.A., White, K.W., Thompson, C., Bus, J., Sherman, J.H., Greim, H., Bolt, H., Marsh, G.M., Checkoway, H., Coggon, D., Clewell, H.J. (2019). Considerations for refining the risk assessment process for formaldehyde: Results from an interdisciplinary workshop. Regulatory Toxicology and Pharmacology 106:210-223.			
HERO ID:	6198249			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	52 million tons of formaldehyde were produced in 2017. (1/14)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	PV Data from 2017. No scope to address variability and uncertainty.
Overall Quality Determination			High	

Study Citation:	Andrews, K., B.A. (1987). An update on testing for formaldehyde release. Textile Chemist and Colorist 19(10):19-25.			
HERO ID:	5940312			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Formaldehyde levels in clothing are typically less than 500 ug/g in unwashed fabric and can be as low as 100-200 ug/g in washed fabric. (1/7)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	Data are for a detection method for formaldehyde in textiles, which is similar to the in-scope occupational scenario finishing agents in textiles, apparel, and leather manufacturing.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in describing the detection and sampling methodology. Variability addressed by comparing different types of formaldehyde sampling.	
Overall Quality Determination		High		

Study Citation:	Anonymous (1982). Preliminary Plant Visit Industrial Hygiene Report, Georgia-Pacific Corporation, Chemical Division, Taylorsville, Mississippi, Report No. CT-114-17a. Monsanto Research Corporation(CT-114-17a):114-117.			
HERO ID:	1167758			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	production capacity 120 million pounds/year			
Process description:	Formaldehyde is manufactured by oxidation of methanol using iron/molybdenum oxide catalyst. Methanol is unloaded from a rail car or tank truck to a bulk storage tanks from which it is pumped to the vaporizer. Air is drawn through a primary filter and combined with vaporized methanol. the methanol-air mixture is fed into the converter, consisting of vertical catalyst-filled tubes. A coolant is pumped through the outside of the converter, removing heat from the reaction. The coolant is condensed and recirculated to the converter. Hot formaldehyde gas from the convert tube is fed to an aftercooler. Cooled gas enters the base of an atmospheric absorber column. liquid formaldehyde from the absorber is applied to a resin bead ion exchange to remove formic acid and stored in a tank. nitrogen and oxygen from the absorber is recycled in the process.			
Number of sites:	1			
Chemical concentration:	35-50%			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (formaldehyde manufacture) is within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 - more than 20 years old
	Metric 5:	Sample Size	N/A	Qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information was from site visit
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information
Overall Quality Determination		High		

Study Citation:	Anonymous (1982). Preliminary Plant Visit, Industrial Hygiene Report, Formaldehyde Production Facilities, Tenneco Chemicals, Inc., Fords, New Jersey, Report No. CT-114-21a. Dayton(CT-114-21a):114-121.			
HERO ID:	1316695			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	production capacity 185 million pounds of formaldehyde per year but typically produces 60 million lbs			
Life cycle description:	manufactured on site, used on site and also sold to customers			
Process description:	Formox Metal Oxide CatalystMethanol is delivered by truck and stored in bulk storage tank. Methanol is vaporized with filtered air. The methanol/air mixture enters one of two large parallel packed-tube reactors and oxidized to formaldehyde. The formaldehyde vapors pass through an aftercooler and are absorbed in water in a single absorber. The formaldehyde solution is stored in a bulk storage tank prior to transfer to an ion-exchange purification system which removed formic acid. the final product is sent to bulk storage and shipped out by tank trucks. Heat from the reactor is recovered using a heat exchanger that uses Dowtherm as a heat transfer solution which is vaporized after creating steam in a low-pressure boiler. Silver CatalystMethanol is pumped from storage tanks. Methanol is vaporized with filtered air. The methanol/air mixture is fed through headers to reactors that contain a silver catalyst for conversion into formaldehyde. Heat from the reactor is recovered in a steam generator. The cooled formaldehyde vapors pass through an absorber column creating a formaldehyde solution at a concentration of 40%. A 60 plate tray stripper is used to concentrate the formaldehyde to 46%. The formaldehyde solution is stored in a bulk storage tank then used on site.			
Number of sites:	1			
Chemical concentration:	46 and 50% formaldehyde solutions			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses high quality data from frequently used source (NIOSH reports) and are generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the US
	Metric 3:	Applicability	High	The data are for an occupational scenario (formaldehyde manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	information based on plant visit in 1981 prior to PEL (1992)
	Metric 5:	Sample Size	N/A	Information provided was qualitative or not applicable to statistical distribution.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was based on IH visit to the site.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Information provided was site-specific and by observation of the site practices, as well as no measurement data, so metric is not applicable.
Overall Quality Determination		High		

Study Citation:		Anonymous (1996). Perstorp formaldehyde process for Brazil. Chemical Week 158(15):16.			
HERO ID:		5956325			
Conditions of Use:		Manufacturing			
EXTRACTION					
Parameter		Data			
Throughput:		200-m.t./day			
EVALUATION					
Domain		Metric		Rating	Comments
Domain 1: Reliability		Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S., or the country of origin is not specified.
		Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
		Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
		Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination				Low	

Study Citation:	Anonymous (1996). Borden expands UK formaldehyde plant. Chemical Week 158(9):19.			
HERO ID:	5956344			
Conditions of Use:	Manufacturing of formaldehyde			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	60,000 - 90,000 metric tons/year at UK plant			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Anonymous (1999). BASF builds formaldehyde at German site. Chemical Week 161(24):28.				
HERO ID:	5956369				
Conditions of Use:	Manufacture				
EXTRACTION					
Parameter	Data				
Throughput:	470,000 MT/yr from Ludwigshafen plant, 40,000 MT/yr from Antwerp plant.				
Number of sites:	2				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1: Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.		
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S.		
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.		
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.		
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted		
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent		
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted		
Overall Quality Determination		Low			

Study Citation:	Anonymous (2004). Extra formaldehyde capacity for Borden Chemical in Canada. Focus on Catalysts 9:6.			
HERO ID:	6278546			
Conditions of Use:	Manufacturing of formaldehyde			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	90,000 tonne/y capacity at a new plant, with 200,000 tonne/y total at the site, and 2 Mtonne/y for the company as a whole			
Process description:	Uses silver catalyst process			
Chemical concentration:	production of 50% formaldehyde solution			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Anonymous, (1979). Canadian petroleum guide to canadian petrochemical plants. Canadian Petroleum 20(4):21.			
HERO ID:	5708674			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	”Borden Chemicals Canada: North Bay, Ontario: 5,000 tons/year West Hill, Ontario: 7,500 tons/year Laval, Quebec: 9,000 tons/year Vancouver, British Columbia: 9,000 tons/year Celanese Canada: Edmonton, Alberta: 50,000 tons/year Reichold: North Bay, Ontario: 22,000 tons/year Port Moody, British Columbia: 6,000 tons/year St. Therese, Quebec: 6,000 tons/year Thunder Bay, Ontario: 17,000 tons/year”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Report does not specify the data used.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Canada, an OECD country.	
	Metric 3: Applicability	High	Data are for the manufacturing of formaldehyde, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Low		

Study Citation:	Anonymous, (1973). Formaldehyde (cdf chimie-ifp process). Hydrocarbon Processing 52(11):136.			
HERO ID:	5956664			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	CdF Chimie-IFP Process for manufacture of formaldehyde from methanol and air is described. A large amount of air is mixed with part of the methanol, exchanged with reactor effluent, and the remaining methanol added before going to the reactor. This air-methanol mixture is heated to reaction temperature in the upper part of the reactor by boiling heat transfer liquid. Excess heat in the transfer fluid is used to generate steam. Reactor effluent is exchanged, cooled and sent to a three section absorption tower, Makeup water is added to the upper part to control tower bottom formaldehyde concentration. The iron-molybdenum oxide catalyst has a life of more than one year.			
Throughput:	For a 25,000 metric-ton/year pure formaldehyde in 1973 (date of the report)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Anonymous, (1970). Formox formaldehyde process. Chemical & Process Engineering 151(4):100-101.			
HERO ID:	5956682			
Conditions of Use:	manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	By 1970, the process was used in approximately 25 plants with a total capacity of about 750,000 t/a calculated as 37% formaldehyde.			
Process description:	The Formox process produces formaldehyde utilizing a molybdenum-based catalyst for the direct oxidation of methanol to formaldehyde. The reaction for the process is CH3OH + 1/2O2 = HCHO + H2O. Methanol is metered to the process, mixed with air, and vaporized in the vaporizer. The vapor mixture enters a fixed-bed tube reactor, which is charged to a specified depth with the metal oxide catalyst. A ratio of methanol to air in the range 5-8 moles methanol per 100 moles of air is used to maintain the desired oxidation atmosphere. The reaction temperature increases as the gas mixture enters the catalyst space and rises very rapidly to a point of maximum reaction in the catalyst mass. After the reaction has reached its peak, the product gases are cooled rapidly until they approach the temperature of the heat transfer medium prior to leaving the catalyst tubes. The product gases leave the reactor and pass to a gas cooler which is operated as a waste heat boiler. Here the gases are cooled before passing to a stainless steel absorption tower. Water is fed into the top of the absorption tower counter-current to the gas flow at a rate which maintains a desired formaldehyde concentration of up to 55% at the tower base. The heat of solution of formaldehyde and heat remaining in the reaction gases is removed by appropriate water cooling.			
Number of sites:	25			
Chemical concentration:	The Formox process produced a product concentration of 55% without additional concentration stages. The process features a high conversion making the recovery of methanol from the final product unnecessary.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

General Engineering Assessment

Study Citation:	Apol, A. G., Okawa, M. (1977). Health Hazard Evaluation Determination, Report No. HHE-76-55-443, Certain-Teed Products, Inc., Tacoma, Washington.			
HERO ID:	1317283			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Process description:	Certain-Teed Products, Inc, processes felt and fibrous glass asphaltshingles and rolled roofing products. The request involves the production of these products. The rolled felt is fed in a continuous ribbon through accumulation loops, makes two 90 degree turns, and enters the saturator; alternatively the feed roll can be put directly in line with the saturator. In the saturator, hot petroleum asphalt of approximately 400 oF is sprayed and flowed onto the felt. As the felt exits the saturator, it is completely saturated with the asphalt. The saturator is enclosed and is kept under negative pressure. The saturated felt then passes into the coater. From this point on, the felt and the fibrous glass are treated the same (the fibrous glass passes through the accumulator loops and saturator, however, no asphalt is applied to the fibrous glass in the saturator). In the coater, hot asphalt that has been thickened with limestone is flowed on the top side of the felt or fiberglass. The coater is enclosed and is provided with local exhaust ventilation. The asphalt is then spread with rollers and passes to the press area where the slate granules are dropped on the surface and pressedinto the asphalt. After the granules have been pressed into the asphalt, a mixture of talc and sand is applied to the back side of the material to prevent sticking. The material passes through a water spray for cooling and another set of cooling and accumulation loops. From there, it passes through an operation called "Seal Down" where a thin stream of asphalt is applied to the shingles. Ithen proceeds to the cutter, where the individual shingles are cut from the continuous ribbon. The shingles are automatically stacked, wrapped, and proceed to the warehouse where they are placed on pallets and stored.			
Number of sites:	1			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses high quality data and/or techniques or sound methods that are from a frequently used source(NIOSH HHEs)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (asphalt roofing manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1976-77: more than 20 years old.
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative information provided
Overall Quality Determination			High	

Study Citation:	Apol, A., Thoburn, T. W. (1986). Health Hazard Evaluation Report HETA-1985-462-1748 Boise Cascade, Vancouver, Washington.			
HERO ID:	8684545			
Conditions of Use:	Paper manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	This plant makes paper from pulp and makes carbonless paper by applying the appropriate coatings to the paper. The paper itself is produced in a continuous sheet from a pulp slurry. There are two types of coating applied to the paper. One is CF coating which is applied to the front of the second and subsequent sheets. The other is a CB coating which is applied to the back of the first sheet and subsequent sheets. Hence, in a three sheet form, the first sheet would have a CB coating applied to the back of the sheet. The second sheet would have a CF coating on the front and a CB coating on the back and the third sheet would have a CF coating on the front and a CB on the back.Changes were recently made in the coating application process. The CF coating is now applied as the paper exits the paper machine. The coating is applied, it passes through a dryer and is wound on a roll. The CB is applied in a separate plant area where previously both the CF and CB were applied. The CB is applied to the paper, the paper passes through a series of dryers and is rewound on a roll. The CF and CB coating are prepared in the coater prep area. The CF coating consists basically of a phenolic resin. It also contains water, dispersant, starch, blade lubricant, and polyvinyl alcohol. The phenolic resins had previously been cooked in the coater prep area. A recent change has been to purchase the phenolic resin already prepared. This change reduced the coater prep personnel exposure to phenol. The CB coating is composed of small urethane capsules that contain a dye, latex, starch, butyl biphenol, petroleum solvent and diethylene triamine.Carbonless paper is such that when pressure is applied with a pencil the capsules in the CB coating break and the dye is released. The dye then reacts with the phenol in the CF coating and a color is produced.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for paper manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - process description.	
Overall Quality Determination		High		

Study Citation:	Asphalt Roofing Manufacturers Association (ARMA), (2019). Comment submitted by Reed B. Hitchcock, Executive Vice President, Asphalt Roofing Manufacturers Association (ARMA) regarding initiation of prioritization of formaldehyde under the Toxic Substances Control Act.
HERO ID:	10369851
Conditions of Use:	Building/construction materials not covered elsewhere

EXTRACTION

Parameter	Data
Process description:	Asphalt Roofing Manufacturing [PDF Pg. 3-4]Although asphalt is used to make a number of different roofing products — including shingles, surfaced and smooth roll roofing, modified bitumen membranes and asphalt-saturated felt —the manufacturing process generally involves the same sequence of steps:a. coating: a mixture of a coating asphalt and a mineral stabilizer is used to coat fiberglass mat; in the case of products using organic felts, the felt is first subjected to a saturation process involving a low softening point asphalt;b. mineral surfacing such as colored granules may be embedded in the surface of the filled asphalt;c. cooling and drying: water-cooling and/or air-drying procedures are used to bring the product to ambient temperatures;d. product finishing: for certain products, formatting the designated asphalt roofing products by embossing, cutting, or painting; ande. packaging.First, the fiberglass mat consists of fibers bonded with a urea-formaldehyde (UF) binder, and some off-gassing of formaldehyde can occur from heating when hot asphalt contacts the fiberglass mat and before the mat is completely encapsulated during the coating step. Second, formaldehyde has been found in emissions from heated storage tanks supplying the coating operation.Asphalt Processing [PDF Pg. 5]Some asphalt roofing product manufacturers also process oxidized asphalt, one of the asphalt types used in roofing manufacturing. Roofing manufacturers can also obtain oxidized asphalt from independent asphalt processors or refineries.Oxidized asphalt is produced by blowing air through hot petroleum residuum, known as roofing flux, made from atmospheric or vacuum distillation, solvent extraction or other refining processes. Roofing flux is typically pumped from a heated tank and/or through a direct-fired or hot oil-heated noncontact heater into reaction vessels called blow stills (sometimes called oxidizers or convertors). Air is injected into the roofing flux in the blow still through perforated pipes. Some of the oxygen in the pumped air is consumed by the reaction of air with the roofing flux. Emissions from blow stills are treated in a variety of separation devices to remove condensed or entrained process oil, and then are oxidized in a thermal oxidizer operating at temperatures that exceed 1200° F (649° C). According to EPA, emissions from all blow stills, whether they are major or area sources of HAPs, are controlled by thermal oxidizers.Fiberglass Mat Manufacturing [PDG Pg. 6-7]Some asphalt roofing product manufacturers produce the fiberglass mat used in the roofing manufacturing operation. Most, if not all, of these operations use urea-formaldehyde-based (UF-based) resins to bond glass fibers together, which can be used as a substrate for many roofing products. The typical process steps are the following:a. Glass fibers are mixed together with water and emulsifiers in mixing vats to form a slurry of fibers and water.b. The glass fiber slurry is pumped to a mat-forming machine, where it is dispensed over a moving screen belt.c. The mat is carried beneath a binder saturator, where binder solution is uniformly applied onto the surface of the mat.d. The screen passes over a vacuum, which draws away the excess binder solution for re-use.e. The mat of fibers and binder passes into drying and curing ovens that use heated air to remove excess moisture and set (i.e., cure) the binder.f. The mat is then cooled, trimmed, wound and packaged to product specifications.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data not from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for building/construction materials not covered elsewhere, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	N/A	N/A - Process description.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.

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Study Citation:	Asphalt Roofing Manufacturers Association (ARMA), (2019). Comment submitted by Reed B. Hitchcock, Executive Vice President, Asphalt Roofing Manufacturers Association (ARMA) regarding initiation of prioritization of formaldehyde under the Toxic Substances Control Act.		
HERO ID:	10369851		
Conditions of Use:	Building/construction materials not covered elsewhere		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	N/A	N/A - Process description.
Overall Quality Determination		High	

Study Citation:	Athanassiadis, B., George, G.A., Abbott, P.V., Wash, L.J. (2015). A review of the effects of formaldehyde release from endodontic materials. International Endodontic Journal 48(9):829-838.		
HERO ID:	2520140		
Conditions of Use:	Manufacture		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	Formaldehyde has been used in the manufacture of particle board, plywood, glues, and foam insulation. Approximately 80% of its use is for plastic and resin manufacture. The remaining 20% is used in agriculture (seed treatment), reagents in laboratories, and preservatives in cosmetics (Restani & Gali 1991).		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from Australia, an OECD country.
	Metric 3: Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2014)
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium	

Study Citation:	ATSDR, (1999). Toxicological profile for formaldehyde.			
HERO ID:	93087			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter		Data		
Production, import, or use volume:		between 6.43 billion pounds and 8.11 billion pounds for 1990, 1991, and the period 1993–1995. 140 million pounds of formaldehyde were imported into the US in 1997. Additional historical data are also included. 23% of formaldehyde is used to make urea-formaldehyde resins, most of which is used to make particle board products. the study provides a more comprehensive listing of uses of formaldehyde		
Life cycle description:		reactant		
Process description:		Two primary methods of manufacturing formaldehyde from methanol are used today. The first uses silver as a metal catalyst in its reactions. In earlier years, facilities used a copper catalyst in this process. The simultaneous reactions involved in the metal catalyst process occur at essentially atmospheric pressure and 600–650.The second method uses a metal oxide catalyst. All of the formaldehyde is produced from an exothermic reaction occurring at atmospheric pressure and 300–400 EC. The patent for formaldehyde production using a vanadium pentoxide catalyst was issued in 1921. Although the patent for an iron oxidemolybdenum oxide catalyst was issued in 1933, the first commercial facility did not begin operating until 1952 .		
Number of sites:		As of 1998, there are 3 manufacturers that represented 50% pf annual capacity (Georgia-pacific resins; Hoechst Celanese Corp, and Borden, inc.. a more comprehensive list is provided in the study.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Medium	The report uses high quality data and/or techniques or sound methods that are not from frequently used sources (SRI and Anonymous) and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	US
		Metric 3: Applicability	High	The report includes production and use data which are occupational scenarios within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1999 based on data from earlier times, many were prior to the most recent PEL (1992) and also more than 20 years old.
		Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
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Study Citation:		ATSDR, (1999). Toxicological profile for formaldehyde.		
HERO ID:		93087		
Conditions of Use:		Processing as a reactant		
Domain	Metric	EVALUATION		Comments
		Rating		
Overall Quality Determination		Medium		

Study Citation:	Aydin, I., Colakoglu, G. (2005). Formaldehyde emission, surface roughness, and some properties of plywood as function of veneer drying temperature. Drying Technology 23(5):1107-1117.			
HERO ID:	5971795			
Conditions of Use:	Adhesive in the manufacture of plywood panels			
EXTRACTION				
Parameter		Data		
Process description:		Veneer drying, which leads to formaldehyde emission, is an important stage in the manufacturing of wood-based panel products such as plywood and laminated veneer lumber (LVL). The drying process accounts for some 70% of the thermal energy consumed in plywood production and approximately 60% of the mill’s total energy requirement. Although drying temperatures of between 90 and 160 deg C may be considered normal, increased temperatures are being used to reduce the overall drying time and increase capacity.		
Chemical concentration:		Urea formaldehyde (UF) resin with 55% solid content was used as adhesive in the manufacture of plywood panels.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	data are from an OECD country other than the U.S.
		Metric 3: Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
		Metric 4: Temporal Representativeness	Medium	report is between 10 and 20 years old
		Metric 5: Sample Size	N/A	Process description and chemical concentration
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	N/A	Process description and chemical concentration
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	N/A	Process description and chemical concentration
Overall Quality Determination			High	

Study Citation:	Azari, M.R., Asadi, P., Jafari, M.J., Soori, H., Hosseini, V. (2012). Occupational exposure of a medical school staff to formaldehyde in tehran. Tanaffos 11(3):36-41.			
HERO ID:	2993436			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	World production of formaldehyde in 2006 was 31,912 kilotons			
Process description:	Cadavers in gross anatomy laboratories are kept in formaldehyde for a longtime. Formaldehyde vapors are emitted from cadavers during dissection. Six ceiling diffusers arranged in two rows are attached to the central air conditioning system and four exhausts provide general ventilation for the laboratory. Cadavers are wrapped in cotton cloth and kept in a vinyl bag while not in use. During the study, nine cadavers were placed over the tables. Containers and barrels containing formaldehyde and phenol are also located in this Laboratory. The dimensions of the gross anatomy laboratory were4.2m × 6.10m × 3.13m (339 m3).			
Throughput:	Flowrate of air sampling was 0.1L/min			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses sound methods that are not from a frequently used source and associated information does notindicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Iran, a non-OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty and variability is addressed in by comparing with other published literature and by sampling in multiple areas.
Overall Quality Determination			Medium	

Study Citation:	Bajaj, P. (2002). Finishing of textile materials. Journal of Applied Polymer Science 83(3):631-659.			
HERO ID:	5972253			
Conditions of Use:	Textile finishing			
EXTRACTION				
Parameter	Data			
Process description:	The major treatment methods currently practiced for producing durable press cotton and other textiles are: pre-cure, garment dip treatment, vapor phase, low wet pick (kiss roll technique), post-cure, spray application and lamination, coating and lamination technology, foam finishing; and low pressure plasma technology.			
Chemical concentration:	BASF crosslinkers mostly contain less than 0.5% free formaldehyde, well below the European Union labeling regulations that are currently specified. Fixapret® ECO, available for 4 years now, contains less than 0.1% free formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S., or the country of origin is not specified.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			Medium	

Study Citation:	Bakke, B., Ulvestad, B., Stewart, P., Lund, M.B., Eduard, W. (2001). Effects of blasting fumes on exposure and short-term lung function changes in tunnel construction workers. Scandinavian Journal of Work, Environment and Health 27(4):250-257.			
HERO ID:	1313955			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances not described by other codes: exposure to blast materials from tunnel construction			
Process description:	Tunnel work follows a sequence that starts with drilling holes into the rock for the placement of explosives. After blasting, workers transport the broken rock out of the tunnel and take care of various support work, in particular the installation and maintenance of ventilation ducting, cables, and pipes. In addition, workers carry out service work on equipment in the tunnel.			
Number of sites:	4			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Norway - and OECD member	
	Metric 3: Applicability	High	The data are for tunnel construction workers which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The study was based on data from 1996-1997. prior to the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation: Barsan, M. E., Kinnes, G. M., Blade, L. (1994). Heta 90-261-2124 June 1991 Rubbermaid, Inc, Reynolds, Indiana.
HERO ID: 1787506
Conditions of Use: Plastic Manufacturing

EXTRACTION

Parameter	Data
Process description:	The production area is divided into three departments. In the Compounding Department, the primary constituents of the plastics are weighed, mixed, blended, extruded and placed in crates for transport to the Pressroom Department where they are molded into the desired shape. Pieces are then sent to the Product Process Department where parts are trimmed and packaged.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Uninformative	The report is for an occupational scenario, however formaldehyde is formed from melamine tablets when heated, not a COU of the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	The report is more than 20 years old
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Site-specific information

Overall Quality Determination **Uninformative**

Study Citation:	Baumann, H. (1990). Facts on formaldehyde in relation to foamed aminoplastics. Cellular Polymers 9(1):36-45.			
HERO ID:	5946972			
Conditions of Use:	Various			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	500,000 ton/year produced in Germany (pg 2)			
Process description:	PD data for foam plastics on pg 2-3			
Chemical concentration:	30-40% in aqueous solution (pg 1); 30-60% solution when used to make UF resins (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Report does not specify the data/techniques/methods used.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.	
	Metric 3: Applicability	High	Data are for various in-scope occupational scenarios.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	PV/concentration/PD data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	PV/concentration/PD data	
Overall Quality Determination		Low		

Study Citation:	Belanger, P. L., Lockey, J. E. (1984). Health hazard evaluation report: HETA-81-227-1408, Manville Corporation, Corona, California.			
HERO ID:	1316906			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Process description:	The plant manufactures approximately 15 fibrous glass product groups (about 500 individual products which utilize approximately 27 individual chemical substances) from conventional glass making raw materials such as borosilicate and low alkaline silicate glasses. The fibrous glass produced by melting and fiberizing silicate glass is called the pot marble process. This is similar to the spin process seen with the manufacture of mineral wool. Once the glass marbles are melted, the fiber strands are pulled through to the gas burners and directed through the forming tubes. The glass fibers are sprayed at the binder header with a phenol-formaldehyde resin. Silicon, oil, dyes, pigments and adhesives may be used in the process. The sprayed glass is collected at the U-Chute on the collection chain after which the material is passed through the searing roll platform and the curing ovens. The glass is then cooled, cut and packaged.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH HHE	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	1981- 1982: more than 20 years old	
	Metric 5: Sample Size	N/A	Qualitative information, no sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Process description.	
Overall Quality Determination		High		

Study Citation:	Bello, A., Xue, Y., Gore, R., Woskie, S., Bello, D. (2019). Assessment and control of exposures to polymeric methylene diphenyl diisocyanate (pMDI) in spray polyurethane foam applicators. International Journal of Hygiene and Environmental Health 222(5):804-815.			
HERO ID:	6134670			
Conditions of Use:	Spray polyurethane foam			
EXTRACTION				
Parameter	Data			
Process description:	The SPF foam is produced from the chemical reaction of two components, commonly referred as part A and part B, which are supplied at an approximate ratio of 1:1 to a spray gun nozzle. Part A is comprised of polymeric methylene diphenyl diisocyanate (pMDI), a mixture of the 4,4’-methylene diphenyl diisocyanate (4,4’-MDI), other MDI isomers (2,4’ - and 2,2’-MDI) and higher oligomers of MDI (such as three ring, and four ring structures). Part B is a mixture of polyols, amine catalysts, blowing agents, flame retardants, solvents, and other proprietary additives (Bello et al., 2018; Marlow et al., 2014; Lesage et al., 2007). The exothermic reaction between the isocyanates in part A and polyols in part B is accelerated by the amine catalysts and other additives in part B. Polymerization reaction starts immediately upon mixing of the two components. The foam expands, solidifies and cures within 2–48 h postapplication, depending on the product type. In this paper, the term isocyanates has been used exclusively to mean pMDI or any of its components, such as MDI isomers, unless otherwise specified.			
Comments:	Study does not mention formaldehyde but has information on the condition of use for spray polyurethane foam application.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	Information is qualitative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			High	

Study Citation:	Bendix Corp, (1979). BCME formation and detection in selected work environments.
HERO ID:	8727394
Conditions of Use:	Industrial Adhesives

EXTRACTION

Parameter	Data
Process description:	Plant G Foundry Products Two foundry processes were studied in this operation: Coremaking and metal pouring. Both processes were conducted as small batch operations. The first process studied was coremaking. Cores are made to provide interior areas within castings. Two types of core materials were used. The first mixture was of the following blend: Sand - 100 parts Phenol-formaldehyde resin - 2 parts Ammonium chloride catalyst in aqueous media - 0.4 part. These items were blended by machine. The technician then checked the mixture for the proper consistency. Since the resin-catalyst system will "set" with time, the mixture was used immediately. The coremaking machine was an air-operated press which heated molding materials to temperatures in excess of 5000 F. The mixture was blown under pressure into the mold of the press. It was then placed under pressure and heated to 4500 F for 1 minute. At the end of 1 minute, the molded cores were removed from the press and allowed to cool. At this point, the resin at the surface of the core was cured. Excess heat retained in the core was dissipated; however, much of it tended to hasten curing of the core's interior. Usually, cooling of a 1-inch by 1-inch by 3-inch core required about 10 to 15 minutes. Coremaking, using this equipment, was conveniently conducted for about 1 hour. A second coremaking was conducted using a slightly different mixture of materials. They included: Sand - 100 parts Furfuryl alcohol-formaldehyde resin - 2 parts Ammonium chloride catalyst in aqueous media - 0.4 part. Again, these items were mixed, molded, and cooled under essentially the same conditions as the phenol-formaldehyde resin mixture. The two resins selected represented the two most commonly used binding resins used in the foundry industry which have both formaldehyde and chloride ions present. The specific resin catalyst systems used were manufactured by the company visited and reflect their particular resin-catalyst formulation. A second process studied was the metal-pouring area. Molten iron was cast in 2,000-gram molds. The mold was a common step-type mold used to determine the qualities of the binders developed by this company. Two molds were prepared which had used the phenol formaldehyde, ammonium chloride binder system. Iron was melted and heated to approximately 2,900° F. It was then poured into a preheated ladle, manually moved to the mold, and poured at 2,700° F. The outer casing of the mold was graphite, a substance that was understood to be inert during the pouring. Once poured, the core was allowed to cool for at least 30 minutes in the mold. The casting was then opened and allowed to air-cool for about 8 hours, at which time it could be handled without protective equipment. Two pourings were made with the phenol-formaldehyde resin, ammonium chloride catalyst mix. Later, the furfuryl alcohol-formaldehyde resin, ammonium chloride catalyst mix was used in two pourings of iron. The process was essentially the same as that discussed for phenol-formaldehyde resin mixes. Plant H. Foundry Products - Full scale. The process in question was the production of ferrous metal castings, using shell molds. The molds were formed using heat and a catalyst to cure the resin/sand mixture. Once cooled and hardened, metal was poured into the molds, allowed to cool, and then removed from the mold. The molding department received a molding sand which was premixed. The components of this mixture included sand, phenol formaldehyde resin, and hexamethylenetetramine. The hexamethylenetetramine was used as a high-temperature catalyst for the curing of the resin. The sand mixture was forced around a metal pattern, pressed into place, and then heated to about 4000 F. The total time involved in this process was about 1-1/2 minutes. The mold was then removed, broken in half, and both halves glued together. The result was a completed mold commonly called a "shell mold" in this facility. Molds were moved into the pouring area. Some molds were simply placed in a sand pit, located centrally in the facility, and poured. No control over effluents from pouring were in use. However, this method was used only in small-job pouring of molds of this type. Castings were cooled in the same area. In a second-type pouring, a cooling range was used. Metal was poured under a slotted hood and then the castings were moved into the cooling range which was ventilated. Because of the smaller size of the castings, cooling usually required only a few hours. Castings were then manually broken out or shaken out of the molds and moved to the finishing area for welding, grinding, cleaning, etc. The whole process, from mold making to being ready for finishing, was accomplished in 2 days.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US

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Study Citation:		Bendix Corp, (1979). BCME formation and detection in selected work environments.		
HERO ID:		8727394		
Conditions of Use:		Industrial Adhesives		
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 3:	Applicability	High	The report is for an occupational scenario (foundry) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Study was implemented in 1976 - more than 20 years old
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	NIOSH Study that clearly documents its data sources.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Bendix Corp, (1979). BCME formation and detection in selected work environments.
HERO ID:	8727394
Conditions of Use:	Reactant - Resin Manufacture

EXTRACTION

Parameter	Data
Process description:	Plant A Dye Auxiliaries (resin) ProductionThe process under investigation was the production. of a resin that was used in the dyeing of various paper products. The process involved a relatively simple reaction whereby an amine formaldehyde resin was produced.In this facility, the resin was produced in 3.5-ton batches. The time needed to produce the finished resin was about 24 hours.Materials were either piped directly into the reaction vessel (formaldehyde, water) or were manually added to the reaction vessel through a small hatch (dicyanamide, ammonium chloride, caustic soda). The step of adding these substances required two employees and about 1/2 hour per batch.Once the major components were placed into the reaction vessel, mixing, heating, and refluxing took place. This continued for at least 6 hours and usually for about 24 hours. Samples were taken at various times to determine the relative completion of the reaction. Once the laboratory was satisfied with the product, it wasthen ready for packing. Occasionally, where product specification dictated, water and caustic soda were added to the mixing batch.The finished product was packed into drums, each containing 400 pounds of the finished resin. This step was done manually by one employee. The resin was piped by gravity flow into a canopy hood, where it was dropped into the drum. The drums were sealed andmoved into the warehousing area. The process required about 2 hours per batch.Plant B Dye ManufactureThe company surveyed was a producer of dyes and auxiliary chemicals for textiles, paper, and leather products; flavors and dyes for food products; colors for plastics; and other industrially oriented organic chemicals. The plant sampled, was one of the major facilities of several owned by the company. Primarily, it produced dyes that are used in the textile and food industry.a. Yellow-Orange Dye Production - The yellow-orange dye which was produced was essentially based on the aniline molecule, with various substitutions used to develop the proper color in the dye material. Part of this substitution process required that the amino group be blocked off from reacting while other substitutions were occurring. This was the role of the formaldehyde in this process. Later in the process, muriatic acid was used to remove this blocking group and allow another chemical rearrangement to occur. Initially, two tanks were used. In one was mixed formaldehyde, sodium bisulfite, and sulfuric acid. The second tank was filled with an aniline mixture. Both were then dropped into a third tank where they were mixed. An exothermic reaction occurred and to slow the reaction, ice was added and the reaction mixture was cooled to nearly 0° C. The mixture was made alkaline by the addition of caustic soda and was then filtered. The resulting filter cake was reslurred, using water and muriatic acid in excess. Again, the mixture was filtered, and the resulting filter cake reslurred. Muriatic acid and phenol were added and the solution was then refiltered. Once this third filtration was completed, the filter cake was dried in steam~heated ovens, milled, mixed to specifications, and packaged into drums.The process was a large-volume one where amounts of various materials added sometimes reached into the several-ton category. Most steps in the process required the manual addition of materials to the reaction vessels. To produce this dye, a single batch required up to 4 days to complete the steps necessary to be ready for drying in the oven. Once ready for drying, the dye material was placed into the ovens for several days to ensure complete drying. The material was then stored in drums until sufficient customer demand or warehousing requirements indicated the need for finalmilling and mixing to customer specifications.b. Cyanide Liquor Waste Water Treatment - Another dyestuff produced at this plant required the use of large amounts of cyanide-containing materials. As a result of liquor removal, large amounts of unreacted cyanides were found in the liquor, which presented a serious waste-water removal problem. To reduce the level of 'cyanide in the wastewater to an acceptable level, the cyanide was bound up in a polymer with formaldehyde.To help the reaction occur to sufficient completeness for wastewater requirements, muriatic acid was added to catalyze the reaction.The reaction was very quick and required little control. All of the operations were closed vessels with only one open point, where the effluents were dumped into a holding pit, awaiting removal to the disposal point. The addition of chemicals was done by piping needed materials directly into the reaction vessel. No manual work was conducted. Throughput: Plant A Dye Auxiliaries (resin) ProductionIn this facility, the resin was produced in 3.5-ton batches. The time needed to produce the finished resin was about 24 hours.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The report is for an occupational scenario (Dye resin manufacture within the scope of the risk evaluation.

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Study Citation:	Bendix Corp, (1979). BCME formation and detection in selected work environments.			
HERO ID:	8727394			
Conditions of Use:	Reactant - Resin Manufacture			
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 4:	Temporal Representativeness	Low	Study was implemented in 1976 - more than 20 years old
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	NIOSH Study that clearly documents its data sources.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Bendix Corp, (1979). BCME formation and detection in selected work environments.			
HERO ID:	8727394			
Conditions of Use:	Reactant - Fertilizer manufacture			
EXTRACTION				
Parameter	Data			
Process description:	Plant C Fertilizer productionThe product produced was known as 10-6-4 with 60 percent organic material urea-formaldehyde fertilizer. In its mixing process, potassium chloride and urea-formaldehyde were mixed in an acid condition. To produce this fertilizer, several steps had to be conducted. Initially, the dry ingredients were placed into a hopper where they were fed into a conveyor at a specified rate based on the specifications of the mix. These ingredients included potash, phosphorus-containing material, limestone, and anhydrous ammonia. Once mixed, the dry materials were ground up and further mixed. They were then placed into an ammoniator. Here, the dry mixture was coated with a mixture of urea-formaldehyde resin (in liquid form) and sulfuric acid.At this point, the reaction occurred which converted the mixture of products into a product that will allow a balanced discharge of nutrients once placed on the lawn or garden. The reaction was exothermic. creating heat of about 200° F in the mixture. Because of the water and liquid present, the fertilizer took a granular form.Before the fertilizer was ready for packing, it first had to be dried to remove the available liquids present, then cooled to approximately room temperature, and sized to the proper granular size for proper application characteristics in the home or-garden.This operation was conducted in two large rotary drums. The dryer was oil-fired to temperatures over 2000 F. Once through the dryer, the fertilizer was moved into the cooler where it was subjected to a flow of cool air. The fertilizer was then sized and either reground to the proper size (in the case of too-coarse granules) or reintroduced into the ammoniator for agglomeration (in the case of too-fine granules).Once delivered from the sizing area, the finished fertilizer was moved into bulk storage. From start to finish, the process was rapid, with a total residence time of 30 minutes or less.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH Study	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The report is for an occupational scenario (fertilizer manufacturer) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Study was implemented in 1976 - more than 20 years old	
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	NIOSH Study that clearly documents its data sources.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Bendix Corp, (1979). BCME formation and detection in selected work environments.
HERO ID:	8727394
Conditions of Use:	Incorporation into an article - Finishing agent in Textiles

EXTRACTION	
Parameter	Data
Process description:	Plant D, Textile Finishing The process of interest for this survey was the resin-finishing operation. One of the more commonly used finishes was glyoxal urea-formaldehyde, a resin with good qualities for crease prevention. The process to resin-finish textiles was a relatively simple one, but one that had several steps. Initially, the cloth was washed, bleached, dyed, and dried before it was ready for resin finishing. The cloth, usually in a roll, was unraveled into a scray. This unraveling prevented sheaves and rollers in the frames farther down the process line from pulling too hard on the cloth, possibly causing danger to the product. It was then ready for resin treating. On a mezzanine above the finishing frame floor were vessels that were used to mix the resin solution to the specifications required by the intended use of the cloth. Typically, 200- to 250-gallon batches of glyoxal resin, and appropriate amounts of magnesium chloride, water, softeners, hand builders, and other substances were used to complete the mixture. This solution was mixed and then gravity-fed to the pad bath area as needed. The cloth was drawn through the pad bath containing the resin solution. The pickup of resins was about 70 to 80 percent of the weight of the cloth. Once through the pad bath, the cloth was squeezed between rollers to eliminate a large amount of the water. Cloth with 30 percent resin weight was started on a process where it was dried and stretched, and the resin cured. Initially, the cloth was drawn through a predryer. Here, temperatures were sufficiently hot to drive off the water found in the resin mixture, but not so hot as to change the resin mixture. The water acted as a carrier in this process but did not have an actual part in the finished product. The next step was more drying, but this time while the cloth was being stretched. By the end of this step, most of the water was removed, but nothing had occurred to the resin. Temperatures in the dryer typically reached 250 0 F. The last major step in finishing was in the cure oven. Here, the temperatures were elevated to those needed to cure or harden the resin with the catalyst present. These approached 300 0 F or higher, as needed. Once curing was completed, the cloth was sent to inspection and on to warehousing for shipment or storage. In this facility, the predryer, dryer, and cure oven were ventilated through enclosures of the equipment. The remaining areas were essentially unventilated, releasing vapors and mists into nearby work environments. Plant E Textile Finishing The first step in the finishing of knit goods at this plant was the mixing of the resin and catalyst. A mezzanine existed in the center of the finishing room area where the resin, in an aqueous form, was gravity-drawn into mixing vessels. Magnesium chloride was added manually with buckets to the specifications of the mix. Softeners and wetting agents were added as needed. The batch, about 200 gallons, was then mixed and, within several minutes, was ready for use. The medium of the resin-catalyst mixture was aqueous. With the addition of the catalyst, the pH of the mixture became slightly acidic with a temperature that was nearly ambient. No pH adjustments were made. The typical mixes of the resins were from about 200 pounds resin/40 pounds catalyst to 100 gallons of water to about 50 pounds resin/10 pounds catalyst to 100 gallons of water. Once the resin-catalyst mixture was produced, it was used on either one of two finishing lines: tubular knit finishing and open knit finishing. Both employed different finishing techniques, hence they require separate discussions. In the tubular finishing operation, the knit goods were moved manually to the pad bath area where the knit goods were drawn through a series of stretchers and exposed to steam. Cloth temperatures were between 900 F and 1050 F at this point. The cloth was then drawn through the resin bath to about 80 percent w/w wet pickup. After the resin bath, the cloth was introduced into the predryer stage where some of the aqueous solution was removed. Temperatures in the predryer averaged about 250 0 F. Once predried, the cloth was calendered, stretched, and steamed to final dimensions. Then the cloth was introduced into the loop dryer-curing ovens. At this point, temperatures reached over 300 0 F for curing of the resin. Again, the residence time was short but was longer than in the drying stages, about 4 minutes. The process was enclosed and ventilated. In this process, with the combination of heat and residence time, the lubricants commonly used in knitting evolved from the knitted cloth as a smoke which was visible in the curing oven. After the completion of curing, the cloth was ready for inspection and movement into the warehousing area. The second method for finishing knitted cloth used at this plant was a process known as open-width finishing. Since knitted cloth is produced in a tubular form, the cloth had first to be cut lengthwise and stretched, forming the more normal cloth appearance. The cloth then entered the finishing line. Initially, the cloth was drawn through the pad box as was the case in the tubular knit process. However, once this was completed, the cloth entered a machine that combined the predryer, dryer, and curing oven into one continuous step. At the end, the cloth was ready for inspection and removed to the warehouse. The machine was commonly known as a tenter frame or more simply "frame." The temperature gradient in the one-step process began at approximately 2500 F and rose about 1000 F before the curing was completed. Although these temperatures were somewhat higher than those found in the tubular finishing process, the residence time was reduced by one-half to one-quarter of that required in the tubular finishing.

EVALUATION	
Domain	Metric
Domain 1: Reliability	
Metric 1:	Methodology
	High NIOSH Study

Continued on next page ...

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Study Citation:	Bendix Corp, (1979). BCME formation and detection in selected work environments.				
HERO ID:	8727394				
Conditions of Use:	Incorporation into an article - Finishing agent in Textiles				
Domain		Metric	EVALUATION Rating		Comments
Domain 2: Representativeness					
	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	High	The report is for an occupational scenario (textiles) within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	Study was implemented in 1976 - more than 20 years old	
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity					
	Metric 6:	Metadata Completeness	High	NIOSH Study that clearly documents its data sources.	
Domain 4: Variability and Uncertainty					
	Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted	
Overall Quality Determination			High		

Study Citation: Bendix Corp, (1979). BCME formation and detection in selected work environments.	
HERO ID: 8727394	
Conditions of Use: Incorporation into the formulation - Other chemical preparation manufacture	
EXTRACTION	
Parameter	Data
Process description:	Plant F Hospital burn centerThe product of this process was a gel pad which was used in the treatment of burn victims. Because of the plastic properties of the gel, it was exceptional in allowing burn victims to rest body weight on sensitive tissue comfortably without hindering thehealing process. Because the gel pad was not presently availablefrom commercial sources, this laboratory was charged with the production of these pads for use in the burn ward of the hospital.The process required to make this product was very much batch-oriented. A typical batch yielded one large pad and several small pads and required about 5 days of processing. Approximately 3,500 ml of deionized water was placed into a stainless steel container v/hich was placed into a hot water bath set to approximately 90° C. Before the deionized water was heated significantly, 400 grams of polyvinyl alcohol were added, and themixture was slowly stirred. When the initial charge of polyvinylalcohol was almost completely dissolved, another 500 grams of polyvinyl was added. This charge was added to 1,600 ml of cold water and was then added to the heated mixture slowly while it was being stirred. The mixture was stirred for 2 to 3 hours while it was heated. When the solution became clear, the mixture was ready for the next step. Up to this point, one person was required. Most of the operations were essentially monitored. No environmental controls were used. The hot, clear mixture vias then taken off the water bath and moved into a hood. With stirring, 4 pints of formalin solution (37 percent formaldehyde), 24 ml of hydrochloric acid, and food coloring were added. This was done as quickly as possible with a fast stirring rate. Once these items were added and the food color appeared to be evenly mixed, the mixture was placed into a large, flat-bottomed, olive -oil-coated pan. The pan was covered with plate glass and placed into an oven se~ to 71° C. The gel pad was cured for 2 to 2-1/2 hours. Upon removal, the pad was placed into a large pan containing cool tap water. Water from the tap was circulated through the pan continuously for 24 hours.Once the pad had been rinsed for 24 hours, it was moved to another larger rinsing pan where water containing 3 percent urea in propylene glycol was washed over the pad. This was conducted for 3 days. The pads were then dried, cut to size as needed, and heat-sealed in polyethylene bags.
EVALUATION	
Domain	Metric
Domain 1: Reliability	Rating
Metric 1:	Methodology
	High NIOSH Study
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Metric 3:	Applicability
	High US
Metric 4:	Temporal Representativeness
Metric 5:	Sample Size
	High The report is for an occupational scenario (manufacture of medical supplies) within the scope of the risk evaluation.
	Low Study was implemented in 1976 - more than 20 years old
	N/A This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	High NIOSH Study that clearly documents its data sources.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	N/A This metric is not applicable to the data being extracted
Overall Quality Determination	
High	

Study Citation:	Benn, R.A., Dutton, A.A., Tully, M. (1972). Disinfection of mechanical ventilators: An investigation using formaldehyde in a Cape ventilator. Anaesthesia 27(3):265-277.			
HERO ID:	6146425			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Process description:	Formaldehyde vapor has been used as a disinfecting agent for mechanical ventilators. In the original method from 1960s, the ventilator circuit was exposed for 8 hours to vapor from a solution of formaldehyde heated in the humidifier. The authors used an experimental technique in which the has from a separate generator was circulated in a cabinet in which the ventilator was placed in open circuit. The system used for the ‘cabinet technique’ was designed by Vickers (Medical) Ltd for the disinfection of equipment which cannot be subjected to conventional sterilization techniques. The metal disinfection cabinet used in the experiments had an internal diameter of about 1 m3 and was connected by flexible plastic tubing to a gas generating console. Each stage of the operation was automatically controlled and timed. Twenty ml of an appropriate solution of formaldehyde was totally evaporated in the generator and the gas was recirculated for a preselected time through the cabinet and ventilator. There was no connection between the inspiratory and expiratory ports of the ventilator during these experiments and the humidifier was empty. There was no bag at the patient Y-piece and formaldehyde vapor entered the ventilator both at the inspiratory port and at the patient-end of the expiratory part of the circuit. The gas was exhausted to the open air from the exhaust outlet on the console, and fresh air was introduced into the system. Residual formaldehyde was neutralized by circulating ammonia generated from a 1 in 3 dilution of 0.88 ammonia and exhausted. A ventilating cycle was then operated for one hour. Formaldehyde was circulated by running the ventilator at a tidal volume of 1 liter and a frequency of 20 ‘breaths’ per minute.			
Chemical concentration:	20 mL of 18 % formaldehyde (w/v) solution were evaporated in the console. The formaldehyde concentrations attained in the empty cabinet were between 0.3 and 0.9mg/L. The higher early peak levels fell sharply and, after 20 minutes, formaldehyde concentrations at all points remained around 0.4 mg/L. The formaldehyde levels obtained by evaporating undiluted solution and assaying from two sites within the ventilator circuit as well as at the cabinet sites were between 0.5 and 1.7 mg/L. Ventilator concentrations remained below 1 mg/L after 20 minutes and in the cabinet following early plot levels after 40 minutes.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Low	report is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium		

Study Citation:	Bernstein, R. S., Stayner, L. T., Elliot, L. J., Kimbrough, R., Falk, H., Blade, L. (1984). Inhalation exposure to formaldehyde: an overview of its toxicology, epidemiology, monitoring, and control. American Industrial Hygiene Association Journal 45(11):778-784.			
HERO ID:	180103			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Approximately 5.2 billion pounds of HCHO were consumed in 1983 in the manufacture of more than 29 types of products (including printing materials, textiles, brake linings, paint pigments, plastic moldings, cosmetics, fumigants and disinfectants) and in the performance of medical services. About 50 percent of the HCHO produced is used to make HCHO-based resins for adhesives in the manufacture of particleboard, fiberboard and plywood. Since 1970, urea formaldehyde foam insulation in over 1 million homes.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Betts, W. D. (2000). Tar and pitch. :1-31.			
HERO ID:	8486216			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Process description:	Cresylic acid are used in phenol-formaldehyde resins; Naphthalene has been used in condensation products from naphthalene sulfonicacids, utilizing formaldehyde as additives to improve the flow properties of concrete (pdf pg. 25)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report is from a frequently used source (Kirk-Othmer).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	Report covers occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	More than 20 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Binding, N., Witting, U. (1990). Exposure to formaldehyde and glutardialdehyde in operating theatres. International Archives of Occupational and Environmental Health 62(3):233-238.			
HERO ID:	1222786			
Conditions of Use:	Use of Cleaning and Furniture Care Products			
EXTRACTION				
Parameter	Data			
Chemical concentration:	0.5-3.0%			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	journal article
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	data pertain to a COU
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1990)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by giving multiple values of concentrations based on the type of product used but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Blade, L. M. (1996). James River Corporation, Packaging Business Greensburg, Indiana HETA 93–0670–2557 January 1996.			
HERO ID:	8048989			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	”In the printing department, mat boards, which are resin-coated matrix boards, are cured in fivemold-making machines at elevated temperatures, and thereby are hardened. Once hardened, the molds can be used to make rubber printing plates, which are affixed to the rollers of printing presses and used to print labels onto plastic films used in packaging. The ””K–6 Mat Boards,”” which are primarily composed of phenolic resin and paper, are cured in one particular mold-making machine. In the bag making department, plastic films are heat–sealed on 58 automated bag machines to make plastic bags for packaging. This process creates air contaminants, including a visible smoke, during normal operation. (4/37)”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for plastic and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Blair, E.B., Bretherton, W.W., Tull, A.H. (1972). A method to render unstained mycobacterial smears safe for storage or shipment. Applied Microbiology 23(4):826.			
HERO ID:	6163980			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Air-dried concentrates on slides were exposed for 10 min in a closed container to fumes from a 1:10 aqueous dilution of 37% formaldehyde solution. Exposure of air-dried smears or 10 min to fumes from 10% formaldehyde resulted in negative cultures from all slides.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	report is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Bono, R., Munnia, A., Romanazzi, V., Bellisario, V., Cellai, F., Peluso, M.E. (2016). Formaldehyde-induced toxicity in the nasal epithelia of workers of a plastic laminate plant. Toxicology Research 5(3):752-760.				
HERO ID:	3420607				
Conditions of Use:	Plastic Manufacturing				
EXTRACTION					
Parameter	Data				
Process description:	The decorative laminate sheet produced in this plant is made of melamine and phenolic resins reacting with FA during the thermosetting process. The resins are laminated onto layers of kraft paper topped with a decorative sheet.				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1: Methodology	High	Source is peer reviewed so likely contains high quality data.		
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data is for Italy, an OECD country.		
	Metric 3: Applicability	High	Data is directly applicable for use of formaldehyde in producing plastic products		
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old (2016).		
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted		
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumption		
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted		
Overall Quality Determination		High			

Study Citation:	Brandt-Rauf, P. W., Fallon, L. F., Jr, Tarantini, T., Idema, C., Andrews, L. (1988). Health hazards of fire fighters: Exposure assessment. Occupational and Environmental Medicine 45(9):605-612.			
HERO ID:	64686			
Conditions of Use:	Firefighting			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Reported concentration ranges for combustion byproducts at fire sites for formaldehyde: 1 to 15 ppm. NIOSH/ACGIH TLV-TWA for formaldehyde is 1 ppm and and the current OSHA PEL is 3 ppm and OSHA acceptable ceiling concentration is 5 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium		

Study Citation:	Breum, N.O., Orhede, E. (1994). Dilution versus displacement ventilation: Environmental conditions in a garment sewing plant. American Industrial Hygiene Association Journal 55(2):140-148.			
HERO ID:	1317514			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Process description:	Formaldehyde is a major component in resins used to treat cotton fabric for shrink-resistant and crease characteristics. Treated fabrics usually contain some residual formaldehyde and off gassing may occur during subsequent processing. Fabric treatment systems may be divided generally into precure and postcure systems.<1 2) In postcure systems the final polymerization does not take place until the garment is manufactured. In precure systems, the final polymerization of the resin takes place in the finishing plant, and there is little residual formaldehyde. Cotton fabrics used in the garment sewing plant were precured.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for fabric, textile and leather products not covered elsewhere, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1994)	
	Metric 5: Sample Size	N/A	Not applicable - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - process description.	
Overall Quality Determination		High		

Study Citation:	Breysse, P. A. (1980). Small plants and their medical problems – the furniture industry: The environmental problems of urea-formaldehyde structures – formaldehyde exposure in mobile homes. NIOSH(NIOSH):56-64.			
HERO ID:	1322359			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	manufacture of a variety of commercial products, themost significant of these involves the production of phenolic, melamine and urea formaldehyde resins (1). Formaldehyde is also used in agriculture, for chemical analysis, in concrete and plaster, in cosmetics and deodorants, in disinfectants andfumigants, in dyes, in hydrocarbon products for leather tanning, in paper manufacture, in photography, in solvents and plasticizers for rubber production, in starch, in wood, in textiles and in embalming fluid. It is also a product of combustion found in automotiveexhaust and in cigarette smoke.			
Process description:	Particle board and chipboard are formed by impregnating wood chips or sawdust with a synthetic resin, usually urea-formaldehyde, and subjecting the mixture to high pressure.Plywood is produced by bonding various layers of wood veneer with a synthetic adhesive under increased temperature and pressure. More than 95% of the hardwood plywoodproduction utilizes urea-formaldehyde as the bonding agent (6). In addition, some of the finishes that are applied to the plywood panels may also contain formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data published by NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative information
Overall Quality Determination			High	

Study Citation:	Broline, B. M., Adams, R. A., Schmidt, R. G. (2002). Phenol-formaldehyde resin emulsions as wood adhesives. :23-29.			
HERO ID:	2864865			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Process description:	In a typical preparation, phenol, formaldehyde, water, and a surface-active agent are treated with base and the resole is advanced at elevated temperatures (70° to 100°C) to the desired molecular weight. The reaction mixture is then neutralized with acid to a pH below 9 at which point the resole separates from the solution and a stable emulsion or dispersion is formed as a white liquid.			
Throughput:	Adhesive resin was applied at 0.04 lb/ft2.			
Chemical concentration:	Resin was 5% phenol-formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Canada (an OECD country) and the U.S.
	Metric 3:	Applicability	High	Data are for adhesive and sealant chemicals used in wood products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Broline, B. M., White, I. (2001). Spray-dried resins for wood. :475-477.
HERO ID:	5950843
Conditions of Use:	Adhesives in wood product manufacturing

EXTRACTION

Parameter	Data
Production, import, or use volume:	50,000 metric tons of UF, PF, and MF resins per year globally
Process description:	Fundamentally, spray drying involves the atomization of a liquid resin into a heated air stream. The spray dryer must be designed to minimize resin advancement (the increase of molecular weight) during the drying process. The four major components of a spray dryer are the drying air supply, the liquid resin atomizer; the drying chamber; and the product recovery system. Figure 1 shows a schematic flow diagram for a spray dryer and the components are briefly discussed. Drying Air SupplyThis component of the spray dryer involves a filter for the inlet air and an air heater. The heating of the air is generally accomplished via a gas burning. The heated air is mixed with the atomized resin and then passed through the drying chamber. The product and air are separated via a cyclone; the product is collected. Resin AtomizationResin atomization involves the conversion of the liquid resin into separated liquid droplets. The energy for this process can be imparted to the liquid stream by a variety of methods. In practice, there are three methods that have been employed for this process. The first, and most widely used, method to produce the resin droplets for drying is centrifugal force. This involves impinging the resin flow on a rotating disk. The disc can contain vanes, or other devices, to channel the flow to the edge of the disk. The revolution of these disks can be many thousands of revolutions per minutes with edge velocities of the disk reaching hundreds of meters per seconds. In general, rotary atomization has the advantage that resin feed pressure is lower than other atomization methods. In addition, this method provides more homogeneous products. A second method to achieve resin atomization is the use of a spray nozzle. This method involves pumping the resin through a rotating nozzle. The sudden pressuredrop on exiting the nozzle forces the liquid into many droplets. This method involves higher feed pressures than the rotary method described and provides a coarser and less homogeneous product. Also, nozzle plugging can be a problem when using this method of atomization. The final method for resin atomization is a kinetic process in which the liquid resin stream and the drying air are impinging on one another in a nozzle. The mixing can occur inside the nozzle (internal mixing) or outside the nozzle (external mixing). Variation of the fluid flows to the nozzle can modify the product size and shape. These atomizers provide more homogeneous products than the spray nozzle method, but suffer from nozzle blockage problems and relative high feed pressure for the liquid resin. As mentioned above, the rotary, or centrifugal, methods are generally used for resin powdered resin production. Drying ChamberThis is the largest component of the spray dryer. The size of the drying chamber will determine the residence time for the resin droplet and the ultimate capacity of the spray dryer. The drying of the resin droplet in the chamber is a two-step process. The first stage of the drying process occurs as the resin droplet leaves the atomizer and contacts the drying air: As evaporation occurs, a skin is formed on the surface of the droplet. At this point in the process, the surface of the droplet is saturated with moisture and the evaporation occurs at a constant rate. The temperature of the droplet at this stage in the process is essentially constant due to evaporative cooling. The second stage of the drying process occurs when the moisture level of the droplet is no longer sufficient to maintain a saturated surface. At this point, the remaining moisture in the droplet diffuses to the surface at a rate dependent on the thickness and porosity of the particle shell. This is also the point of the process where particle heating occurs. There is insufficient moisture for evaporative cooling to maintain a constant temperature and particle heating occurs. At this point, the dried droplet is removed from the drying air. Product RecoveryThe final step in the spray drying of resins is recovery of the product. As the flow exits the drying chamber, it consists of a mixture of the dried resin particles and moist air. The separation of the dried particles should be accomplished as soon as possible to minimize the amount of moisture that is transferred back into the dried particles. This separation is accomplished via cyclones, bag filters, or electrostatic precipitators.
Chemical concentration:	Typical liquid phenol formaldehyde (PF) resins for OSB contain approximately 50 percent water. Powdered resins, however generally contain greater than 95 percent resin solids.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			

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Study Citation:		Broline, B. M., White, I. (2001). Spray-dried resins for wood. :475-477.		
HERO ID:		5950843		
Conditions of Use:		Adhesives in wood product manufacturing		
Domain		Metric	EVALUATION Rating	Comments
	Metric 2:	Geographic Scope	Medium	PV data are based on global values which include OECD and non-OECD countries.
	Metric 3:	Applicability	High	Data are for adhesive resins, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	No sample data. Process description is the main information from the article.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Brown, S.K. (1990). Hydrolysis and durability of urea formaldehyde foam insulation. Polymer Degradation and Stability 27(2):121-143.			
HERO ID:	5971289			
Conditions of Use:	Building/construction materials – wood and engineered wood products; Building/construction materials not covered elsewhere			
EXTRACTION				
Parameter	Data			
Number of sites:	Used as insulating foam in 500,000 houses in US and 500,000 in Great Britain.			
Chemical concentration:	0.05-.35% w/w			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	the assessment or report uses high quality data and/or techniques	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Great Britain and the USA	
	Metric 3: Applicability	High	an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old	
	Metric 5: Sample Size	N/A	# of sites and Concentration data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumption	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Report provides only limited discussion of the variability and uncertainty	
Overall Quality Determination		Medium		

Study Citation:	Bruno, E., Somma, G., Russo, C., Porozej, D., Pietroiusti, A., Alessandrini, M., Magrini, A. (2018). Nasal cytology as a screening tool in formaldehyde-exposed workers. Occupational Medicine 68(5):307-313.			
HERO ID:	4471271			
Conditions of Use:	pathology and anatomy laboratories			
EXTRACTION				
Parameter		Data		
Process description:		formaldehyde is commonly used in fixation and preservation of the tissues		
Chemical concentration:		formalin (aqueous solution of 40% formaldehyde)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S. (Italy), and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
		Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
		Metric 5: Sample Size	N/A	Information is qualitative.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			High	

Study Citation:	Bruze, M., Almgren, G. (1988). Occupational dermatoses in workers exposed to resins based on phenol and formaldehyde. Contact Dermatitis 19(4):272-277.			
HERO ID:	1222793			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The laminate was built up of several layers of Impregnated paper sheets. The core consisted of papers Impregnated with phenol-formaldehyde resins, with resol resins based on phenol and formaldehyde the most common. The outer paper layer was Impregnated With melamine- formaldehyde resins (M-F-R). In varnishing machines, paper from rolls passed through a resin bath, which was filled from a closed system. The Impregnated paper then moved through a drying zone and was subsequently cut into sheets of appropriate size. The possible exposure of the workers to P-F-R at this stage occurred during cleaning of the machines or if the paper roll was accidentally broken. The next part of the process was stacking the Impregnated sheets of paper to achieve the desired laminate thickness. This was done manually by several workers and their hands were continuously exposed to uncured P-F-R. Following this step, curing took place in a press at a certain temperature, pressure, and time. Finally, the post-lamination processing of the product involved sawing, cutting and inspection steps, which were associated with skin exposure to dust from the laminate.			
Comments:	This data source pertains to the industrial use of resins based on phenol and formaldehyde (P-F-R) and melamine- formaldehyde resins (M-F-R) for the manufacture of decorative equipment by the impregnation of paper sheets with these resins.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1988)
	Metric 5:	Sample Size	N/A	Not applicable - process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - process description.
Overall Quality Determination			High	

Study Citation:	Bufalino, L., Albino, V.C., Sa, V.A., Correa, A.A., Mendes, L.M., Almeida, N.A. (2012). Particleboards made from Australian red cedar: Processing variables and evaluation of mixed-species. Journal of Tropical Forest Science 24(2):162-172.			
HERO ID:	1956861			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Commercial urea formaldehyde adhesive: 6-9%			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Brazil, a non-OECD country.
	Metric 3:	Applicability	High	Data are for adhesives and sealants in construction, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on current industry conditions and data no more than 10 years old. (2011)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Burkhart, J. E. (1995). Health hazard evaluation report No. HETA-95-0162-2536, RCA Rubber Company, Akron, Ohio. :95-0162.				
HERO ID:	1317129				
Conditions of Use:	Rubber Product Manufacturing				
EXTRACTION					
Parameter	Data				
Process description:		Rubber flooring is manufactured at RCA Rubber by blending materials (clay, color additives, activators, and rubber) in Banbury mixers, transferring the material through a series of mills (dump mills, break-down mills, and jelly roll mills), pressing the material into sheets in a calendar, and finally curing the flooring in presses. After the flooring is cured in the presses, it is transported to the finishing department, then sent for packaging and shipping.			
EVALUATION					
Domain		Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH HHE	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	1995 - more than 20 years old	
	Metric 5:	Sample Size	N/A	This report provided qualitative information	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Process description.	
Overall Quality Determination			High		

Study Citation:	Burkhart, J. E., Jennison, E. A. (1994). Health hazard evaluation report no. HETA 92-0297-2396, Exxon Chemical Company, Pottsville Film Plant, Polyethylene Film Department, Mar-Lin, Pennsylvania.
HERO ID:	3970604
Conditions of Use:	Incorporation into an article- Plastic and Rubber Products

EXTRACTION	
Parameter	Data
Process description:	Resin pellets produced at an Exxon facility in Baton Rouge, Louisiana, are usually shipped to the Pottsville plant by rail. Color concentrate and pellets made of recycled plastics arrive by truck. Recycled materials have been used in the plant for about a year and a half. The bulk handlers deliver the resin pellets by forklift to each of the ten blown film machines. There are two electric and ten propane forklifts in the polyethylene department. Pellets are gravity-fed into most machines, except for those on the upper level to which pellets are airpumped. Once in the machine, a combination of heat and pressure is used to melt the pellets. The machine is heated to 350oF and heat from friction raises the temperature of the molten resin to about 410oF. The molten material is then extruded through a die which has a chilled air ring. As this occurs, the material takes the shape of a bubble. This is a continuous sheet of polyethylene which ranges from 20-40 feet high depending on the machine set-up. On the five older machines (P-Line), the bubble air cools. The five new machines (500 Line) have a cooling stack inside the bubble. At the top of the polyethylene sheet is a series of rollers which collapse the bubble. The polyethylene then passes through another series of rollers where it receives an electrostatic charge which roughens the surface to allow it to accept printing ink applied by the customer. The air gap for this charge is 1/16 of an inch. The polyethylene tube is then slit to make two polyethylene sheets, which are then wound on a cardboard core. Any excess from the trimming process is returned to the extrusion area to be re-used. The machines located on the upper level operate in the same manner except that the melting and extrusion occur on the upper level and the slitting and winding occur on the lower level.
Number of sites:	Study investigated 1 site.

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses sound methods that are from frequently used sources (NIOSH HHEs) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The report is for an occupational scenario (plastic and resin manufacturing) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5: Sample Size	N/A	process description
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	process description

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Study Citation:	Burkhart, J. E., Jennison, E. A. (1994). Health hazard evaluation report no. HETA 92-0297-2396, Exxon Chemical Company, Pottsville Film Plant, Polyethylene Film Department, Mar-Lin, Pennsylvania.		
HERO ID:	3970604		
Conditions of Use:	Incorporation into an article- Plastic and Rubber Products		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Burr, G. A., Richardson, F. D. (1988). Health Hazard Evaluation Report HETA 87-250-1888, GTE Products Corporation, Williamsport, Pennsylvania, April 1988.			
HERO ID:	1989341			
Conditions of Use:	Processing aid			
EXTRACTION				
Parameter	Data			
Life cycle description:	designs and develops custom products for the computer andcommunications industries. SEM modules are designed and built for private system contractors and the U.S. Navyfor use in ships, submarines, and airborne and ground support installations. Site manufactures over 460 differentmodule types in designs ranging from simple, discrete components to complex memory, microprocessor types.			
Process description:	The Standard Electronic Module (SEM) assembly and testing area operations include part preparation, surface mounting, solder assembly, solder touch-up and repair, quality assurance, and final inspection. SEM operations which have the greatest potential for generating airborne contaminants are wave soldering, automatic (belt-fed) vapor degreaser (using Freon* 113), and numerous manual solder touch-up stations.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data from frequently used source (NIOSH HHE).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old
	Metric 5:	Sample Size	N/A	qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources (NIOSH IH site visit and site interviews)
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Extracted information is site-specific, not applicable for addressing variability or uncertainty.
Overall Quality Determination			High	

Study Citation:	Burroughs, G. E. (1978). Health Hazard Evaluation Determination, Report No. HE 77-32-459, Conalco, Hannibal, Ohio.		
HERO ID:	1878249		
Conditions of Use:	Use of metal products		
EXTRACTION			
Parameter	Data		
Process description:	Conalco Aluminum Rolling mill in Hannibal, Ohio produces aluminum rolls and plates from impure aluminum blocks. There are basically three steps involved: 1) production of aluminum alloys from raw material, 2) hot and cold rolling, and 3) finishing. The article provides descriptions of these steps. In addition to production operations, some maintenance employees are potentially exposed to toxic substances. Various welding and painting operations are performed, and these are sources of metal fume and solvent vapor exposure. the exact compound depending on the composition of the metal being welded or the paint being sprayed.		
Chemical concentration:	Formaldehyde - OSHA: 3 ppm, 5 ppm ceiling; NIOSH: 1 ppm ceiling, 30 minutes; TLV: 2 ppm ceiling		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium	

Study Citation:	Burroughs, G. E., Thomasino, J. (1976). Health Hazard Evaluation Report No. 75-145-327, Formica Corporation, Cincinnati, Ohio.			
HERO ID:	1317290			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The Formica Corporation manufactures laminates by bonding several layers of resin-impregnated paper under pressure. Most of the resin used by the company is produced on site in their resin plant, located in a separate building adjacent to their main manufacturing plant, by combining formaldehyde, phenol, melamine, and various catalysts, inhibitors, carriers, and minor reactants. These resins are piped to the filler treating area -of the manufacturing plant, where they -are used to impregnate kraft paper either by spray or immersion. The impregnated paper is cut into four-by-eight foot sections to form filler sheets.Large pallets of filler sheets are taken successively to the filler sorting area, the collating area, and the press build-up area. Depending on the type of laminant being prepared, workers count out varying numbers of these filler sheets, pile them on a second pallet, add a cover sheet printed in the graining room with some pattern, possibly add a layer of material to give a special effect~ then add a separator sheet and repeat the process for successive layers. When a load of material is assembled in this manner, it is placed in a press where the sheets of each layer are bonded to one another to produce the laminate, with the separator sheets creating non-bonding barrier between laminates.			
Number of sites:	1			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (laminates manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1976 - more than 20 years old
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative, site-specific information provided
Overall Quality Determination			High	

Study Citation:	Burton, N. C., Hall, R., Kinnes, G., Todd, W. (1993). Health hazard evaluation report No. HETA-92-090-2296, General Castings Toledo Street Facility, Delaware, Ohio. :92-090.
HERO ID:	1320875
Conditions of Use:	Use of Adhesives and Sealants

EXTRACTION	
Parameter	Data
Process description:	At the time of the site visit, the company was producing gray iron from one furnace while the other furnace was being repaired.The furnaces were totally relined with a silica refractory each year. Metal scrap yards were located both inside and outside the facility.The metal pouring operation was performed on the day shift in two open areas inside the facility using stationary molds (large mold and small mold pouring). The metal was manually poured using the ladle fly-wheel. Overhead crane systems were used to position the ladles for pouring in both the small and large mold pouring areas. The molds were allowed to cool in the location where they were poured. A mold provides the cavity into which the metal is poured to produce a casting; a core is used to define the internal hollows desired in the casting. There were two coremaking areas: the smallcore room and the large coremaking area. Cores were made by hand and by machine. In the small core room, oil-based cores were baked in a gas-fired oven. In the large coremaking area, cores and molds were made of a phenolic-formaldehyde binder mixed with silica sand in an automatic mixer. A polymeric methylene phenylene diisocyanate (MDI) was used as the binder catalyst. The no-bake binders used were PEPSET I®, PEPSET II®, and PEPSET III®. Crane hoists were used for lifting small molds. A "blue dip primer" containing isopropanol, magnesium silicate, titanium oxide, and xylenes was utilized to seal the cores and molds after forming. The molds and cores were set afire to burn off the residual isopropanol in the primer to form a smooth surface. Compressed air was used to remove excess sand in the coremaking and molding departments.The metal castings were shaken out of the molds while still hot (referred to as "shakeout") on second and third shifts. A large shaker table was moved into the center of the large pouring area.Castings were lifted to the top of the shaker table using the overhead cranes and shaken out. For certain castings, compressed air was used to remove excess sand from internal cavities.Sledge hammers were also used to manually remove sand from the castings. A sand reclamation system with a side draft exhaust hood was used. Two Bobcat® front-end loaders were used to load the sand reclamation system and shake out some of the castings. The castings were loaded unto flat bed trucks, using cranes and chain hoists, and transported to another facility owned by the company for cleaning. Brooms were used to clean up excess dry sand throughout the facility.
Throughput:	the plant used two coreless electric channel furnaces which operated at 1500 kilowatts with a melt rate of 60 tons per day.
Number of sites:	1

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High The assessment or report uses high quality data and/or techniques or sound methods thatare from frequently used sources (NIOSH study)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High US
	Metric 3:	Applicability	High The report is for an occupational scenario (foundry/ use in adhesives/binders) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low 1992 - more than 20 years old
	Metric 5:	Sample Size	N/A Mostly Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty			

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Study Citation:	Burton, N. C., Hall, R., Kinnes, G., Todd, W. (1993). Health hazard evaluation report No. HETA-92-090-2296, General Castings Toledo Street Facility, Delaware, Ohio. :92-090.				
HERO ID:	1320875				
Conditions of Use:	Use of Adhesives and Sealants				
			EVALUATION		
Domain	Metric		Rating	Comments	
	Metric 7:	Metadata Completeness	N/A	Qualitative information provided	
Overall Quality Determination			High		

Study Citation:	Burton, N. C., McCullough, J. (2002). Health hazard evaluation report 98-0237-2872 Mueller Company Chattanooga, Tennessee April 2002.			
HERO ID:	667639			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Process description:	Bags of resin-coated sand (phenol-formaldehyde base with hexamethylenetetramine) are loaded into a sand hopper which feeds sand into the machine. The unit turns upside down and is heated to 450°F, creating a hard shell. Loose sand is shaken into the hopper. The complete cycle takes about five to seven minutes. The machine opens, and the core sis checked for flaws, and a water-based graphite core wash is applied . The core wash generates steam when applied to the hot cores. The green sand operation consists of an automated filling station, a conveyor system on which the molds are assembled, a conveyor pouring line, and a conveyor cooling line that leads to shake-out. The Pepset process uses an organic binding system containing an alkyd polyester, Stoddard solvent, polycyclodiene, 1,2,4-trimethylbenzene, dimethylethanolamine, 4,4'- diphenylmethane diisocyanate (MDI), polymethane polyphenyl isocyanate, xylene, a manganese compound, and a zinc compound. A heptane, talc, and mica-based coating is used. The resin is automatically added to the sand in the hopper. Recycled sand is used in this process. A three-part chemical system is used to produce the cores. Part I consists of a phenolformaldehyde based resin. Part II contains MDI, petroleum naphtha, and trimethylbenzene; and Part III is a drying agent which contains trimethylbenzene, xylene, and cumene. Recycled sand is used in this process. Pre-heated resin-coated sand is applied at the beginning of the conveyor system followed by a white Zircon™ wash. The box is turned over and goes through an infrared (IR) heater. Pepset cores into the bottom of the box and then add the top and close. Excess sand is removed using compressed air. Molds are lined up for the pouring.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (coremaking/molding operations) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1999 - more than 20 years old
	Metric 5:	Sample Size	N/A	Qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information derived from site visit
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	Burton, N. C., Monestersky, J. (1996). Health hazard evaluation report 96–0135–2612 Eagle Knitting Mills, Inc. Shawano, Wisconsin December 1996.			
HERO ID:	1320760			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Process description:	From the storage area, the material is moved to the staging area where it is pulled out of its protective bag and allowed to sit for at least a half-day before cutting. In the cutting department, the fabric is taken to either automatic spreading machines or to tables on which the fabric is hand-laid to match stripes. Occasionally, solvent-based adhesives are used to glue the pattern pieces in place. A band saw or straight knife is used to cut fabric and a rotary saw is sometimes used to cut elastic pieces. The cut pieces go to the bundling area where they are sorted into buckets (20 to 50 pieces depending on the garment to be made). Tote carts are used to transport the buckets to the sewing area. The sewing department utilizes a variety of machines, including three-thread, single-needle, multi-needle, flat-bed hemmer, pocket setter, tacker, labels, button-holer, snap, and needle-nose. The machines used vary, depending on the garment being produced. To reduce the size of needle marks in the fabric, a solution of silicone lubricant, fabric softener, and water is used on the material. The completed garments are taken to the finishing department, where they are inspected for things such as stitching, loose threads, matching stripes, spots, and stains. There are two spotting stations, used to remove stains from the garments, located adjacent to the sewing department. These spotting stations are used as needed. A heat press is used occasionally for fusible pella fabric. After inspection, the garments are folded and packed to ship to the customer. (page 10-11 of 32)			
Chemical concentration:	See Table 2 on page 23 of 32: Formaldehyde content of fabrics Interlock (berry red) 110 ug/g Lycra (charcoal) ND Flat Back Rib (Copenhagen) 920 ug/g Interlock (ivory maple leaf) 120 ug/g Interlock (red) 57 ug/g Fleece (gray) 89 ug/g Rib (navy) 160 ug/g Lycra (berry flora) 33 ug/g Jersey (banana) 68 ug/g Stripe (red and ivory 2x2) 160 ug/g Jersey (gray) 47 ug/g			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH study - AATCC test method 112-1993	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The report is for an occupational scenario (garment fabrication) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	1996 - more than 20 years old	
	Metric 5: Sample Size	High	Results from sampling of the formaldehyde content of individual fabrics were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed by NIOSH method using AATCC test method 112-1993	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Information provided was derived from NIOSH site visit.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Results from sampling of the formaldehyde content of individual fabrics were provided which could be used to evaluate variability between fabrics. Uncertainty was not discussed but assumed that it was addressed by NIOSH method using AATCC test method 112-1993	
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Study Citation:	Burton, N. C., Monestersky, J. (1996). Health hazard evaluation report 96–0135–2612 Eagle Knitting Mills, Inc. Shawano, Wisconsin December 1996.		
HERO ID:	1320760		
Conditions of Use:	Use of fabric, textile and leather products		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	California Office of Environmental Health Hazard Assessment (OEHHA) (2014). Appendix D: Individual acute, 8-hour, and chronic reference exposure level summaries.			
HERO ID:	5155603			
Conditions of Use:	Uses			
EXTRACTION				
Parameter	Data			
Life cycle description:	Formaldehyde has four major applications: as an intermediate in the manufacture of melamine, polyacetal, and phenolic resins; as an intermediate in the production of industrial chemicals; as a bactericide or fungicide; and as a component in the manufacture of end-use consumer products. Phenol-formaldehyde resins are used in the production of plywood, particleboard, foam insulation, and a wide variety of molded or extruded plastic items. Formaldehyde is also used as a preservative, a hardening and reducing agent, a corrosion inhibitor, a sterilizing agent, and in embalming fluids. Indoor sources include upholstery, permanent press fabrics, carpets, pesticide formulations, urea-formaldehyde foam insulation, and cardboard and paper products. Outdoor sources include emissions from fuel combustion (motor vehicles), industrial fuel combustion (power generators), oil refining processes, and other uses (copper plating, incinerators, etc.). The largest portion of outdoor ambient formaldehyde results from photochemical oxidation of a number of reactive organic gases in the atmosphere			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report is from California office of environmental health so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is applicable to multiple COUs, primarily manufacturing, processing, and industrial uses.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Carvalho, de, A. B., Kato, M., Rezende, M. M., Pereira, d.P., P. A., Andrade, de, J. B. (2013). Exposure to carbonyl compounds in charcoal production plants in Bahia, Brazil. Environmental Science and Pollution Research 20(3):1565-1573.			
HERO ID:	1454536			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Brazil is the largest wood charcoal producer at 5 million tons (2009)			
Life cycle description:	Reactant: charcoal production			
Process description:	The charcoal production process consists of burning wood, usually Eucalyptus or Pinus varieties that are grown on plantations, in an oxygen-poor environment in brick kilns. The rudimentary brick kilns have several small orifices and lateral exhaust chimneys (stacks). The kilns are usually devoid of any system for controlling or eliminating the emission of smoke into the atmosphere. Briefly, the production process consists of four primary activities: (1) tree cutting, (2) filling the kilns, (3) combustion (carbonization) of wood in the kilns, and (4) removal of the charcoal. The wood combustion process takes up to 7 days in these types of kilns, and it varies according to the size of the kiln and the density and freshness of the wood. The carbonization process is completely dependent on the knowledge of a worker (kiln burner), who examines the color and the amount of smoke to assess the stage of combustion. The emission of smoke is more intense during the beginning of the burning process, and a blue and transparent smoke indicates the conclusion of the carbonization process. At that time point, the oxygen content in the kiln is gradually reduced by covering the kiln orifices with pieces of brick and clay as the pyrolysis progresses. When the carbonization is complete, the kiln workers manually remove the charcoal. Manually loading wood and unloading charcoal are still the standard procedure in most parts of the country.			
Number of sites:	2			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Sampling or analytical methodology is not specified, though it was noted that samples were collected using Sep-Pak C18 cartridges coated with a 0.2 % acidic solution of 2,4-dinitrophenylhydrazine. The quantification of the resulting 2,4-dinitrophenylhydrazone derivatives was conducted using a high-performance liquid chromatography system with UV detection.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Brazil - not an OECD member
	Metric 3:	Applicability	Medium	The data are for charcoal production, which is an occupational scenario within the scope of the risk evaluation - but the processes used in rural Brazil may not be similar to the industry in the US.
	Metric 4:	Temporal Representativeness	High	The data were published in 2012, after the most recent PEL (1992) and less than 10 years old.
	Metric 5:	Sample Size	N/A	Extracted data not catharized by this metric
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
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Study Citation:	Carvalho, de, A. B., Kato, M., Rezende, M. M., Pereira, d.P., P. A., Andrade, de, J. B. (2013). Exposure to carbonyl compounds in charcoal production plants in Bahia, Brazil. Environmental Science and Pollution Research 20(3):1565-1573.			
HERO ID:	1454536			
Conditions of Use:	Processing as a reactant			
		EVALUATION		
Domain	Metric	Rating	Comments	
	Metric 7: Metadata Completeness	Medium	The report addresses variability but information about uncertainty was not provided.	
Overall Quality Determination		Medium		

Study Citation:	Casteel, S. W., Vernon, R. J., Bailey, E. M. (1987). Formaldehyde: Toxicology and hazards. Veterinary and Human Toxicology 29(1):31-33.			
HERO ID:	1314633			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	US produces about 7 billion lbs of FA each year.			
Life cycle description:	FA used primarily in the production of urea-, phenol-, acetal-, and melamine- formaldehyde resins. Remainder is used to make other industrial chemicals, leather products, agricultural products, and to prepare vaccines, drugs, disinfectants, and fumigants. FA based resins are used as adhesives in making plywood, veneers, and particleboard, and in the production of plastics, textiles, insulating materials, paper and rubber products.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is applicable to production of FA and exposure to FA in homes.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1987).
	Metric 5:	Sample Size	Low	Primarily qualitative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Only contains PV data, life cycle, and some area sampling data.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation: Ceballos, D., Boradwater, K. (2015). Evaluation of occupational exposures at a drycleaning shop using SolvonK4.				
HERO ID: 8684521				
Conditions of Use: Dry cleaning solvent				
EXTRACTION				
Parameter	Data			
Process description:	Fabrics, including clothes, drapes, and other textiles, were received from customers, labeled, and sorted for cleaning. Prior to dry-cleaning, some stained fabrics were pre-cleaned or spot cleaned. The shop used several spot-cleaning agents including a custom mixture of 40% SolvonK4, 40% PrenettK4™, and water or undiluted Greased Lightning® Super Strength cleaning product. The dry-cleaning machine cleaned fabrics by saturating them with SolvonK4 in enclosed drums. The cleaning cycle was 70 to 80 minutes. Cleaning additives (e.g., ClipK4™ detergent and PrenettK4 spotting agent) were automatically injected into the solvent flow line or into the drum of the dry-cleaning machine. At the end of the cleaning cycle, the solvent was automatically removed by draining and then heating and tumbling the cleaned fabrics under vacuum to remove any that remained. Employees manually spot-cleaned fabrics that were still stained or soiled after dry-cleaning with the same products used in precleaning. Employees pressed the cleaned fabrics and ironed as needed, then hung them on hangers covered with plastic wrapping while awaiting customer pick-up or delivery. (5/22)			
Throughput:	The shop dry-cleaned 20–40 loads per week. (7/22)			
Chemical concentration:	Bulk analysis of SolvonK4 revealed that this solvent contained more than 99% butylal, 0.05% butanol, and less than 0.00045% formaldehyde. (9/22)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Uninformative	Data are for dry-cleaning solvents, which isn’t included in the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (concentrations) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology in the study. Variability addressed by sampling multiple locations and different job operations.
Overall Quality Determination		Uninformative		

Study Citation:	Ceballos, D., Roberts, J., Whittaker, S., Lee, E. G., Gong, W. (2015). Evaluation of occupational exposures at drycleaning shops using SolvonK4 and DF 2000.			
HERO ID:	8684520			
Conditions of Use:	Laundry and dishwashing products			
EXTRACTION				
Parameter	Data			
Process description:	In the shops that we evaluated, the drycleaning machines had enclosed drums where the fabrics being cleaned were saturated with the drycleaning chemical. In all the alternative solvent drycleaning machines we observed in this evaluation, any cleaning additives (e.g., detergent, stain repellant) were injected into the solvent flow line or into the drum of the drycleaning machine (in contrast to an older method that involved predissolving the detergent in the solvent). When the cleaning cycle was complete, the solvent was drained, and the cleaned fabrics were placed under vacuum, heated, and tumbled to remove any remaining solvent. Employees could manually spot-clean fabrics that were still stained or soiled after drycleaning, using the same products used in precleaning. The cleaned fabrics were pressed (Figure 1) and ironed as needed, then hung on hangers and covered with plastic wrapping awaiting customer pick-up.Modern drycleaning machines prevent the release of solvent vapors to ambient air by recycling the solvent in a closed loop system and automatically evacuating the air in the cleaning chamber before the machine is opened. The heated solvent vapors generated during the drying cycle pass through a refrigerated condenser [LHWMP 2014a]. The condenser cools the air and condenses the solvent vapor to be recovered. Recovered solvent is then pumped into a vacuum still. This distillation process prevents impurities from building up in the solvent. Steam coils in the still heat the solvent to boiling. The solvent vapors flow through a condenser to removewater. This process also generates a concentrated waste material called “still bottoms” that contains residual solvent in addition to nonvolatile components, such as detergent, sizing, waxes, oils, and greases. After the drycleaning machine has cooled (usually overnight), the still bottoms are manually transferred to a waste container (Figure 2) with a specially designed rake, usually by the shop owner. Depending on the volume of drycleaning processed in a shop, the still bottoms are removed every 1–2 weeks.(pg. 8)			
Chemical concentration:	The drycleaning SystemK4 developed by Kreussler GmbH uses SolvonK4, a chemical that contains primarily butylal (> 99%), with small amounts of n-butanol (< 0.5%) and formaldehyde (< 0.05%). (pg. 7) NIOSH analyzed bulk sample of SystemK4 and measured 0.007% (pg. 12)			
Comments:	In addition, additional process information is given on drycleaners but extracted only for site that used formaldehyde containing product.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for laundry and dishwashing products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old (data collected in May 2013).	
	Metric 5: Sample Size	Medium	A sample was taken for concentration but only 1 sample so variability in formaldehyde content is not addressed.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	This metric is not applicable to the data being extracted	
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Study Citation:	Ceballos, D., Roberts, J., Whittaker, S., Lee, E. G., Gong, W. (2015). Evaluation of occupational exposures at drycleaning shops using SolvonK4 and DF 2000.		
HERO ID:	8684520		
Conditions of Use:	Laundry and dishwashing products		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Ceballos, D.M., Whittaker, S.G., Lee, E., Roberts, J., Streicher, R., Nourian, F., Gong, W., Broadwater, K. (2016). Occupational exposures to new dry cleaning solvents: High-flashpoint hydrocarbons and butylal. Journal of Occupational and Environmental Hygiene 13(10):759-769.
HERO ID:	3421340
Conditions of Use:	Use of laundry and dishwashing products

EXTRACTION	
Parameter	Data
Process description:	Fabrics, including clothes, drapes, and other textiles, are received from customers, labeled, and sorted for cleaning. Prior to dry cleaning, stained fabrics may be pre-cleaned or “pre-spotted.” Many different spot cleaning agents are used in the shops. These products are formulated according to the types of stains to be removed (i.e., hydrophilic or hydrophobic stains). Modern dry cleaning machines use enclosed drums where the fabrics being cleaned are saturated with the dry cleaning solvent. Cleaning additives (e.g., detergent, sizing or fabric finishes, and stain repellent) are injected into the solvent flow line or into the drum of the machine (in contrast to an older method that involved predissolving the detergent in the solvent). When the cleaning cycle is complete, the solvent is drained, and the cleaned fabrics are placed under vacuum, heated, and tumbled to remove any remaining solvent. In our evaluations the duration of the dry cleaning cycle for SolvonK4 and DF- 2000 machines was 70–80 min. Workers can manually spot-clean fabrics that are still stained or soiled after dry cleaning by using the same products used in precleaning. The cleaned fabrics are pressed (Figure 1) and ironed as needed, then hung on hangers and covered with plastic wrapping awaiting customer pick-up. Modern dry cleaning machines like the ones we evaluated minimize the release of solvent vapors to ambient air by recycling the solvent in a closed loop system and evacuating the air in the cleaning chamber before the machine is opened. The heated solvent vapors generated during the drying cycle pass through a refrigerated condenser. The condenser cools the air and condenses the solvent vapor to be recovered. Recovered solvent is then pumped into a vacuum still. This distillation process prevents impurities from building up in the solvent. Steam coils in the still heat the solvent to boiling. The solvent vapors flow through a condenser to remove water. This distillation process generates a concentrated waste material called “still bottoms” that contains residual solvent in addition to nonvolatile components such as detergent, sizing, waxes, oils, and greases. After the machine has cooled (usually overnight), the still bottoms are manually transferred to a waste container (Figure 2) with a specially designed rake, usually by the shop owner. Depending on the volume of dry cleaning processed in a shop, the still bottoms are removed every 1–2 weeks.
Number of sites:	36,000 commercial dry cleaning shops

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			

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Study Citation:	Ceballos, D.M., Whittaker, S.G., Lee, E., Roberts, J., Streicher, R., Nourian, F., Gong, W., Broadwater, K. (2016). Occupational exposures to new dry cleaning solvents: High-flashpoint hydrocarbons and butylal. Journal of Occupational and Environmental Hygiene 13(10):759-769.
HERO ID:	3421340
Conditions of Use:	Use of laundry and dishwashing products

		EVALUATION	
Domain	Metric	Rating	Comments
	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination	High

Study Citation:	Celanese Corp, (2020). Comment submitted by Stephanie Daigle, Vice President, Government Affairs, Celanese Corporation regarding the draft scope of the risk evaluation for formaldehyde.		
HERO ID:	10370219		
Conditions of Use:	Multiple: Manufacture, Processing as a formulation, mixture, or reaction product- Plastic Compounding		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	less than 500 million lbs (less than 0.5%) were POM, global annual POM production exceeds 1,000 kiltons (pg. 3)		
Life cycle description:	POM copolymer (from formaldehyde-derived compounds) products are used in automobiles, medical devices, specialty consumer products, and a variety of other high-value applications (pg. 2)		
Process description:	Production processes include oxidation of methanol to formaldehyde; reaction of formaldehyde to form trioxane, dioxolane, and paraformaldehyde; polymerization of the formaldehyde-derived chemicals into POM; and formation of the polymers into pellets or flakes.Die face and underwater cutting are generally enclosed processes used for highest volume manufacturing. Lower volume production may also use strand cut systems, which force the polymer out of a die to create strands that are quickly pulled through a water bath and chopped to pellets. Most of this low-volume strand cutting occurs outside of enclosures...as the polymer is extruded, the strands are directed through water baths, which both solidify the polymer and absorb any formaldehyde emissions. Most POM polymer as pellets to customers who process those pellets directly into products or parts. A small portion is shipped in a flake form that is provided to processors who may add their own colorants or additives in an extrusion process(pdf pg. 5)		
Chemical concentration:	Residual formaldehyde in specialty is low, at approximately 100 mg/kg, or 0.01% by weight. Celanese specialty polymers contain less than 1 ug/cm2 (pdf pg. 12)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5: Sample Size	Low	Chemical concentration is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		Medium	

Study Citation:	Celanese Corp, (2022). Comment submitted by Celanese Corporation regarding characterization of occupational exposures during formaldehyde manufacturing, use as an intermediate, and compounding of formaldehyde-based polymers.			
HERO ID:	10385727			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Celanese’s Bishop, Texas plant manufactures >300 kt/yr of formaldehyde. [PDF Pg. 4]			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			High	

Study Citation:	CEPE, (2020). SpERC Fact Sheet: Industrial application of coatings by spraying.			
HERO ID:	10442901			
Conditions of Use:	Industrial Use of Paints and Coatings			
EXTRACTION				
Parameter	Data			
Throughput:	Typical maximum daily usage, for any one substance, based on sector knowledge 1000 kg product/day at any one location. Also includes amounts based on chemical function (pg. 2/5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report is from the EU and is generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country(EU) other than the U.S.
	Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation but information is not specific to formaldehyde. Information is collected in general for the industry.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	Medium	Characterized by a maximum with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results and assumptions. For extracted data, data sources or justification are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by providing different values based on chemical function, but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	CEPE, (2020). SpERC Fact Sheet: Professional application of coatings and inks by spraying.			
HERO ID:	10442902			
Conditions of Use:	Use of Paints and Coatings			
EXTRACTION				
Parameter	Data			
Throughput:	Typical maximum daily usage for any one substance, based on sector knowledge- 100 kg product/day. Includes estimates based on function.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report is from the EU and is generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country(EU) other than the U.S.
	Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation but information is not specific to formaldehyde. Information is collected in general for the industry.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	Medium	Characterized by a maximum with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results and assumptions. For extracted data, data sources or justification are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by providing different values based on chemical function, but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Chaharsoughi, M. A., Najafi, S. K., Behrooz, R. (2019). Formaldehyde emission from PVC-wood composites containing MDF sanding dust. Journal of Vinyl and Additive Technology 25(2):159-164.			
HERO ID:	5970712			
Conditions of Use:	Incorporation into Article- Wood composites			
EXTRACTION				
Parameter		Data		
Production, import, or use volume:		Production and consumption of wood-based panels are growing as a promising position in the wood industry. For example, the amount of particleboard and MDF that were produced in the world in 2013 are about 99.3 million m3 and 88.2 million m3, respectively		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Production volume data is cited to FAO, FAO Yearbook of Forest Products 2009–2013, FAO, Rome (2013). This is not a frequently used source but no associated information indicates flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is cited from study authored in Iran, a non-OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Chauvel, A., Delmon, B., Hölderich, W. F. (1994). New catalytic processes developed in Europe during the 1980s. Applied Catalysis A: General 115(2):173-217.
HERO ID:	5640288
Conditions of Use:	Processing

EXTRACTION

Parameter	Data
Process description:	Processes involving formaldehyde include the following: (A) Name - Methacrylic acid/methyl methacrylate (MMA-) process, Raw materials - ethylene + CO/H ₂ + formaldehyde, Product - methyl methacrylate, Originality - (1) hydrocarbonylation of ethylene to propionaldehyde, (2) condensation with formaldehyde to methacrolein, (3) oxidation to methacrylic acid, (4) esterification with methanol; (B) Name – Citral process, Raw materials – isobutene, formaldehyde, Products – citral, intermediate for ionone, carotins, vitamine A, Originality - cheap, easily available starting materials oxidation with O ₂ . In the BASF methacrylic acid/methyl methacrylate (MMA-) process, ethylene, syngas, formaldehyde and methanol are used as starting materials for the production of MMA. In the first step of this process, ethylene is hydroformylated to propionaldehyde in the presence of a Rh/Co-triphenylphosphine at 130 degC approximately and 15 bar. In a following Mannich-condensation, propionaldehyde is condensed with formaldehyde in an adiabatic reactor to form methacrolein in high yields above 90%. This reaction is carried out at 160-210 degC and 45-50 bars in the presence of dimethylamine in acetic acid. In the third step, methacrolein is oxidized with oxygen in the gas phase over a heterogeneous catalyst in a fixed bed reactor. The methacrylic acid is isolated and sold or is converted to MMA with very high yield in a classical acid catalyzed esterification with methanol. The BASF process has the favorable advantage of cheap easily accessible raw materials; however, there is a need for integrated production site to make the process more profitable. The BASF process for manufacturing citral starting from isobutene and formaldehyde is a noteworthy and outstanding example of the use of molecular oxygen in the synthesis of fine and intermediate chemicals. The BASF route starts from comparatively cheap isobutene and formaldehyde. In this condensation reaction, 3-methyl butene-3-01 (isoprenol) is formed. A part of this alcohol is isomerized in the process. The notable central step in this new process is the regioselective oxidation of this alcohol to the corresponding aldehyde over a special supported silver catalyst in the gas phase. This is the key precursor for citral manufacture developed by BASF researchers. In a continuous flow reactor at 500°C and a residence time of about 0.001 s, isoprenol is transformed in the presence of excess of oxygen to the temperature sensitive isoprenal with 95% yield. In order to keep the residence time short and to avoid hot spots, the reaction has to be carried out in a short fixed bed reactor. In a following Cope-rearrangement citral is formed from isoprenol and isoprenal. This example demonstrates nicely that even temperature-sensitive fine chemicals such as isoprenal can be produced in a commercial unit operating in the gas phase with molecular oxygen as oxidant.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5: Sample Size	N/A	Process Description
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Report clearly documents its data sources.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Process Description

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Study Citation:	Chauvel, A., Delmon, B., Hölderich, W. F. (1994). New catalytic processes developed in Europe during the 1980s. Applied Catalysis A: General 115(2):173-217.		
HERO ID:	5640288		
Conditions of Use:	Processing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	CHEMetrics, (2018). Safety Data Sheet (SDS): Chlorine CHEMets and ULR CHEMets refills.			
HERO ID:	11328018			
Conditions of Use:	Other (chemical substances in products not described by other codes): Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Chemical concentration:	0.1-0.2 %[weight]			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses sound methods that are not from frequently used sources (e.g., European Union or OECD reports, NIOSH HHES, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The report is for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4:	Temporal Representativeness	High	The report is less than 10 years old.
	Metric 5:	Sample Size	N/A	SDS
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	N/A	SDS
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	SDS
Overall Quality Determination			High	

Study Citation:	Cheney, J. E., Collins, C. H. (1995). Formaldehyde disinfection in laboratories: Limitations and hazards. British Journal of Biomedical Science 52(3):195-201.
HERO ID:	5942015
Conditions of Use:	Disinfectant

EXTRACTION	
Parameter	Data
Process description:	Describes process for disinfecting a laboratory

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from the UK, an OECD country.
	Metric 3: Applicability	Uninformative	Data are for a FIFRA use which is not in-scope or similar to an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	Only qualitative data provided.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination	Uninformative

Study Citation:	Chrisope, D.R., Rogers, P.E. (1995). Chemical safety - Formaldehyde, sodium-hydroxide hazard. Chemical & Engineering News 73(2):2-2.			
HERO ID:	5970016			
Conditions of Use:	Industrial Use			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	20mM of formaldehyde is present in Monsanto’s system. (1/1)			
Chemical concentration:	Monsanto manufactures, ships, and stores solutions of organic acid sodium salts that initially contain residual formaldehyde levels of 300-700 ppm and NaOH at about 1.5 weight %. (1/1)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for industrial use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	Chrostek, W. J. (1985). Health hazard evaluation report: HETA-84-392-1597 - Syntex Dental Products, Inc., Audubon, Pennsylvania.			
HERO ID:	1317246			
Conditions of Use:	Use of Paper Products			
EXTRACTION				
Parameter	Data			
Process description:	Approximately one-half of the building is occupied by offices and research while the other half is occupied by packaging and light manufacturing of dental equipment and supplies. Formaldehyde was measured in carbonless paper used at site, which is why formaldehyde was measured at the site.			
Number of sites:	1			
Chemical concentration:	A sample of the carbonless paper was collected to determine if formaldehyde was present. This sample was analyzed according to the Burlington Industries standard test for latent formaldehyde. The paper contained approximately 120 micrograms of latent formaldehyde per gram of bulk sample.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses sound methods from frequently used sources (NIOSH Study)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (use of carbonless paper) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1984 - 85 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	Low	Only one sample taken for formaldehyde concentration of paper
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability is not applicable as this is site-specific data but uncertainty in formaldehyde concentration in the paper is not discussed.
Overall Quality Determination		Medium		

Study Citation:	Chrostek, W. J. (1984). Health hazard evaluation report: HETA-83-261-1448. Rolling Hill Hospital, Elkins Park, Pennsylvania. 83-261-1448:1-12.			
HERO ID:	5096596			
Conditions of Use:	Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Process description:	Human tissue, removed during an operation, is examined visually and sent to the laboratories where it is mounted on slides and examined microscopically for tissue and cellular structure. The areas of concern were the Gross Pathology Laboratory, where tissue is preserved in a formalin solution with a phosphate buffer prior to visual examination, and the Cytology and Histology Laboratories where organic solvents are used in the preparation of slides for microscopic evaluation. (4/12)			
Chemical concentration:	Tissue is preserved in a 10% formalin solution. (4/12)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (concentrations) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

General Engineering Assessment

HERO ID: 1316339 Table: 1 of 1

Study Citation:	Clark, R.P. (1983). Formaldehyde In Pathology Departments. Journal of Clinical Pathology 36(8):839-846.			
HERO ID:	1316339			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	60,000-145,000 (tonnes)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from the United Kingdom, an OECD country.
	Metric 3:	Applicability	Uninformative	Data are for manufacture, an in-scope occupational scenario. but the throughput is for UK.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Uninformative		

Study Citation:	Clausz, J.C., MacIntyre, B.A., Malone, E.S., Twelmeyer, J.M. (1984). Atmospheric formaldehyde levels in an academic laboratory. Journal of Chemical Education 61(4):A121-A123.			
HERO ID:	5964008			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Chemical concentration:	"Formaldehyde is a readily polymerizable gas which is commercially available as a 37-50% aqueous solution and may contain up to 15% methanol to inhibit polymerization." (1/3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Reference simply states commercially available concentration of formaldehyde.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the use of laboratory chemicals, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty
Overall Quality Determination		Medium		

Study Citation:	Co, H.F. (1996). Initial submission: Letter from HB Fuller Co to USEPA regarding employee exposure to UCAR Latex 379, dated 04/03/96.			
HERO ID:	4113789			
Conditions of Use:	Paints and coatings (automotive coating)			
EXTRACTION				
Parameter	Data			
Chemical concentration:	0.1% (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for paints and coatings, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	concentration data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	concentration data
Overall Quality Determination			Medium	

Study Citation:	Cocalis, J. C., Rao, C. Y., Kestenber, K. A., Martin, J. E. (2001). Health Hazard Evaluation Report 2000-0098-2862, Robinson Run Mine, Shinnston, West Virginia, July 2001.		
HERO ID:	8016652		
Conditions of Use:	Other- Byproduct of Biocide in MWF		
EXTRACTION			
Parameter	Data		
Process description:	The Robinson Run mine uses the continuous and longwall methods to mine coal from the 7.5-16 foot thick Pittsburgh coal seam. Continuous miners are used to develop entryways for the longwall panel. The longwall panel is a 1000 foot wide passageway whose roof is supported by 98 hydraulic shields. A track mounted, chain driven shearer with a rotating drum takes a 2-foot deep cut from the seam of coal as it moves up and down the 1000-foot face. The shearer is equipped with water sprays that are used for dust suppression. The cut coal falls onto a panline and is transported to the headgate (fresh air entry point to the longwall panel). At the headgate, the coal passes though a stage loader and onto abeltline where it is transported out of the mine along a fresh air entryway. The longwall panel is ventilated with approximately 60,000 cubic feet per minute of fresh air that passes from headgate to tailgate. The longwall sections are associated with high relative humidity (i.e., >70 percent) during the summer months as a result of intake air being cooled to mine temperature (about 70-74 degrees Fahrenheit dry bulb during the summer) and as a result of water sprays being applied as a dust suppressant at the shearer and along the beltline.		
Throughput:	Solcenic HL concentrate was delivered, at 3-5 week intervals, in 5,000-gallon truckloads to an 8,000- gallon tank that is located in a surface building. The dilution ratio is 24 parts water to one part Solcenic HL concentrate. The 4-percent emulsion is piped from the surface by gravity feed some 3.5 miles into the mine to replenish losses in a closed loop system.Based on a estimated annual delivery of 65,000 gallons of concentrate (one truckload every four weeks) and a dilution rate of twenty four parts water to one part concentrate, approximately 1,500,000 gallons of the diluted emulsion were piped into thehydraulic system in the preceding year		
Chemical concentration:	Solcenic HL is a hydraulic fluid that is mixed into a4 percent emulsion with water during use. The fluid does not contain formaldehyde but contains triazine compound (acts as a biocide by decomposing into formaldehyde).		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The report uses high quality data and/or techniques or sound methods that are from frequently used sources (NIOSH HHEs) and are generally accepted by the scientific community, and associatedinformation does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evalu- ated.
	Metric 3: Applicability	Uninformative	The report is for an occupational scenario that is similar to an occupational scenari- owithin the scope of the risk evaluation, in terms of the type of industry, operations, and workactivities. Rated unacceptable due to function as biocide, which is non-TSCA
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment,and worker activities that are expected to be outdated.
	Metric 5: Sample Size	N/A	Qualitative information
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty			
Continued on next page ...			

Formaldehyde

General Engineering Assessment

HERO ID: 8016652 Table: 1 of 1

...continued from previous page

Study Citation:	Cocalis, J. C., Rao, C. Y., Kestenberg, K. A., Martin, J. E. (2001). Health Hazard Evaluation Report 2000-0098-2862, Robinson Run Mine, Shinnston, West Virginia, July 2001.
HERO ID:	8016652
Conditions of Use:	Other- Byproduct of Biocide in MWF

		EVALUATION		Comments
Domain	Metric	Rating		
	Metric 7: Metadata Completeness	N/A	N/A	

Overall Quality Determination **Uninformative**

Study Citation:	Coggon, D., Ntani, G., Harris, E.C., Palmer, K.T. (2014). Upper Airway Cancer, Myeloid Leukemia, and Other Cancers in a Cohort of British Chemical Workers Exposed to Formaldehyde. American Journal of Epidemiology 179(11):1301-1311.			
HERO ID:	2337789			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Formaldehyde is a major industrial chemical, with total annual production in the United States and Western Europe exceeding 10 million tons.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data is 10 to 20 years old
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability of production or uncertainty in the estimate.
Overall Quality Determination			High	

Study Citation:	Cohen, S., Sparer, J. (1984). Health hazard evaluation report: HETA-82-107-1444 - Torrington Company, Torrington, Connecticut.			
HERO ID:	8637901			
Conditions of Use:	Processing aids, not otherwise listed			
EXTRACTION				
Parameter	Data			
Process description:	High carbon steel wire is fed from large shipping spools into a series of units. During these processes, the wire is cut into cylindrical segments and the coarse edges are shaped according to various design specifications. Then, some of the parts are washed in tumblers with emery for crude reductions in outside diameter. Some parts are sent through another tumbling operation to remove metal burrs. The cylindrical rods and pins are placed in grinding machines which further shape and reduce them to a desired tolerance. (5/29)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	Data are for metalworking fluids, which is similar to the in-scope occupational scenario processing aids not otherwise listed.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	Process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Coleman, R. (1995). Reducing the levels of formaldehyde exposure in gross anatomy laboratories. Anatomical Record 243(4):531-533.			
HERO ID:	1511770			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Process description:	"This is perfused by cannula via the femoral artery using a mechanical pressure pump at 750-1,100 mmHg. The cadavers are closed in polyethylene sheeting and stored in this embalming solution for at least 3 months prior to dissection"			
Chemical concentration:	Embalming solutions are composed of 1 liter of formaldehyde (36-38%).			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Israel, an OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1995)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Cooke, T. F., Weigmann, H. D. (1982). The chemistry of formaldehyde release from durable press fabrics. II. Textile Chemist and Colorist 14(6):33-41.			
HERO ID:	6028034			
Conditions of Use:	manufacture			
EXTRACTION				
Parameter	Data			
Process description:	The reaction of formaldehyde with cellulosic fabrics depends a number of factors, including (1) the reactant composition, (2) the nature and amount of the catalyst, (3) the time and temperature of cure, (4) impurities in the formaldehyde reactant, (5) the condition of the fabric, and (6) the additives to the impregnating bath. The amount of formaldehyde released from the treated fabric will depend on all of these factors plus the effect of rate of hydrolysis, concentration of reactant, free formaldehyde in the impregnating bath, afterwashing of the treated fabric (if carried out) and any aftertreatment of the fabric such as treatment with a compound that will react with formaldehyde.			
Chemical concentration:	no available information			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	data sources not indicated
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium		

Study Citation:	Cooley, R.L., Stilley, J., Lubow, R.M. (1984). Formaldehyde emitted by chemical vapor sterilizers. Oral Surgery, Oral Medicine, and Oral Pathology 57(1):28-30.			
HERO ID:	6201928			
Conditions of Use:	Sterilization			
EXTRACTION				
Parameter	Data			
Process description:	One type of sterilizer that has gained wide popularity is the chemical vapor sterilizer or Chemiclave. It has the advantage of limiting the rusting, dulling, or corroding of metal instruments, which is a big concern in dental offices. The chemical vapor sterilizer uses heat, pressure, and a chemical vapor to achieve sterilization. The chemical solution that produces this vapor is composed of ethyl alcohol, isopropyl alcohol, tertiarybutyl alcohol, methyl ethyl ketone, acetone, and formaldehyde.			
Throughput:	The manufacturer indicates that the Chemiclave vaporizes approximately 15 ml of the chemical solution during a single sterilizing cycle. The first sterilizer averaged 7.7 cycles per day, while the second sterilizer averaged 4.5 cycles per day			
Chemical concentration:	When the condensate of the chemical vapor was analyzed, it was found to contain 2% formaldehyde			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	report uses high quality data and/or techniques or sound methods that are not from a frequently used sources
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Cornitius, T. (1995). Georgia Pacific to boost formaldehyde capacity. Chemical Week 157(12):18.			
HERO ID:	5946887			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter		Data		
Production, import, or use volume:		9,345 million pounds per year produced in the US, on a 37% basis		
Throughput:		110 million pounds/yr at this site in Channelview, TX		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Cornwell, R. (1988). Health Hazard Evaluation Report HETA 88-230-1939, Morgan Shirt Company, Morgantown, West Virginia, December 1988.			
HERO ID:	8140526			
Conditions of Use:	Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The company receives pre-cured, finished fabric from a textile finishing plant. The shirt fabric is treated with formaldehyde-based resins at the finishing plant which give the fabric crease-resistant characteristics, and the resin treated fabric is cured before it is received by the plant. The first step in the process is the cutting of shirt parts from the fabric. Many layers of fabric are spread out, one on top of another, on a long table. All of the layers are cut with handheld saws or with dies. After cutting, the shirt parts are assembled. Most of the various assembly require sewing machines. Some operations make use of heat to form of fuse together parts. The finished shirts are moved to the apparel press operation where conventional hand irons are used to press the shirts. (5/16)			
Chemical concentration:	An 80/20 polyester/cotton blend had 93 ppm formaldehyde. Collar fusing material had 1440 ppm formaldehyde by weight. (15/16)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for finishing agents in textile manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by mentioning the limit of detection. Variability is not addressed.	
Overall Quality Determination		High		

Study Citation:	Cornwell, R. J. (1990). Hazard Evaluation and Technical Assistance Report No. RDHETA-90-145-2086, MAP International, Fairmont, West Virginia.				
HERO ID:	NIOSH:90-145.1317193				
Conditions of Use:	Construction Manufacturing				
EXTRACTION					
Parameter	Data				
Life cycle description:	Fibrous material manufactured is used for thermal and acoustical insulation				
Process description:	Delivery and unloading of raw material (sand, limestone, soda ash feldspar, and borax); transport to storage silos. Mix to form the raw batch that is transported using a screw auger to the furnace for melting. In the furnace the batch is converted to a homogenous mass of molten glass. the molten glass leave the furnace after passing under a skimmer and through the throat, which is below the level of the molten glass. Connected to the throat, is the forehearth which acts as a channel to move the glass into the fiberizer. The glass fiber is produced when the molten glass passes through the fiberizer. Directly under the fiberizers are cooling fins and a spray of water . the water spray is followed by a solution of phenolic resin binder (phenol, formaldehyde) urea, ammonium sulfate, petroleum emulsion, anhydrous ammonia and carbon black. The binder solution is sprayed on the fibers as they are collected on a conveyor belt. The binder solution coasts the fibers for lubrication and protection of the fibers. It also provides for reinforcement and better bonding of the fibers, and gives them a specific handling characteristic. The mat of fibers is then wound onto a rotating cylinder. The rolled mat of fibers may then be removed for storage and drying. For some specific products, additional drying may be necessary. If this is the case the mat is not collected on the rotating cylinder but is passed through a drying oven before being cut. Depending how they are to be used, the mat is either stored and shipped form the plant or are moved to the molding department. The molding department has 3 production lines where the mats are placed in molds and then into a heated press to form the desired item. The items placed on the sterling line are sprayed with a black fire resistant coating.				
Number of sites:	1				
EVALUATION					
Domain	Metric	Rating		Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The reports uses information from a site visit and is from a frequently used source, NIOSH study.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	High	The report is for an occupational scenario (fibrous glass manufacture) within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	1990 more than 20 years old	
	Metric 5:	Sample Size	N/A	This report provided qualitative information	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit, it clearly documents sources and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	This report provided site-specific qualitative information	
Overall Quality Determination			High		

Study Citation:	Correia, V. M., Judd, S. J., Stephenson, T. (1994). Characterisation of textile wastewaters: A review. Environmental Technology 15(10):917-929.			
HERO ID:	6110946			
Conditions of Use:	Textile finishing			
EXTRACTION				
Parameter	Data			
Process description:	Source contains process descriptions for sizing, weaving, desizing, scouring, bleaching, mercerizing, carbonizing, milling, dyeing, and special finishing			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	N/A	Information is qualitative	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.	
Overall Quality Determination		High		

Study Citation:	Cox, J. E. (1985). OSHA reconsidering formaldehyde. ASHRAE Journal 27(9):10.			
HERO ID:	5936914			
Conditions of Use:	MFG; Plastic Material and Resin Manufacturing; Processing as a Reactant; Fabric Finishing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	5.4 billion lbs produced in 1983, 60% used for resin manufacturing, 35% to synthesize other chemicals, 2% for treating textiles and remaining small amounts for consumer products			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for multiple in-scope occupational scenarios.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	PV data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	PV data	
Overall Quality Determination		High		

Study Citation:	Cox, J. E. (1988). Formaldehyde levels reduced. ASHRAE Journal 30(4):16-17.			
HERO ID:	5936917			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Formaldehyde is used: in preparation of adhesive resins for use in the wood-products industry, used as an intermediate in the production of industrial chemicals, and in textile treating.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Report does not specify the data used.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for the processing of formaldehyde, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	No sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Life Cycle description.	
Overall Quality Determination		Medium		

Study Citation:	Cox, J. E. (1988). Formaldehyde levels reduced. ASHRAE Journal 30(4):16-17.			
HERO ID:	5936917			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	In 1985, almost 6 billion lbs of formaldehyde were produced. (2/2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Report does not specify the data used.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for the manufacture of formaldehyde, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	No sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Production data from 1985. No data to address variability and uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Cox, J. E. (1984). Formaldehyde issue is in the air - EPA faces a tough opposing camp. ASHRAE Journal 26(5):8.			
HERO ID:	5951313			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	HCHO, is produced at a rate of approximately six billion pounds per year.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data is for manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	PV data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	PV data	
Overall Quality Determination		Medium		

Study Citation:	Cox, J. E. (1984). Formaldehyde issue is in the air - EPA faces a tough opposing camp. ASHRAE Journal 26(5):8.			
HERO ID:	5951313			
Conditions of Use:	Processing (Resins in wood product manufacturing)			
EXTRACTION				
Parameter	Data			
Life cycle description:	”About half of the production [6 billion lbs/year] is used in resins applied to plywood, particleboard, foam insulation and other materials.”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	Life cycle description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Life cycle description.	
Overall Quality Determination		Medium		

Study Citation:	Cox, J. E., Miro, C. R. (1991). OSHA to lower formaldehyde exposure level. ASHRAE Journal 33(11):14.			
HERO ID:	5936923			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	5.7 billion pounds in 1985			
Life cycle description:	intermediate in producing resins and industrial chemicals, bactericide, fungicide, compound in textile treating			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	Cox, J.E. (1986). Formaldehyde study released - exposure in the workplace is the target of the 4-year investigation. ASHRAE Journal 28(7):8.			
HERO ID:	5936913			
Conditions of Use:	Manufacturing/Commercial Uses			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Produced in the United States at a rate of 9 billion pounds per year.			
Life cycle description:	1) The manufacturing of apparel from fabrics treated with formaldehyde resins2) Residing in conventional and manufactured homes containing construction materials in which formaldehyde resins are used			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	N/A	Life cycle description and manufacturing volume. No sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Life cycle description and manufacturing volume.	
Overall Quality Determination		Medium		

Study Citation:	CPChem, (2002). Initial submission: Ltr fr CPChem to USEPA reporting residual production of formaldehyde in a polystyrene production unit, dated 102402.			
HERO ID:	6574134			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The article is related to residual production of formaldehyde in a polystyrene production unit. Production of formaldehyde from oxidative decomposition of polystyrene at temperatures of about 250 degrees C has been demonstrated in the literature. However, the facility in this article reports formaldehyde production from decomposition of polystyrene in polystyrene production process when the reactor temperature is maintained between 135 degrees C and 155 degrees C, which are far below the temperature expected for.			
Chemical concentration:	During recovery and condensation of un-reacted styrene vapors, a white semisolid residue is deposited in the condenser tubes. A sample of this white material indicated that the material was approximately 30% paraformaldehyde, 68% water, 0.4% styrene, and the remainder being possibly polystyrene. Paraformaldehyde is formed from polymerization of formaldehyde as a result of cooling in the condenser tubes.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment or report uses high quality data and/or techniques.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data.	
	Metric 3: Applicability	High	Report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	Data is between 10 and 20 years old.	
	Metric 5: Sample Size	N/A	No sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Process description and concentration information. No scope to address variability and concentration.	
Overall Quality Determination		High		

Study Citation:		CPSC, (1983). United States Government Memorandum: Completion of surveillance testing of consumer products for formaldehyde emissions.		
HERO ID:		10370055		
Conditions of Use:		Processing		
EXTRACTION				
Parameter		Data		
Life cycle description:		"Formaldehyde (CH20) resins are incorporated in a wide variety of consumer and construction materials. Generic product lints include pressed—wood products, urea—formaldehyde foam insulation (UFFI), fibrous glass insulation, ceiling panels, and non—apparel and apparel textiles." pg. 11/39		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
		Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	Low	Report is over 20 years old
		Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	CPSC, (1982). Investigation of exposure to formaldehyde from preserved biological specimens.			
HERO ID:	6574135			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Process description:	Formaldehyde is the fixative of choice for animal specimens. Animal specimens used for teaching purposes are either pickled by immersion in the formaldehyde solution or embalmed by injection of the formaldehyde solution directly into the body cavity or circulatory system. An estimated 75 percent of all specimens are embalmed. After being “fixed”, specimens traditionally packed in a 3.7% formaldehyde solution, and shipped to teaching laboratories in pails or barrels. The preservation process retards spoilage, permitting ample time for transport of the specimens and for students to work on specimens for the weeks or months necessary to the learning process			
Chemical concentration:	10% formalin (3.7 percent formaldehyde in water) traditionally has been used as a biological tissue fixative. The fixative solution may contain, in addition to formaldehyde and other aldehydes, water, phenol, and alcohol.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data	
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	N/A	Process description and concentration information only.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Process description and concentration information only.	
Overall Quality Determination		Medium		

Study Citation:	CPSC, (1982). Preliminary economic report on the use of formaldehyde in school laboratories.				
HERO ID:	6574136				
Conditions of Use:	Laboratory Chemical				
EXTRACTION					
Parameter	Data				
Process description:	Formaldehyde is manufactured from methanol (methyl alcohol)				
Chemical concentration:	Because gaseous formaldehyde is unstable and difficult to handle, it is usually sold in solution with water. Typically, such a solution contains 35-40% formaldehyde by weight, and is referred to as formalin. Methanol (1-15% by weight) is almost always present in formalin and acts to stabilize the dissolved formaldehyde, which has a tendency to polymerize. Other concentrations, both in and various other alcohols, are available.				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data	
	Metric 3:	Applicability	High	Report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	Data more than 20 years old.	
	Metric 5:	Sample Size	N/A	Process description and concentration.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Process description and concentration.	
Overall Quality Determination			High		

Study Citation:	Crowl, D.A. (1995). Introduction. Environmental Science and Pollution Control Series 15:1-19.			
HERO ID:	664303			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume: 6.98 billion of pounds produced in 1992				
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	No samples
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	No statistics
Overall Quality Determination			High	

Study Citation:	Cuadros, S., Font, J., Izquierdo, F., Cuadros, R.,osa, M., Olle, L., Marsal, A. (2016). Determination of formaldehyde content in leather: Standard EN ISO 17226 (parts 1 and 2), revision and possible improvements. Journal of the Society of Leather Technologists and Chemists 100(4):167-174.		
HERO ID:	5938589		
Conditions of Use:	Incorporation into Article- Leather Tanning; Leather Articles		
EXTRACTION			
Parameter	Data		
Process description:	The retanning process is the main application of formaldehyde in the tanning industry since formaldehyde participates in two groups of synthetic organic tanning agents: syntans and resins. Resins can be hydrolyzed with the result that formaldehyde is released. Thus formaldehyde in leather can be free or from hydrolysis of resins. In the tanning industry, formaldehyde has a wide and variety of applications. Traditionally formaldehyde was used as tanning agent because of its ability to crosslink collagen. However, today there has been mostly replaced by glutaraldehyde and other aldehyde derivatives. In the production of wet-white, formaldehyde still has some application to stabilize the hide before splitting orshaving: "as a preservative, in dilutedversions of certain chemicals in the wet-end andfinishing operations; as fixing agent in protein finishessuch as casein and in the dyeing process of someunfinished leather articles like suede or nubuck and inthe ironing of wool in furriery." "the main causes of itspresence in leather at present are: impurity in syntansand resins (very frequent presence in products of Asianorigin); residue of the fixing operation of proteinfinishes such as casein (rare presence); residue of theironing of wool in furriery (frequent presence) andresidue as preservative in chemicals in the wet-endoperations (frequent presence)."		
Chemical concentration:	[mg formaldehyde/kg article] Table 4 ranges from 27.4-415(HPLC); Table 5 4.7-200(colorimetry); Table 6 13.6-151 (different agitation)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The report uses the standard EN ISO 17226, and also uses a new proposed modification of the method. The article was published in the SLTC journal, so has undergone peer review. Associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from Spain, an OECD country. Leather article used was of german origin.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The report is generally no more than 10 years old (accepted 2015).
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a averages with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Multiple retanning treatments are tested with different resins (low-formaldehyde and high-formaldehyde) but uncertainty is not well characterized.
Overall Quality Determination		High	

Study Citation:	Daftarian, H. S., Roegner, K. C., Reh, C. M. (2000). Health hazard evaluation report 98-0011-2801 Woodbridge Corporation Brodhead, Wisconsin July 2000.
HERO ID:	1317223
Conditions of Use:	Construction Manufacturing

EXTRACTION

Parameter	Data
Process description:	The Woodbridge Brodhead plant produces flexible polyurethane foam cushions for automobile seats. The process involves commonpolyurethane foam chemistry, the core reaction of which is a diisocyanate reacted with a polyol/resin mixture to form a carbamate, commonly referred to as a polyurethane. The diisocyanate used at the plant is the monomeric form of a mixture of 2,4- and 2,6-isomers of TDI. TDI is delivered to the plant by either rail car or tank truck and is offloaded under positive pressure into one of five, 5000-gallon storage tanks.Woodbridge Brodhead operates two production lines: A-line and B-line, both of which are in nearly continuous operation. Each line consists of a chain of heated molds which continuously cyclethrough a series of stations. The stations are as follows: 1) wax application, 2) insert, 3) pourhead, 4) heating/curing oven, and 5) demold. A robot applies the wax to molds on the B-line. On the A-line wax is applied manually. The term “wax dispersion” is used to describe the liquid form in which wax is applied to the mold bowls. The liquid formulation is a wax dispersed in naphtha solvent. The waxdispersion is applied to the bowl of the mold using an air atomization spray gun. The organic solvent evaporates upon contact with the heated mold, leaving a wax residue. This residue prevents the foam cushion from adhering to the mold. In the insert area, components such as metal frames/wires and velcro patches are inserted into the bowl of the mold before it reaches the pourhead. The pourhead is the point where the TDI and polyol components come together and the mixture is dispensed by a robot into the bowl of an open mold. Each of the pourheads is fully automated. The molds close as they move away from the pourhead and into the heating/curing oven, which is maintained at a nominal temperature of 150 degrees Fahrenheit. A mold moves through the oven in four minutes as the foam should fully set. The lid of the mold opens as the mold moves from the oven to the demold area.At the demold work station, the foam cushions are loosened and removed from the molds, trimmed, sorted, inspected, and repaired. The finished foam cushion is then placed on a conveyor belt. Next, the mold is cleaned in preparation for the next cycle.
Comments:	Noted that the source of formaldehyde is within the plant, but actual sources could not be identified.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The study uses high quality data from frequently used source (NIOSH HHE)
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	Low	The data are for an occupational scenario but the source of formaldehyde exposure is unknown. "Thesource of the formaldehyde at the Brodhead plantis unknown at this time."(p. 30) Therefore data cannot be matched with a COU within the scope of the risk evaluation, however it may be suitable for commercial use of building materials
	Metric 4: Temporal Representativeness	Low	1999 - more than 20 years old.
	Metric 5: Sample Size	N/A	This report provided qualitative information
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	This report clearly documents its data sources (IH site visit)
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	This report is site-specific data so variability and uncertainty is not applicable

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Study Citation:	Daftarian, H. S., Roegner, K. C., Reh, C. M. (2000). Health hazard evaluation report 98-0011-2801 Woodbridge Corporation Brodhead, Wisconsin July 2000.		
HERO ID:	1317223		
Conditions of Use:	Construction Manufacturing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Daniels, W., Almaguer, D., Kramkowski, R. (1987). Health Hazard Evaluation Report HETA-86-0343-1822 Sheller-Glose (Allen Industries, Inc.), Herrin, Illinois. ;23.			
HERO ID:	8197552			
Conditions of Use:	Processing-Reactant-Intermediate in-Plastic materials and resin manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	During the reactions which take place during the processing of some phenolic resins, it is possible for formaldehyde to be evolved.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (NIOSH HHEs) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Process description
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty
Overall Quality Determination			Medium	

Study Citation:	Daniels, W., Kramkowski, R. (1986). Health Hazard Evaluation Report HETA 1985-0083-1705 Summit Finishing Company, Inc., Mooresville, Indiana.			
HERO ID:	8684543			
Conditions of Use:	Plating agents and surface treating agents in all other chemical product and preparation manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Prior to electroplating, the surface of the workpiece is thoroughly cleaned with solvent. Acid solutions are used to remove layers of metal oxides, and alkaline solutions are used to remove oils and solids. A water rinse tank is used after the cleaning. During electroplating, an anode, cathode, and electrolytic solution are placed together. The application of a current causes a migration of the metal ions from the electrolyte solution to the cathode where they are deposited onto the base metal. Metal from the anode then dissolves into the solution to replace the metal ions as they are depleted from the electrolyte. (5/25)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for plating agents, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Dement, J. M., Zumwalde, R. D., Parnes, W. (1972). Fibrous Glass Dust and Industrial Hygiene Survey at Pittsburgh Plate Glass Industries, Shelbyville, Indiana.
HERO ID:	1320952
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product

EXTRACTION	
Parameter	Data
Process description:	The Shelbyville plant is one of three fibrous glass plants owned by Pittsburgh Plate Glass Industries and is the only facility manufacturing wool insulation. The other two plants are located inLexington, North Carolina and Shelby, North Carolina. Both of theseplants manufacture fibrous glass textiles (yarns and rovings).Fibrous glass is formed at Shelbyville by either centrifugalfforming or flame-jet forming. Flame jet forming is designated as "Superfine" by the company and centrifugal forming designated "Rotary". There are five superfine lines in this plant and one rotary line.Glass charges for both types of furnaces are mixed in a batchhouse. Boro-silicate glass is made and the raw materials includesand (50%), soda ash (14%), B203(12%), nepheline syanite (12%), fluorspar, rutile, and clay. Rutile is being phased out due to its high cost.Both hand and automatic mixing are used. The major raw materials(sand, etc.) are pneumatically conveyed from storage silos outside the building to the mixer. The minor ingredients are weighed and hand dumped into a mix station where a bucket elevator carries the materials to the mixer. After the raw materials are completely mixed they are either emptied into batch cans for the superfine furnaces or pneumatically conveyed to the rotary furnace.In the flame jet forming process, glass batch is fed into thefurnace where boro-silicate glass is formed at temperatures of approximately 2500°F. After the glass is formed, it is fed into a refractory container known as a forehearth where the glass is held at approximately 2250 F. The glass next flows through platinum bushings in the bottom of the forehearth to form primary fibers of rather large diameter. Upon leaving the forehearth the primary fibers are fed into high velocity gas flame blowers which further attenuate the fibers into desired diameters by a pulling action.As the attenuated fibers move away from the blowers, a phenol-formaldehyde binder is applied by a spraying process. The fibers, which are coated with the uncured binder, are collected on a conveyor, thus forming a continuous blanket.After the glass fiber blanket leaves the forming area, the bindermay be cured or left uncured. Blankets used as home insulation arecured in an oven at temperatures between 400 and 500°F. Blankets used to make molded pipe insulation are left uncured. Home insulation is either cut into bats or rolled onto a cardboard tube following curing. Uncured blankets are rolled and taken to the pipe insulation area for further processing.The only major difference between centrifugal forming and flamejet forming is the method used to form fibers. In the centrifugalfforming process, glass from the forehearth is fed into spinners where centrifugal force is used to force the glass through small holes in the periphery of the spinner thus forming fibers. Upon leaving the spinners, each glass fiber is met by a high velocity air stream which further attenuates the fibers. A phenol-formaldehyde binder is also added at this time. The centrifugal forming process at Shelbyville uses three spinners with a total of 90,000 cfm being drawn through the forming hood. The operations which follow forming are the same as previously mentioned for the superfine process.Molded pipe insulation is made from superfine mats coated withuncured phenol-formaldehyde binder. The mats are cut to length and rolled onto a steel mandrel and then clamped between two forming halves. The assembly is then cured in an oven at 500°F. Following curing, the mandrel is removed, the ends are trimmed, and the insulation cut into halves. Finally a vapor binder is applied to the outer surface and the material packed for shipment.Flexible fibrous glass air ducts are constructed from mats madein the rotary process. In this process, the glass mat is woundaround a steel wire cage and the ends glued together. A polyethylene covering is next slide over the duct. These ducts are next inspected and packaged for shipment. The glue used in this process uses acetone and n hexane as solvents.The final process to be discussed is the manufacture of "textrafinell insulation mats. This process is mainly one of "scrap recovery" although the resulting product is higher in cost than other insulation blankets.In the textrafine process, textile scraps are received from PPG's two North Carolina plants and scraps from this facility are shredded, dried, and baled. These bales are next fed into breakersand blenders similar to those used in textile mills. From the blender, the fibers enter a carding section where the fibers arecombed into parallel position to form a tenuous web. High velocityair is next used to blow a powdered phenolic resin onto the fibers.The fibers, impregnated with resin, are next collected on a conveyor to form a mat and cured in a curing oven. Following curing, the mats are cut and packed for shipment.
Number of sites:	1

EVALUATION	
Domain	Metric
Domain 1: Reliability	
Metric 1:	Methodology
	High NIOSH study
Domain 2: Representativeness	

Continued on next page ...

Formaldehyde

General Engineering Assessment

HERO ID: 1320952 Table: 1 of 1

...continued from previous page

Study Citation:	Dement, J. M., Zumwalde, R. D., Parnes, W. (1972). Fibrous Glass Dust and Industrial Hygiene Survey at Pittsburgh Plate Glass Industries, Shelbyville, Indiana.				
HERO ID:	1320952				
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product				
			EVALUATION		
Domain		Metric	Rating	Comments	
	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	High	The report is for an occupational scenario (glass fiber manufacture) within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	1972 - more than 20 years old	
	Metric 5:	Sample Size	N/A	qualitative information provided	
Domain 3: Accessibility/ Clarity					
	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.	
Domain 4: Variability and Uncertainty					
	Metric 7:	Metadata Completeness	N/A	qualitative information provided	
Overall Quality Determination			High		

Study Citation:	Demir, A., Aydin, I., Ozturk, H. (2018). Formaldehyde Release from Plywood Manufactured with Two Types of Urea Formaldehyde Resins after Fire Retardant Treatment of Veneers. Drvna Industrija 69(2):193-199.
HERO ID:	4741999
Conditions of Use:	FA use in manufactured plywood.

EXTRACTION	
Parameter	Data
Process description:	2 mm-thick rotary cut veneers with the dimensions of 500 mm by 500 mm were obtained from beech, poplar, alder, and scots pine logs. A lab scale rotary type peeler with a max horizontal holding capacity of 800 mm, was used for manufacturing veneer. While the alder and poplar veneers were manufactured from freshly cut logs, beech and spruce logs were steamed for 12 h before veneer production. The main function of steam heating is to soften the veneer log temporarily, making it more plastic, pliable, more readily peeled, and improving the quality and quantity of the material recovered from the log. Therefore, beech and spruce logs were steamed to make easier the rotary cutting, whereas alder and poplar veneers were manufactured from freshly cut logs because alder and poplar logs can be peeled freshly. The horizontal opening between knife and nosebar was 85 % of the veneer thickness, and the vertical opening was 0.5 mm in rotary cutting process. The veneers were then dried to 6-8 % moisture content in a veneer dryer. After drying, veneer sheets were treated with some fire retardant chemicals. For this aim, 5 % aqueous solutions of zinc borate, boric acid, monoammonium phosphate (MAP) and ammonium sulfate were used. The veneers were subjected to re-drying process at 110 °C after they being immersed in the fire retardant solution for 20 min. Three-ply-plywood panels, 6 mm thick, were manufactured by using two types of urea formaldehyde resin with different free formaldehyde ratios. The formulations of adhesive mixtures used for plywood manufacturing are given in Table 2. Veneer sheets were conditioned to approximately 5-7 % moisture content in a climatization chamber before gluing. The glue mixture was applied at a rate of 160 g/m2 to the single surface of veneer by using a fourroller glue spreader. Hot press pressure was 12 kg/ cm2 for alder and beech and 8 kg/cm2 for scots pine and poplar panels, while hot pressing time and temperature were 6 min and 110 °C, respectively. Two replicate panels were manufactured for each test group.
Chemical concentration:	Formulations of Urea-formaldehyde glue mixtures are in Table 2: UF1 free formaldehyde max: 0.16%; UF2 free formaldehyde max: 0.20%

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Source is peer reviewed so contains high quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data is from Turkey, an OECD country
	Metric 3: Applicability	High	Data is applicable to manufacturing of plywood.
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old (2018).
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Addresses variability by looking at two different adhesive mixtures and different types of plywood.

Overall Quality Determination	High

Study Citation:	Dimenstein, I.B. (2009). A Pragmatic Approach to Formalin Safety in Anatomical Pathology. Laboratory Medicine 40(12):740-746.			
HERO ID:	1986504			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Formalin, as formaldehyde’s water solution, became the prevalent fixative in the anatomical pathology laboratory and in embalming in the 20th century. Laboratory practice employs a 10% formalin or 4% formaldehyde water solution. The concentrated water solution (37%–40%) of formaldehyde is called Formalin by its German trade name.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Medium	data is between 10 and 20 years old	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Dixit, S., Yadav, A., Dwivedi, P. D., Das, M. (2015). Toxic hazards of leather industry and technologies to combat threat: a review. Journal of Cleaner Production 87(Elsevier):39-49.
HERO ID:	2952861
Conditions of Use:	Textile Finishing

EXTRACTION

Parameter	Data
Production, import, or use volume:	1.68 x 10 ⁹ m ² of leather made annually around the world (2001)
Life cycle description:	Fig 1 provides all possible technological operations from raw hide to finished product: raw hide → pre tanning (trimming, soaking, liming, unhairing, reliming, fleshing, deliming, bating, scudding, pickling) → pelt → tanning (chrome/vegetable-tanning, basification, piling) → Wet Blue leather → Post tanning operations (sammying, splitting, shaving, re-chroming, neutralization, re-tanning, fat-liquoring, dyeing, setting, drying) → Crust Leather → Finishing operations (conditioning, staking spraying/roller coating, toggling, trimming buffing, measuring, plating/polishing) → finished product.
Process description:	Manufacturing process for leather preparation can be divided into 3 basic sub-processes: preparatory stage/beam house stage, tanning stage and crusting stage. Surface coating may be an addition step into the leather process. Preparatory stage or the beam house operation stage is carried out when the hide/skin is prepared for tanning. This stage includes preservation, soaking, liming, unhairing, fleshing, splitting, reliming, deliming, bating, degreasing, bleaching, pickling and depickling. At the onset, the hides are trimmed and soaked not only to restore the lost moisture during curing but to get rid of salt and other solids. Subsequently, the hides are fleshed to remove excess tissue, muscles or fat adhering to the hide so that uniform thickness may be obtained. Dehairing is performed mostly by liming process using a series of drums containing lime liquors (calcium hydroxide) and sharpening agents, however thermal, oxidative, and chemical methods may also be applied. The softness and flexibility to the leather may be obtained by bating and deliming, which is performed by keeping the hides in a solution of ammonium salt dissolved in water along with proteolytic enzymes at 27-32C. Pickling is required as the next step to adjust the acidity with the use of a brine solution and sulphuric acid. Tanning converts the rawhide or skin into a stable material that dries out to a flexible form without putrefying and becomes suitable for a wide variety of end applications. In general, depending upon the end application of the leather, two tanning methods is used; vegetable tanning or chrome tanning. The process of vegetable tanning usually requires 3 weeks so that the dye penetrates to the hide. Further, the hides are dipped in sodium bicarbonate or sulphuric acid drums for bleaching and for the removal of tannins bound to the surface. Before set out to dry, lagnosulfate, corn sugar and oils may be added to the leather and then it undergoes further finishing steps. Chrome tanning is done by the reaction between the hide and trivalent chromium salt, most commonly basic chromium sulphate. At pH 3 the tanning materials are introduced and the pH is raised. The soaking, fleshing, liming/dehairing, deliming, bating, and pickling and the drying/finishing steps are essentially the same as in the case of vegetable tanning except that an additional processes of retanning, dyeing, and fat liquoring to produce usable leathers. Many a times oil is applied on the skin before leather drying to replace the natural oil lost during beam house and tanyard processes; this step is called fat liquoring. The leather is thereafter wrung, set out, dried, and finished. The pH of chrome tanned leather finish between 3.8 and 4.2. Chrome-tanned leather is more superior to vegetable tanned leather due to its softness, high thermal and water stability and less time consuming. Almost all leather made from the skin of sheep, lambs, goats, pigs is chrome tanned. Crusting takes place after the thinning, re-tanning and lubricating of the hide. Sometimes dye is also added in this process. During crusting, the chemicals added have to be fixed followed by drying and softening process. Crusting involves several steps like wetting back, sammying, splitting, shaving, re-chroming, neutralization, re-tanning, dyeing, fat liquoring, filling, stuffing, stripping, whitening, fixating, setting, drying, conditioning, milling, staking, and buffing. Finishing process consists of surface coating that include: oiling, brushing, padding, impregnation, buffing, spraying, roller coating, curtain coating, polishing, plating, embossing, ironing, combing (for hair-on), glazing and tumbling...”The use of formaldehyde is inevitable in the manufacture of various types of leathers due to its action as cross linker for casein top coats.”
Chemical concentration:	Mandatory residual substance limits in leather products: Germany - >1500 ppm; Austria - >1500 ppm; France - 200-400 ppm; Netherlands - 120 ppm

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			

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Study Citation:	Dixit, S., Yadav, A., Dwivedi, P. D., Das, M. (2015). Toxic hazards of leather industry and technologies to combat threat: a review. Journal of Cleaner Production 87(Elsevier):39-49.			
HERO ID:	2952861			
Conditions of Use:	Textile Finishing			
Domain		Metric	EVALUATION Rating	Comments
	Metric 2:	Geographic Scope	Low	Data is from India, a non-OECD country.
	Metric 3:	Applicability	High	The report is for an occupational scenario, finishing agents for leather, within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data is a mix of information the 90s, 2000s, and 2010s.
	Metric 5:	Sample Size	N/A	Data is qualitative information.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at all the methods of creating leather products and the waste methods. Does not address uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Doane, M., Sarenbo, S. (2014). Exposure of farm laborers and dairy cattle to formaldehyde from footbath use at a dairy farm in New York State. Science of the Total Environment 487:65-71.				
HERO ID:	2402019				
Conditions of Use:	Non-TSCA				
EXTRACTION					
Parameter	Data				
Chemical concentration:	3% formalin footbaths				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	high quality data	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data	
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation	
	Metric 4:	Temporal Representativeness	High	data within 10 years	
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination			High		

Study Citation:	Dong, H., Jiang, L., Shen, J., Zhao, Z., Wang, Q., Shen, X. (2019). Identification and analysis of odor-active substances from PVC-overlaid MDF. Environmental Science and Pollution Research 26(20):20769-20779.			
HERO ID:	5432879			
Conditions of Use:	Use in adhesives (PVC-overlaid MDF)			
EXTRACTION				
Parameter	Data			
Process description:	PVC-overlaid medium density fiberboard (MDF) is one of the commonly used interior materials, and many scholars have studied the release of VOCs from MDF. The basic production parameters for PVC-overlaid MDF are as follows; density – 0.74 g/cm3, hot pressing temperature - 190 deg C, hot pressing time – 60 to 80 seconds, adhesive used			
Chemical concentration:	urea-formaldehyde adhesive, glue amount – 11% for surface layer and 9% for core layer.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics (only provide concentration specification from one site).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		Medium		

Study Citation:	Dorner, F., Berger, D., Mueller, U., Brueggemann, O., Panzer, U. (2012). Rapid determination of formaldehyde emission potentials of binders for the woodworking industry. Holz als Roh- und Werkstoff 70(1-3):299-306.			
HERO ID:	1958703			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Process description: Process description shown in Figure 1 on PDF Pg. 301				
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Austria, an OECD country.	
	Metric 3: Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2012)	
	Metric 5: Sample Size	N/A	Not applicable - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - process description.	
Overall Quality Determination		High		

Study Citation:	Dow Chemical, (2017). [Redacted] Industrial hygiene study: Employee exposure and area air monitoring for formaldehyde during the operation of the twin screw extruder machine in 3113 building, Midland Plant.			
HERO ID:	10602469			
Conditions of Use:	Plastic Converting			
EXTRACTION				
Parameter	Data			
Process description:	Delrin material can release formaldehyde when overheated. The extruder was set to heat the material to 190 degC at the feed port and 210 degC at the die head. This melts the thermoplastic resin and forms it into strands which are cooled in a water bath before being pulled through the pelletizer. (pg 5 of 7)			
Chemical concentration:	Delrin 100P is a thermoplastic resin consisting of polyoxymethylene (POM) and < 0.005% formaldehyde (pg 4 of 7, 2nd paragraph)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The report uses high quality data that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	Low	The data is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, and assumptions. Data sources and methods are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Dow Chemical, (2017). [Redacted] Industrial hygiene assessment of employee exposures to formaldehyde during manufacturing of Dow Corning® IT MQ-1644H Solid Resin in MOD B 2901 Building Dow Corning Midland Plant, Midland MI.			
HERO ID:	10602471			
Conditions of Use:	Plastics material and resin MFG (Degradant)			
EXTRACTION				
Parameter	Data			
Process description:	Dow Corning® IT MQ1644H Solid Resin is manufactured on twin screw extruder in MOD B 2901... Concerns of formaldehyde exposures were raised due to the twin screw operating temperature of 300 F. (pg 3)Solid flake resin (Dow Corning® IT MQ-1644 Solid Resin) is manufactured in Mod B of the 2901 building of the Dow Corning Midland Plant, Midland, MI. The resin is packaged into either 50 lb bags or 1000 lb super sacks... The twin screw extruder is located on the second floor of Mod B in 2901 building. Resin material exits the extruder through an enclosed chute to the bagging operation on the lower floor of Mod B. Bags are filled as the material is generated about one bag every 20-30 minutes. Twin screw operating temperature of 300 F, these higher temperatures may lead to the possible formation of formaldehyde. (pg 4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for plastics material and resin MFG, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	N/A	process description	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Du, Z., Mo, J., Zhang, Y. (2014). Risk assessment of population inhalation exposure to volatile organic compounds and carbonyls in urban China.			
HERO ID:	Environment International 73:33-45.			
Conditions of Use:	2536230			
	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Chinese production 2007, 12,000 kt			
Life cycle description:	65% used to synthesize resins			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Article is from 2014 but the data is from 2007
	Metric 5:	Sample Size	N/A	No samples
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	No statistics, just PV's
Overall Quality Determination			Medium	

Study Citation:	Dugheri, S., Bonari, A., Pompilio, I., Colpo, M., Mucci, N., Arcangeli, G. (2018). An integrated air monitoring approach for assessment of formaldehyde in the workplace. Safety and Health at Work 9(4):479-485.			
HERO ID:	6072310			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	world production is expected to exceed 52 million tons in 2017			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report provides a citation for the data presented
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., though locality-specific factors do not come into play.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Dunky, M. (2004). Adhesives based on formaldehyde condensation resins. Macromolecular Symposia 217(1):417-429.			
HERO ID:	2872373			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	On global basis approximately 15 million tons of formaldehyde-based resins in liquid form are used annually. In Europe approx. 6 million tons in this liquid form are sold, whereby UF resins sum up to approximately 80% of this volume, MUF/MUPF to approximately 10 % and PF to approximately 5 %. Worldwide UF resins climax to approximately 6 million tons per year, based on a usual solid content of 66% of mass (= approx. 10 million tons in liquid form).			
Life cycle description:	Fields of application for the various formaldehyde based wood adhesives resins are as follows: urea-formaldehyde-resin (UF) – a, e, f, g, h (j), i (j); melamine-urea-formaldehyde (MUF) – a (k), e; melamine-formaldehyde-resin (MF)/MUF – b (l), c, e, f, g; melamine-urea-phenol-formaldehyde resin (MUPF) – b, e, f; phenol-formaldehyde resin (PF)/ phenol-urea-formaldehyde resin (PUF) – b, d, e, f. Descriptions of a through l are as follows: a) particleboard according to DIN 68761 (part 1 und 4), DIN 68763 (V20) and EN 312-2 to 4 and-6; b) particleboard according to DIN 68763 and EN 312-5 and 7, option 2 (internal bond after boil test according to EN 1087-1); c) particleboard according to EN 312-5 and 7, option 1 (cycle test according to EN 321); d) hardboard (wet process) according to EN 622-2; e) medium density fiberboard according to EN 622-5; f) plywood according to EN 636 with various resistance against influence of moisture and water; g) blockboard: solid wood panels according to OeNORM B 3021 to B 3023 (prEN 12775, prEN 13353 part 1 to 3, prEN 13017-1 and 2, prEN 13354); h) veneering and covering with foils; i) production of furnitures; j) partly powder resins); k) boards with reduced thickness swelling e.g. for laminate flooring; l) only possible as MUF+PMDI			
Process description:	Formaldehyde based glue resins are built up by the reaction of formaldehyde with mainly urea, melamine or phenol, or some combinations of these three substances.			
Chemical concentration:	Monomer concentrations for PF resins are in the range of < 0.3 to 0.5 mass% for the free formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Dunky, M. (1998). Urea-formaldehyde (UF) adhesive resins for wood. International Journal of Adhesion and Adhesives 18(2):95-107.
HERO ID:	5968910
Conditions of Use:	Urea formaldehyde resin for wood based panels

EXTRACTION

Parameter	Data

Production, import, or use volume:	UF resins are the most important type of the so-called aminoplastic resins. Currently, approximately 6 billion tons are produced per annum worldwide, based on a usual solids content of 66% by mass.
Life cycle description:	UF resins are thermosetting duromers and consist of linear or branched oligomeric and polymeric molecules, which also always contain some amount of monomer. Non-reacted urea is often beneficial to achieve special effects, e.g. better stability during storage. However, the presence of free formaldehyde is ambivalent. On the one hand, it is necessary to induce the hardening reaction. On the other, it causes formaldehyde emission during the press cycle as well as subsequent, displeasing, formaldehyde emission from the pressed boards, a fact that has led to a total change in the formulation of UF resins during the last 20 years. These days the problem of subsequent formaldehyde emission has been solved, at least in Europe, where the most stringent formaldehyde emission regulations in the world exist. Other countries have already followed, will follow or should follow this trend. After hardening UF resins form an insoluble, threedimensional network and cannot be melted or thermoformed again. In their stage of application UF resins are still soluble or dispersed in water or in the form of spray dried-powders, which, in most cases however, are redissolved in water for application.

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Study Citation:	Dunky, M. (1998). Urea-formaldehyde (UF) adhesive resins for wood. International Journal of Adhesion and Adhesives 18(2):95-107.
HERO ID:	5968910
Conditions of Use:	Urea formaldehyde resin for wood based panels

		EVALUATION	
Domain	Metric	Rating	Comments
Process description:	The reaction of urea and formaldehyde is basically a two-step process: usually an alkaline methylation followed by an acid condensation. Methylation refers to the addition of up to three (four in theory) molecules of the bifunctional formaldehyde to one molecule of urea to give the so-called methylolureas. Each methylation step has its own rate constant, k_i with different k_i values for the forward and backward reactions. The reversibility of this reaction is one of the most important features of UF resins, and is responsible for both the low resistance against hydrolysis caused by the attack of moisture or water and the subsequent formaldehyde emission. This is so because emittable formaldehyde results from the slight hydrolysis of weakly bonded formaldehyde. The formation of methylol groups mostly depends on the F/U molar ratio, with higher molar ratios increasing the tendency to form highly methylolated species. Products of side reactions are acetals, hemiacetals and etherified products, with residual methanol always present in small amounts from the production of formaldehyde. The methylol groups are more or less stable in slightly alkaline conditions. Alkaline condensation might also occur to a limited extent, but this is of no industrial importance. Starting the reaction of urea and formaldehyde in the usual molar ratio but under acidic conditions gives methylene-linked ureas which tend to be insoluble in water with ca. five or six urea units. Methyleneureas are used as long-term fertilizers, as neutral fillers and as a white pigment, with some other ideas for industrial and commercial use still being at the development stage. The UF polymer builds up in the acid condensation step: the methylols, urea and free formaldehyde still present in the system react to give linear and partly branched molecules with medium and even higher molar masses. The type of bond between the urea molecules depends on the conditions used: low temperatures and only slightly acidic pH favour the formation of methylene ether bridges (-CH₂-O-CH₂-), while higher temperatures and lower pHs lead to the more stable methylene (-CH₂-) bridges. Ether bridges can rearrange to methylene bridges by splitting off formaldehyde. One ether bridge needs two formaldehyde molecules and it is not as stable as a methylene bridge. Hence it is recommended to avoid such ether groups in UF resins under today's common conditions of low formaldehyde content by virtue of the low final molar ratio of the resins. The acid condensation step itself is still performed at the same high molar ratio as given in the alkaline methylation step (F/U"1.8 to 2.5). Molar ratios lower than ca. 1.8 lead to some precipitation during the acid condensation step, causing inhomogenities in the solutions as well as problems in the determination of the proper endpoint of the reaction by water dilutability or by cloud point. The low molar ratio of the final UF resin is adjusted by the addition of the so-called second urea, which also might be added in several steps. Special knowledge of this step is important for the production of resins with good performance, especially at the low molar ratios usually in use today in the production of particleboards and medium-density fibreboards (MDFs). The production of UF resins is performed in a discontinuous as well as in a continuous way; the latter is useful only for the production of large batches to avoid too often the preparation of off-grade products. The reaction is influenced by several parameters and requires precise control of purity, amount and sequence of addition of the raw materials and of alkaline and acid catalysts. The preparation conditions are adjusted and monitored with respect to temperature, pH and concentration of the reactants. Usually, a three-stage process is used. The first stage is always the methylation step which is usually performed under alkaline conditions and at high molar ratio (F/U"1.8 to 2.5). This step is necessary to build up the different methylolureas, the types and proportions of the methylols formed being dependent on the F/U molar ratio. The polycondensation reaction takes place in the subsequent acid condensation step to form polydisperse patterns of oligomers and polymers of different molar masses. The determination of this molar mass distribution can be done by means of GPC. The molar mass distribution (according to the degree of condensation) is one of the most important characteristics of the resin and determines several of its properties, e.g. viscosity and flow behaviour, wetting behaviour of a wood surface and penetration into the wood surface. The last production step includes distillation of the resin solution usually to 65-66% solids content, which is performed by vacuum distillation in the reactor itself or in a thin layer evaporator. Before or after this step an addition of urea in one or more steps at different temperatures, including also maturing times, can take place in order to decrease the final molar ratio. Different examples for the production of UF resins are described in detail in the literature. During the curing process a more or less three-dimensional network is built up. This yields an insoluble resin that is no longer thermoformable. The hardening reaction is the continuation of the acid condensation step. Whereas gelling in the reactor is to be avoided, the same process needs to take place in the glue line. The acid conditions can be adjusted by the addition of a so-called latent hardener, or by the direct addition of acids (maleic acid, formic acid, phosphoric acid and others) or acid compounds which dissociate in water (e.g. aluminium sulfate). Common latent hardeners are ammonium sulfate and ammonium chloride. The latter, however, has not been used in the German and Austrian particleboard and MDF industry for several years now, because of the generation of hydrochloric acid during combustion of wood-based panels causing corrosion problems and the suspected formation of dioxins. Ammonium sulfate reacts with the free formaldehyde in the resin to generate sulfuric acid, which decreases the pH. This low pH and the ensuing acid conditions enable resumption of the condensation reaction and finally the gelling and hardening of the resin. The rate of decrease of pH depends on the amounts of available free formaldehyde and hardener, and is greatly accelerated by heat.		

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability			

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Study Citation:		Dunky, M. (1998). Urea-formaldehyde (UF) adhesive resins for wood. International Journal of Adhesion and Adhesives 18(2):95-107.		
HERO ID:		5968910		
Conditions of Use:		Urea formaldehyde resin for wood based panels		
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 1:	Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	Medium	Data is for Austria, an OECD country.
	Metric 3:	Applicability	High	Data is applicable to production of UF resins and its future application on fiber boards.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Low	Qualitative data.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Dunn, D. W., Johnson, M. L., Hedley, W. H., Pate, J. B., Barrett, G. J., Mckinnery, W. N. (1983). Reducing plant pollution exposure - Control practices at formaldehyde production plants. Chemical Engineering Progress 79(3):35-38.			
HERO ID:	5972538			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	8.5 billion lb in 1980 (pg 2) Large facilities: >140 million lb/yr; medium: 100-140 million lb/yr; small: <100 million lb/yr (Table 1, pg 1)			
Process description:	"Formaldehyde produced in the United States is manufactured by two general processes: one using a metal oxide catalyst, Figure 2; the other using a silver catalyst, Figure 3. These two processes are very similar except for the addition of a distillation column in the silver process to concentrate the aqueous formaldehyde to a usable concentration and to reduce the methanol content. Methanol, normally received from offsite, is transferred from storage tanks and vaporized in a vaporizer. Vaporized methanol, mixed with preheated air, enters the converter and is oxidized (or dehydrogenated and oxidized if silver catalyst is used) to formaldehyde. Typically, the converter has a packed-tube configuration, but catalyst beds are also used. Efficiency of conversion of methanol to formaldehyde range from 65 to 90% for the silver process and is approximately 99% for the metal oxide process (6). After conversion, the hot formaldehyde gas [the reactor is generally operated at approximately 635°C (6)) is cooled in an after-cooler to a temperature of about 70°C and then absorbed in water. Aqueous formaldehyde solution is recirculated through the absorption tower until the desired concentration is achieved. If a silver catalyst is used in the converter, the product is concentrated in a distillation column, a step in which methanol is also recovered. Formaldehyde is generally stored as a 50% solution at 50°C (which helps prevent paraformaldehyde formation)."			
Number of sites:	52 plants representing 15 companies (pg 2)			
Chemical concentration:	50% (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	No sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Mainly process description and facts.	
Overall Quality Determination		High		

Study Citation:	Dunn, W., Toy, H. D., Wright, A. J., Hedley, W. H., Holmes, L., Barrett, G. J. (1983). Detailed Industrial Hygiene Survey Formaldehyde Production, E. I. DuPont DeNemours and Company, Linden, New Jersey, Report No. CT-114-20b. NIOSH(068-03-3025):068-03.			
HERO ID:	1167915			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Life cycle description:	Manufacturing			
Process description:	Formaldehyde is manufactured by a combination of the Oxidation-dehydrogenation process using silver as a catalyst. Methanol is provided by a tank truck to a large bulk storage tank and is pumped to a methanol vaporizer. air is drawn through a water scrubber, preheated, and combined with the vaporized methanol in a converter. Hot formaldehyde passed through an atmospheric absorber column. liquid formaldehyde from the absorber is stored in heated tanks. The formaldehyde is then passed through an ion-exchange column to remove formic acid and blend inline to produce the desired solution. Hydrogen, nitrogen, and traces of formaldehyde and methanol from the absorber are burnt in the waste heat recovery boiler.			
Throughput:	rated capacity of 160 million pounds/site on a 37% basis (~59 million pounds/site/yr			
Number of sites:	1- DuPont Production Unit in Linden, NJ			
Chemical concentration:	37% - 50% product concentration			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (formaldehyde manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 more than 20 years old
	Metric 5:	Sample Size	N/A	information was mostly qualitative
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Clear that information provided was from site visit
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Information provided was qualitative and site-specific.
Overall Quality Determination		High		

Study Citation:	Durgam, S., Page, E. (2011). Formaldehyde exposures during Brazilian blowout hair smoothing treatment at a hair salon – Ohio.			
HERO ID:	8684525			
Conditions of Use:	Personal care products			
EXTRACTION				
Parameter	Data			
Process description:	The Brazilian Blowout treatment process has six steps: 1. Hair was washed with the Brazilian Blowout Acai Professional Anti-Residue Shampoo in the hair wash/dry room. 2. The hairstylist used a brush to apply the Brazilian Blowout Acai Professional Smoothing Solution – Formaldehyde Free Smoothing Formula to all parts of the wet hair in a systematic fashion in the hair treatment room. The hairstylist wore disposable latex gloves during this stage of the treatment only. 3. Hair was then brushed and blow dried with an Artizen® 3300 5kV Ionic hair dryer that was set at the highest heat setting. 4. A flat iron set at 450°F was used four to five times on each section of the hair. 5. The Brazilian Blowout Acai Deep Conditioning Masque was then applied to the dried hair and rinsed off with water in the hair wash/dry room. 6. Hair was again blow dried with the same hair dryer in the hair treatment room. (10/28)			
Chemical concentration:	The Brazilian Blowout Acai Professional Smoothing Solution – Formaldehyde Free Smoothing Formula contained 11% formaldehyde by weight, and the Brazilian Blowout Acai Professional Anti-Residue Shampoo contained 0.046% formaldehyde by weight. The Brazilian Blowout Acai Deep Conditioning Masque contained 0.0013% formaldehyde by weight. (13/28)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Uninformative	Data are for commercial use of hair care products, outside the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (concentrations) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed by mentioning the limit of detection in the analyzed solution. Variability is not addressed.	
Overall Quality Determination		Uninformative		

Study Citation:	Eastman Chemical Company, (2020). Comment submitted by Emily Clark, Product Stewardship and Regulatory Affairs, Eastman Chemical Company regarding the draft scope document for the risk evaluation of formaldehyde with list of studies.			
HERO ID:	10370213			
Conditions of Use:	Processing - Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Process description:	Formaldehyde formation results when polyesters based on ethylene glycol, are heated to melt processing temperatures. In our manufacture of the copolyester pellets, we expect any formaldehyde generated to be stripped out due to the high temperature and vacuum conditions in the manufacturing process. In the subsequent next step where the pellets are formed into the final article by extrusion or injection molding processing by our customers, formaldehyde could also be generated at low levels (order of 10 ppm) as a by-product from ethylene glycol. [PDF Pg. 1]			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for processing - incorporation into formulation, mixture, or reaction product, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	N/A	N/A - Process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - Process description.	
Overall Quality Determination		High		

Study Citation:	Eastman Kodak, (2009). Material Safety Data Sheet (MSDS): Kodak Flexicolor Stabilizer III and Replenisher/C-41.			
HERO ID:	11328020			
Conditions of Use:	Chemical substances in packaging, paper, plastic, and hobby products: Photographic supplies			
EXTRACTION				
Parameter	Data			
Process description:	photographic processing chemical, For industrial use only.			
Chemical concentration:	5-15 Weight% (pg 1)			
Comments:	Safety data sheet			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Source is from manufacturer and associated information does not indicate flaws or quality issues..
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report captures formulations that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old (2007).
	Metric 5:	Sample Size	Medium	Distribution is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, data sources, and assumptions. Methods are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Formaldehyde

General Engineering Assessment

HERO ID: 1256545 Table: 1 of 1

Study Citation:	EC, (2000). Priority substances list assessment report. Formaldehyde. :1-62.		
HERO ID:	1256545		
Conditions of Use:	Manufacture		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	Canadian domestic demand: 191,000 tonnes		
Chemical concentration:	0.002-37% in pest control products (pg. 17/111)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Canada, an OECD country.
	Metric 3: Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1999)
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium	

Study Citation:	ECHA, (2019). Annex XV restriction report, proposal for a restriction: Formaldehyde and formaldehyde releasers.			
HERO ID:	5155562			
Conditions of Use:	Manufacture + Processing as a reactant			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	FA is made in quantities > 1 million tons per year. Total FA production in Europe in 2015 was around 3.2 million tonnes (as 100% pure FA) which is equivalent to 8.6 million tonnes as 37% water solution. According to Eurostat (2018) data, FA imports into the EU from extra-EU countries were in the range of 20-30 thousand tonnes annually between 2015 and 2017, which accounts for less than 1% of the amount produced in Europe. Almost 98% of total FA produced or imported in the EU is used as an intermediate to produce formaldehyde based resins, thermoplastics and other chemical. Urea FA resins: 95% of UF resins are used in binders or adhesives in wood-based panels. Approximately 60% of phenol formaldehyde resins are used in the building and construction industry for applications including insulation binder, wood-based products and laminates, other end uses include automobile applications and foundry binders. Melamine formaldehyde resins are used widely in the building and construction industries in the form of laminates and surface coatings, which account for more than 95% of its consumptions with applications also in the automotive sector and for housewares. Around 60% of the whole amount of FA used in the EU is used in the manufacture of resins which are used to produce a broad range of articles for consumer use: manufacturing of wood-based panels as bonding agents which include plywood, particleboard, oriented strand board, medium density fibreboard, and other fibreboard. Also used in the production of other wood-based based products including furniture, flooring, and building elements for indoor and outdoor use. Remaining 40% of the FA manufactured and imported into the EU is used in the production of paints for industrial use, in the production of mineral wool, in the textile and leather industry, and in the production of foams for insulation of buildings and cars. Table 2 is a COU table for consumer uses.			
Life cycle description:	Formaldehyde is predominantly used as a chemical intermediate in the production of formaldehyde-based resins and other chemicals. The most common substances manufactured from formaldehyde include urea formaldehyde resins, phenol formaldehyde resins and melamine formaldehyde resins. Such formaldehyde-based resins are the biggest group of formaldehyde releasers, a broader group of substances with the common element that they can release formaldehyde under foreseeable conditions of use. Formaldehyde-based resins are widely used as adhesives and binders in the woodworking, pulp and paper, as well as the synthetic vitreous fibre industries, in the production of plastics and coatings, and in textile finishing.			
Process description:	At an industrial scale, formaldehyde is manufactured by catalytic oxidation of methanol via either a silver or metal-oxide catalyst process. Production capacity is split almost equally between the two processes. In the metal-oxide process, methanol is oxidised with excess air in the presence of a modified iron-molybdenum-vanadium oxide catalyst at 250-400 °C and atmospheric pressure (methanol conversion, 98-99%) (IARC, 2006). In the silver process methanol is directly converted into formaldehyde and hydrogen at 600-780 °C. Figure 1 presents an illustrative summary of the formaldehyde manufacturing process (metal-oxide conversion). At all sites formaldehyde manufacturing is integrated with the manufacturing of formaldehyde-based resins and/or other chemicals, representing the vast majority of the intermediate use of formaldehyde. In addition, ± 11 non-integrated sites produce large volumes of formaldehydebased organic chemicals – mainly methylene diphenyl diisocyanate (MDI) and polyols – and some others may use rather small quantities of formaldehyde to produce specialty chemicals. Figure 1 provides flow chart of FA manufacturing process			
Number of sites:	73 sties in 21 EU member states. Austria - 3 sites, Belgium - 5 sites, Bulgaria - 1 site, Czech Republic - 1 site, Denmark - 1 site, Finland - 3, France - 1; Germany - 12, Hungary - 2, Ireland - 1, Italy - 10, Lithuania - 1, Netherlands - 4, Poland - 6, Portugal - 2, Romania - 3, Slovakia - 1, Slovenia - 2, Spain - 6, Sweden - 3, UK - 5			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report developed by ECHA so generally accepted by the scientific community
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for multiple EU countries that are classified also as OECD countries.
	Metric 3:	Applicability	High	Data is applicable to multiple COUs.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old.
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Study Citation:	ECHA, (2019). Annex XV restriction report, proposal for a restriction: Formaldehyde and formaldehyde releasers.			
HERO ID:	5155562			
Conditions of Use:	Manufacture + Processing as a reactant			
Domain		Metric	EVALUATION	
			Rating	Comments
		Metric 5: Sample Size	Medium	Characterized by a range of data with uncertain statistics.
Domain 3: Accessibility/ Clarity				
		Metric 6: Metadata Completeness	High	Includes process descriptions, production volume, % use volumes, number of sites, life cycle descriptions.
Domain 4: Variability and Uncertainty				
		Metric 7: Metadata Completeness	Medium	Addresses variability by looking at multiple EU countries and various different methods of use/production of FA. Does not address uncertainty.
Overall Quality Determination			High	

Study Citation:	Echt, A. (1993). Health Hazard Evaluation Report HETA 93-0028-2366, West Helena - Helena Sportswear, Inc., West Helena, Arkansas.			
HERO ID:	1316765			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Process description:	Pre-cured permanent-press fabrics received from various suppliers are spread on large tables and then cut according to the garment pattern. Cut pieces are fused (fusing bonds a lining to the garment), bundled, and have bar tags sewn on to the piece. The cut pieces are then sewn to assemble the garment. Finally, the assembled garment is pressed, inspected, bagged, and shipped.			
Throughput:	1,000 garments are produced every day.			
Number of sites:	1 (report investigated 1 site)			
Chemical concentration:	Two bulk samples of settled dust was measured for formaldehyde. They contained 0.70 and 0.80 ug/mg formaldehyde of sampled material. The samples were collected from on top of aflourescent light near the cutting department, and from the base of a metal column adjacent to the cutting and pocket departments, respectively.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses high quality data (observations from an IH site visit) from a frequently used source (NIOSH HHEs).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (textile work) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Study implemented in 1993 more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was based on the NIOSH site visit. Clearly documents results, assumptions, and methods.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information (site-specific information)
Overall Quality Determination			High	

Study Citation:	Edling, C., Hellquist, H., Odkvist, L. (1988). Occupational exposure to formaldehyde and histopathological changes in the nasal mucosa. British Journal of Industrial Medicine 45(11):761-765.			
HERO ID:	31774			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Reactant: particle board and laminae manufacture			
Number of sites:	3: 2 processing particle boards and one laminae			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data is from Sweden, an OECD country.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.	
Overall Quality Determination		Medium		

Study Citation:	Elliott, L. J., Stayner, L. T., Blade, L. M., Halperin, W., Keenlyside, R. (1987). Formaldehyde-exposure characterization in garment-manufacturing plants: a composite summary of three in-depth industrial-hygiene surveys.
HERO ID:	2298103
Conditions of Use:	Textile Finishing

EXTRACTION	
Parameter	Data
Process description:	The garment manufacturing facilities surveyed during this study receive pre-cured finished fabric from a textile-finishing plant. The fabric is treated at the textile-finishing plant with methylolated(formaldehyde-based) resins to give the fabric crease-resistantcharacteristics (permanent press). The resin-treated fabric was cured before it was received by the garment plant.The first step in the process is the cutting of garment parts from the fabric. In order to do this, many layers of fabric must first be spread out, one on top of another, on a long table. All of the layers are then cut simultaneously with hand-held saws ("cutters") or with dies. When a hand-held cutter is used to perform this step, a pattern is first laid over the top layer and the operator cuts according to this pattern.After cutting, the garment parts are assembled. Individual parts (e.g. cuffs, collars, sleeves, etc.) are assembled into complete pieces, then the major pieces are assembled further into completed garments. Host of the various assembly operations require sewing with sewing machines appropriately modified for each type of operation. Some sewing operations in a plant, such as attaching of pockets to shirt fronts ("pocket setting"), have been "de-skilled". This means that a degree of automation has been utilized in the process. The workers position the parts to be sewn together onto the machines; the machines then hold the parts in the proper position and make the required stitches without further guidance from the workers. Other sewing tasks are accomplished with more conventional sewing machines. Several assembly operations make use of heat to form or fuse together (in conjunction with a heat-sensitive adhesive) various parts. Conventional hot electric irons are used to press the fabric in some locations. The following assembly operations apply heat to the fabric:1. Fusing of Lining to Collar: The adhesive-coated lining and the collar are heated to approximately 320°F (160°C) and rolled together, which fuses them.2. Collar Forming and Pressing: The operator forms the collar with fabric on a specialized machine, and the machine presses the collar at a temperature of 300-350°F (149-176 0 C) to give it permanent shape. 3. Collar Band Creasing: Prior to the assembly of the (collar) bands, the bands are formed to specific shapes and heat is applied to maintain those shapes.4. Label Attach: The labels are fused to the shirts by applying heat[about 400°F (2040 C») to the heat-sensitive adhesive which is on the labels. The fusing method of label attach is currently used to avariable extent across garment plants and intermittently in some plants; labels are sewn on in other plants or at other times.5. Re-do Collar Press: This pressing machine, set for 300-310°F(149-1540 C), is often used to re-press collars which are wrinkled.6. Hand Ironing of Collar Bands ("Re-do"): Conventional irons are used to re-press wrinkled bands.7. The completed garment may then be pressed (in some facilities) on steam applied apparel presses as the final finishing step. Finished garments are moved to an area where they are properly folded for packaging. When the cuff will show in the package, it is pressed in this area. The fronts and collars also are pressed with hand irons as necessary. The garments are packaged in boxes or bags and are ready to ship. These process operations are typical of the garment manufacturing industry. No substantial changes in the garment manufacturing process from 1955 to 1985, other than improved resin systems, were identified which could have affected formaldehyde exposure levels. (P. 14/58)
Number of sites:	3 (p. 10/58)

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The report is for an occupational scenario (garment work) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1981 - more than 20 years old
	Metric 5: Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity			

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Study Citation:	Elliott, L. J., Stayner, L. T., Blade, L. M., Halperin, W., Keenlyside, R. (1987). Formaldehyde-exposure characterization in garment-manufacturing plants: a composite summary of three in-depth industrial-hygiene surveys.			
HERO ID:	2298103			
Conditions of Use:	Textile Finishing			
Domain		Metric	EVALUATION	
	Metric 6:	Metadata Completeness	Rating	Comments
			High	information derived from NIOSH site visit
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:		Elmer’s, (2012). (M)SDS For: Elmer’s CraftBond Acid-Free Multi-Purpose Spray Adhesive, Aerosol.			
HERO ID:		6547455			
Conditions of Use:		Adhesives and Sealants; Paint and coatings			
EXTRACTION					
Parameter		Data			
Chemical concentration:		<0.00030% (pg2)			
EVALUATION					
Domain		Metric		Rating	Comments
Domain 1: Reliability		Metric 1:	Methodology	High	Source is from the manufacturer and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2:	Geographic Scope	High	The data are from the United States.
		Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
		Metric 4:	Temporal Representativeness	Medium	The report captures formulations that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.
		Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium		

Study Citation:	English, A., E&C, Brown, J., Rovner, J., Davies, S. (2015). Methanol. :1-19.			
HERO ID:	9493556			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Life cycle description:	Worldwide, the largest amount of formaldehyde is consumed in the production of urea–formaldehyde resins, the primary end use ofwhich is found in building products such as plywood and particle board. In the United States, the greatest market share for formaldehyde is again in the construction industry. However, a fast-growing market for formaldehyde can be found in the production of acetylenic chemicals, which is driven by the demand for 1,4-butanediol and its subsequent downstream product, spandex fibers.			
Process description:	Methanol undergoes reactions that are typical of alcohols as a chemical class (3). Dehydrogenation and oxidative dehydrogenation to formaldehyde over silver or molybdenum oxide catalysts are of particular industrial importance.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - process description.
Overall Quality Determination			High	

Study Citation:	Environmental Defense Fund, (2021). Comment submitted by Environmental Defense Fund (EDF) regarding information on potentially exposed or susceptible subpopulations associated with 1,3-butadiene, formaldehyde, and ortho-phthalates undergoing TSCA risk evaluations.			
HERO ID:	10385454			
Conditions of Use:	Processing/Use			
EXTRACTION				
Parameter	Data			
Life cycle description:	"Formaldehyde is used in many commercial and consumer products including wood and particleboard-based furniture, textiles,carpeting, medicines, cosmetics, dishwashing liquids, carpet cleaners, glues, lacquers, and preservatives (in some cases, in foods) (Kim et al., 2011; Lam et al., 2021). In addition to formaldehyde releases from products, formaldehyde is also released into the air from commercial and industrial operations using or manufacturing formaldehyde and from automobile exhaust and cigarette smoke (ATSDR, 1999)" pg. 8/21			
Number of sites:	Table 5, pg. 10/21, uses TRI and states there were 824 total facilities that reported releasing formaldehyde between 2015 - 2020.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		High		

Continued on next page ...

General Engineering Assessment

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Study Citation:	Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.
HERO ID:	8727392
Conditions of Use:	Reactant Manufacture in Construction Material

Domain	Metric	EVALUATION Rating	Comments
Study Citation:	Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.		
HERO ID:	8727392		
Conditions of Use:	Reactant Manufacture in Construction Material		

Parameter	Data

Process description:

The Urea-Formaldehyde Foam Insulation SystemManufacturing ProcessA two-component urea formaldehyde foam insulation system, consisting of a resin and a foaming agent, is made at each of these facilities. The manufacturing process and the chemical components of the urea formaldehyde-based system at Manufacturer B have recently been patented;however, the patent number is not yet available.Manufacturer ATwo batches of urea formaldehyde resin are made daily in a 1500-gallon rectangular stainless steel reactor. The bottom of the reactor is heated directly with open propane gas burners. The reactor is vented through a stack equipped with a double-reflux condenser at its base. There is a small rectangular access door on the top side of the reactor for batch sampling. Formalin (37 percent formaldehyde in water inhibited with a maximum of 1 percent methanol) is piped directly to the reactor from a large storage tank located in the west end of the production area. The pH of the formalin is then adjusted with sodium hydroxide. Simultaneously, prilled urea is augered into a cylindrical stainless steel kettle and dissolved in warm water. This vessel, known as the addition tank, is also gas-heated and is located near the reactor. Water and aqueous ammonia are added to the reactor and the pH of the solution is adjusted with sodium hydroxide. The reaction proceeds until a predetermined degree of condensation has been reached; at that time, the urea solution is pumped from the addition tank into the reactor. After an additional required degree of condensation has been reached, the pH of the resin is adjusted with sodium hydroxide and the resin allowed to cool. When the resin has cooled to a specified temperature, a fire retardant, an anti-shrinking agent and a humectant are added; these are proprietary materials. In addition, a cross-linking agent (furfuryl alcohol) is added. The batch of resin is then piped from the reactor into a 2000-gallon holding tank. A hose attached to the holding tank is used to convey the resin from the tank into 55-gallon plastic drums. The drums are either filled with the lid off or, more frequently, through the lid opening. The foaming agent, or "B" component, is blended in the southwest section of the production area. The main ingredient is a proprietary blend of "cross-linking and emulsifying agents" purchased by the company; it is received in large plastic drums and pumped into a 2000-gallon tank. Proprietary hardeners, a proprietary catalyst, and water are added andblended to form the foaming agent "concentrate"The foaming agent is dispensed through a hose into 55-gallon drums and through a spigot into 5-gallon plastic pails. One of the hardeners is added directly to the 5-gallon pails. Manufacturer BBatches of resin are made in a 2750-gallon reactor. The productionschedule varies with demand for the product from the installers, ranging from two to ten batches per week. The reactor, which is heated and cooled by piping water through a system of coils, vents through a reflux condensor. The reactor is charged with base materials consisting of a methylolurea prepolymer, small amounts of acetaldehyde, urea, and phenol in an aqueous solution. The base materials are piped directly to the reactor from storage tanks in the production area. Small amounts of phenol and prilled urea are added to adjust the composition of the reaction mixture and the mixture is heated with constant agitation. Formic acid solution is added and the reaction proceeds until the proper degree of condensation is reached. The reaction is stopped with sodium hydroxide and cooled, and additives including fructose and urea solution are introduced. The finished resin is piped through a hose from the bottom of the reactor into 55-gallon metal drums. The drums are filled through the lid openings. The foaming agent is manufactured in batches of approximately 2300gallons. Generally, one batch of foaming agent is made for each batch of resin produced. Foaming agent is manufactured by mixing a sulfonic acid emulsifier containing small amounts of sulfuric acid, and oxalic orphosphoric acid with water. The emulsifier is a proprietary compoundpurchased by Manufacturer B, and the use of oxalic or phosphoric acid is determined by the ambient temperature at the location where the product will be applied. Mixing continues at room temperature for approximately 6 hours, after which the foaming agent is transferred to 55-gallon drums.The Polyurethane Foam Insulation System Manufacturing ProcessRigid polyurethane foam systems for thermal insulation consist of an "A" and a "B" component which, when mixed, form a rigid foam. The 11A11 component consists of a mixture of polymeric (50%) and monomeric (50%) methylene bisphenyl isocyanate (MDI), which is purchased in bulk and repackaged into drums. Alternately MDI may be blended with a flame retardant and then drurraned.The "B"component, or resin, is a mixture of ingredients which are prepared by a blending process. The process does not involve a chemical reaction. The formulation of a resin may vary depending upon the end use of that product. Resins produced by both manufacturers are intended for a variety of uses, including thermal insulation.The resins used for thermal insulation contain one or more polyols (polyhydroxy compounds), a silicone oil copolymer, one or more tertiary amine catalysts, an organotin catalyst, Fluorotrichloromethane (used as a blowing agent), and alpha-methyl styrene (used as a stabilizer). A phosphate ester-based flame-retarding agent may also be added.Manufacturer CThe MDI repackaging process at this facility is conducted several times per week, as needed, and usually involves only one employee. Twenty to fifty thousand pounds (40-100 drums) may be drummed per day. This operation takes place inside a 100 1 x 290 1 building which also serves as a warehouse. The bulk MDI tank car is located adjacent to this building; there is a permanent pipe connection to the MDI loading area. In the resin manufacturing process any one of several various sized vessels may be used. All of the vessels are located inside the 40 'x 50 'compounding room. Raw materials, including polyols, silicone oil copolymers, and fluorotrichloromethane are poured from drums into the top opening of the vessel using an electric drum lifter. Ingredients are measured by weighing each drum before and after pouring. Ingredients are mechanically stirred until homogeneous and then sampled for quality control. After

Formaldehyde

General Engineering Assessment

HERO ID: 8727392 Table: 1 of 2

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Study Citation:	Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.
HERO ID:	8727392
Conditions of Use:	Reactant Manufacture in Construction Material

Domain	Metric	EVALUATION		Comments
		Rating		

Domain	Metric	EVALUATION		Comments
		Rating		

Domain 1: Reliability

Metric 1:	Methodology	High	NIOSH study

Domain 2: Representativeness

Metric 2:	Geographic Scope	High	US
Metric 3:	Applicability	High	The report is for an occupational scenario (insulation manufacture) within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness	Low	1979 - more than 20 years old
Metric 5:	Sample Size	N/A	Qualitative information provided

Domain 3: Accessibility/ Clarity

Metric 6:	Metadata Completeness	High	NIOSH study

Domain 4: Variability and Uncertainty

Metric 7:	Metadata Completeness	N/A	Qualitative information provided

Overall Quality Determination

High

Study Citation:	Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.		
HERO ID:	8727392		
Conditions of Use:	Chemical substances in Construction products		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	Production of Plastic Foams Used as Thermal Insulation in the Interior Construction Market Application 1972/1974 257 millions of pounds1980 500 millions of pounds1985 840 millions of pounds		
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Study Citation:	Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.
HERO ID:	8727392
Conditions of Use:	Chemical substances in Construction products

EVALUATION			
Domain	Metric	Rating	Comments
Process description:	The Urea, Formaldehyde Foam Insulation SystemApplication ProcessApplicator AExterior Retrofit Applications Manufacturer A's foaming agent is received in 5-gallon plastic pails (2.5 gallons per pail) and the resin in 55-gallon plastic drums. Prior to use, the foaming agent is diluted with water to 55 gallons. The resin and foaming agent are stored in the warehouse along with other insulation materials, mortar mix, and application equipment. The warehouse is a one-story, 2500-square foot structure situated adjacent to the office. It also serves as a vehicle storage garage and as a location for rebuilding application equipment. Application equipment is rebuilt as time permits. Applicator A has three urea formaldehyde foam application crews. The urea formaldehyde foam application 'crew usually consists of five individuals—one Foam Mechanic and four Laborers. The Foam Mechanics are certified applicators of Manufacturer A's urea formaldehyde foam. Certification is awarded by Manufacturer A after a 1-week foam application training course. The crew members arrive at the office at 7:00 a.m. Job sites are designated by the production manager. The crews leave the warehouse area between 7:15 a.m. and 7:45 a.m. in three 12-foot step vans. There is a partition between the front and back sections of one of the vans. The vans are stocked with the necessary supplies and equipment on the preceding evening. Upon arriving at the job site, a determination is made of the appropriate method for gaining access to the wall cavity, which is generally referred to as "opening" the structure. Masonry is drilled, aluminum siding and shingles are removed, and weatherboard is knocked through with a hammer. The holes are made between studs and fire-stops. The resulting openings are relatively small—3/4 inch in masonry and 2-3 inches in weatherboard. The building is opened by the four Laborers and, when he is not performing other duties, by the FoamMechanic.While the building is being opened, the Foam Mechanic cleans the application gun and hose, and starts circulating resin and foaming agent. The resin and foaming agent circulate from storage drums through plastic tubing and a pump and back into the drums. This is done to assure a uniform product. Application equipment components downstream of the foaming chamber usually cake with dried foam. The components are disassembled with a wrench and cleaned with hot water and a rag or by scraping with a tool such as a screwdriver. Some Foam Mechanics choose to clean their equipment in the afternoon, following completion of foam application for the day.Foaming begins after the structure has been opened to a point where foam application can proceed without interruption, the application equipment has been cleaned and reassembled, and the resin and foaming agent have been properly circulated. Before the foam is applied, a density determination is made. This is accomplished by filling a standard volume with foam and weighing. Resin, foaming agent, or nitrogen adjustments are made until the foam density is within an acceptable range. Foam is also discharged onto the ground so that foam body can be evaluated. This is known as making "beehives" due to the appearance of the resulting pile of foam. Occasionally, a piece of the foam is tasted as part of the qualitative testing.After the foam has passed the qualitative and quantitative tests,application begins. Figure 1 is a drawing of the foam applicationsystem. The application gun is suspended from the Foam Mechanic's shoulder by a strap. The application hose, located on the end of the application gun, is inserted into the wall opening. A lever on the gun is depressed, and proper amounts of nitrogen and foaming agent mix in a chamber with plastic beads. The nitrogen serves as a blowing agent. Downstream of the mixing chamber, resin is introduced. The resulting foam, similar in appearance to shaving cream, leaves the application hose and fills the wall cavity. After the space has been filled, a Laborer removes the excess foam from the wall with water from a garden hose. The hole is then "closed" (i.e., covered, plugged, or filled) by another Laborer. For example, shingles are nailed back into place, masonry is filled with a small amount of mortar, and aluminum siding is put back into place. On occasion, one employee is stationed in the house to listen for structural stress caused by overfilling the wall cavities. After all the cavities have been filled, the Foam Mechanic cleans the application equipment (if that is his preference) and stores it in the van. He then sketches and measures the square footage of the structure to check the measurements previously made by the salesman. In the meantime, the Laborers finish closing and clean waste material from the area. The trash is placed in the back of the van in plastic bags. The crew's workday ends when they return to the warehouse. At the warehouse, waste material is disposed of into a dumpster, and the van is stocked with adequate foaming agent and resin for the next day. This is done by the Warehouseman. Open-Bay ApplicationIn this procedure, the urea formaldehyde foam is applied between exposed studs before the wallboard is put into place. Usually, small amounts of the foam are first "splattered" onto the surface. This is accomplished by increasing the nitrogen pressure and pinching the end of the application hose. After the form has been splattered, the nitrogen pressure is reduced and a rectangular, transparent piece of plastic is placed on the end of the application hose. There is a hole in the plastic to allow foam to flow through it. The plastic bridges the two adjacent studs and serves as a trowel as the foam is applied from floor to ceiling in the cavity. Good foam body prevents the foam from falling out of the cavity. The foam slightly overfills the cavity. A flat-edged shovel is used to bridge twoadjacent studs and scrape the excess foam off and onto the floor. This is done by a Laborer approximately 15 minutes after the cavity has been filled with foam. Normally, a third Laborer nails a polyethylene sheet over the insulation. Other aspects of open-bay application activities are similar to exterior retrofit application activities.Applicator BExterior Retrofit ApplicationThe resin and foaming agent are stored in the warehouse, which is an 11,000-square foot, one-story stone structure. Other items stored in the warehouse include: cellulose insulation, cellulose insulation adhesive, commercial mortar mix, muriatic acid, and application equipment. In addition to being a storage area, the warehouse also serves as a shop for performing light maintenance on equipment. Occasionally, foam is tested by discharging foam onto the warehouse floor. Generally, the application team consists of the company president's two sons; both have been certified by Manufacturer Bas foam applicators. A third individual is utilized for large jobs. The application team arrives at the warehouse about 8 a.m. and loads a 12-foot step van with the application equipment and insulation components. About 8:15 a.m., the application team leaves the warehouse for the job site.Applicator B's opening, circulating, equipment cleaning, and foamapplication processes are similar to Applicator A's with a fewexceptions. Applicator Buses air compressed by a gasoline-powered compressor instead of compressed nitrogen. The application gun used by Applicator B differs from Applicator A's in that the blowing agent and foaming agent do not mix in a chamber containing plastic beads. After all the cavities have been filled, the application equipment is put away. The applicator then assists in closing operations. At the end of the day, trash foam is put into plastic bags and placed in the van. The application team then returns to the warehouse to store equipment, dispose of trash, and perform maintenance on equipment if necessary.Open-Bay ApplicationInitially, the		

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Study Citation:		Enviro Control Inc., (1983). Industrial hygiene characterization of urea formaldehyde and polyurethane foam insulation.			
HERO ID:		8727392			
Conditions of Use:		Chemical substances in Construction products			
Domain		Metric	EVALUATION Rating		Comments
Domain		Metric	EVALUATION Rating		Comments
Domain 1: Reliability		Metric 1: Methodology	High	NIOSH study	
Domain 2: Representativeness		Metric 2: Geographic Scope	High	US	
		Metric 3: Applicability	High	The report is for an occupational scenario (insulation installation) within the scope of the risk evaluation.	
		Metric 4: Temporal Representativeness	Low	1979 - more than 20 years old.	
		Metric 5: Sample Size	N/A	Qualitative information provided	
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	NIOSH Study	
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	N/A	Qualitative information provided	
Overall Quality Determination			High		

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General Engineering Assessment

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Study Citation:	ERG, (1998). Air emissions inventories, volume 2: Point sources: Chapter 11: Preferred and alternative methods for estimating air emissions from plastic products manufacturing.
HERO ID:	7349020
Conditions of Use:	Chemical substances in plastic products

EVALUATION			
Domain	Metric	Rating	Comments
Study Citation:	ERG, (1998). Air emissions inventories, volume 2: Point sources: Chapter 11: Preferred and alternative methods for estimating air emissions from plastic products manufacturing.		
HERO ID:	7349020		
Conditions of Use:	Chemical substances in plastic products		

EXTRACTION	
Parameter	Data
Process description:	Plastic products manufacturing involves molding, forming, shaping, or otherwise altering plastic resins or plastic materials to produce an intermediate or final product. This manufacturing industry is also commonly referred to as plastics processing or polymer processing. The manufacture of resins is not a part of plastic products manufacturing; however, some facilities manufacture resins at the same site as where the resins are processed. Solid and foamed plastic products are manufactured using plastic resins or solid plastic chips as the starting material. Most plastic products are manufactured by mixing plastic resins with additives, applying heat or pressure to the mixture, and shaping the mixture to form the desired product. Types of Plastics Plastic products can be fabricated into a solid or foam state. The basic properties of a plastic product are influenced and limited by the physical and chemical characteristics of the plastic resin from which it is made. Plastic resins are generally defined by their rheology, or ability to flow under heat or pressure. Thermoplastic resins (or dry blends) and thermoset resins are the two major classes of resins that are used to manufacture plastic products. Although most resins fall into one of these two classes of resins, some resins can be classified as both a thermoplastic and thermoset resin. Thermoplastics Thermoplastic resins (or thermoplastics) are plastic resins that will repeatedly become soft when heated and hard when cooled. Thermoplastics do not normally undergo a chemical change during forming. Plastic products manufacturing facilities usually purchase and use thermoplastics in solid pellet form for processing. An economic advantage of products made from thermoplastics is that they can be easily remanufactured or reprocessed. Thermoplastics account for the major share of domestic polymer production. The following six thermoplastics are processed in the largest quantities in the United States: Low-density polyethylene; High-density polyethylene; Polyvinyl chloride; Polypropylene; Polystyrene; and Linear low-density polyethylene. Thermosets Thermoset resins (or thermosets) undergo a chemical reaction and become permanently solid when heated, pressurized, or reacted with a hardening agent. Thermosets are usually available in liquid or powder form for processing. Unlike thermoplastics, thermosets cannot be easily remelted or refabricated. However, scraps from thermoset processing operations can be used as fillers for other products. Some widely used thermosets include: Epoxy; Phenolic; Unsaturated polyester; and Urea. Foamed Plastics Foamed plastics (or foams) have a unique cellular structure that is different from solid plastics. For this reason, foams are often called “cellular plastics.” Foams, which are rigid, semi-rigid, or flexible, can be manufactured with thermoplastic or thermoset resins. Many of the manufacturing techniques used to fabricate solid plastic products are also used to make foam products. The process used to manufacture foams influences the properties of the final foam product. Some typical foams include: Polystyrene foam; Polyurethane foam; and Polyethylene foam. Manufacturing Techniques Solid and foamed plastic products are manufactured by a variety of methods. The choice of manufacturing techniques used to process a plastic product depends largely on whether the resin is a thermoplastic or thermoset, and the dimensions, shape, or physical qualities of the desired product. Extrusion is the most widely used processing technique, followed by injection molding, blow molding, and foam processing. Extrusion The extrusion process is a common technique used to form thermoplastic materials into long plastic shapes including pipes, tubes, coated wires, coated cables, rods, and continuous sheets and films. The types of extrusion methods are as diverse as the products that can be fabricated by extrusion. Extrusion methods include blown film, sheet extrusion, cast film, extrusion coating, profile extrusion, pipe and tubing extrusion, wire and cable coating, and fiber extrusion. In most extrusion operations, dry resin material is poured into a hopper, which directs the resin material into the feed throat of the extruding machine where the resin is heated. A large continuously revolving screw encased in a long heating chamber then carries the heated resin down the length of the screw toward a die (orifice) at the end of the chamber. The revolving screw forces the fluidized resin material through the die which has the shape of the cross section of the final plastic product. After the resin material exits the die, it may be wound into a roll, or transported on rollers or a conveyor belt where it is cooled by air or water immersion. Molding In most molding operations, the forming of the intermediate or final plastic product takes place in a closed mold. Molding methods vary depending on resin type, raw materials, desired plastic product shape, and other factors. Some of the more typical molding methods include injection, blow, general, rotational, transfer, reaction injection, and compression injection. Injection Molding Injection molding is one of the more common methods used to mold thermoplastics; however, this method can also be used to mold thermosets. The injection molding process is similar to the extrusion method except that in injection molding, the molten material is injected into a mold rather than forced through a die. Plastic pellets are fed into a heating chamber and are pushed along by a plunger until they are homogenized and fluidized. The fluid plastic is then injected (forced under high pressure) through a nozzle into a relatively cold mold. The fluid plastic conforms to the shape of the clamped mold, which is released once the plastic solidifies. The reciprocating screw injection machine, which serves as both a plasticizer and injection ram, is the most common machine used for injection molding. Reaction Injection Molding is a recently developed injection molding technology that mixes liquid plastic (i.e., polyols and isocyanates) at low temperatures before injecting the liquid plastic into a mold. Unlike standard injection molding, an exothermic reaction takes place in reaction

...continued from previous page

Study Citation:	ERG, (1998). Air emissions inventories, volume 2: Point sources: Chapter 11: Preferred and alternative methods for estimating air emissions from plastic products manufacturing.				
HERO ID:	7349020				
Conditions of Use:	Chemical substances in plastic products				
		EVALUATION			
Domain	Metric		Rating		Comments
Throughput:	urea formaldehyde thermoset plastics 1,816 million pounds				
		EVALUATION			
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA EIIP program	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	Medium	The report is for an occupational scenario (plastic product manufacture) within the scope of the risk evaluation. Detailed process description but not specific to formaldehyde	
	Metric 4:	Temporal Representativeness	Low	1998 - more than 20 years old	
	Metric 5:	Sample Size	N/A	Qualitative information provided	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided	
Overall Quality Determination			Medium		

Study Citation:	Estlander, T., Jolanki, R., Kanerva, L., Plosila, M. (1990). An artist’s allergy to reactive dyes and formaldehyde. Contact Dermatitis 23(4):271.			
HERO ID:	1317568			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Chemical concentration:	The formaldehyde content in the whole pigment paste was 0.04%, and in one of the paste components about 2%.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3:	Applicability	High	Data are for fabric, textiles and leather products not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1990)
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	FCW, (2017). Statistical Report 2016.		
HERO ID:	10472414		
Conditions of Use:	Flooring		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	Tables 1-6 includes US sales, import and export volumes (pgs. 12-13)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	Medium	Report contains economic data that be useful for the occupational scenario- commercial use of flooring.
	Metric 4: Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5: Sample Size	Medium	Total for the country values are provided; Numbers are generated based on totaling the sales which may have contained ranges not stated in the report.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, data sources, and assumptions. Methods are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		Medium	

Study Citation:	Feigal, R. J. (1983). Potential contraindications for the use of formaldehyde in dentistry. Illinois Dental Journal 52(2):90-92.			
HERO ID:	6249915			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Chemical concentration:	The most popular formulation of formocresol contains 19% formaldehyde and 35% cresol in a vehicle of 15% glyceride and water.(1/3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	Report does not specify the data used.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for use in dental procedures, which is similar to the in-scope occupational scenario use of laboratory chemicals.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium		

Study Citation:	Fent, K. W., Musolin, K., Methner, M. (2013). Evaluation of chemical exposures during fire fighter training exercises involving smoke simulant.
HERO ID:	2452610
Conditions of Use:	Firefighting

EXTRACTION	
Parameter	Data
Process description:	Exercises involving smoke simulant are conducted to train fire fighters on proper fire-attack and victim-rescue techniques in low visibility conditions inside the training tower. The training rooms on each floor had different obstacles, all made of steel. The first floor training room had a stove, the second floor training room had a bed, and the third floor training room had a desk. A built-in MDG Fog Generator System generated the oil-based smoke simulant. This system was controlled remotely from a nearby classroom. MDG Neutral Fluid was heated (maximum of 140 degrees Fahrenheit [°F]) in an external reservoir and pressurized (50 pounds per square inch). It was then transported along with pressurized nitrogen sheath gas (50 pounds per square inch) to the training rooms on each floor. The gas and fluid terminated at the nozzle in each room to produce airborne oil-based aerosol with a reported particle size of 0.5 to 0.7 micrometers (μm). In addition to the oil-based smoke simulant, the fire department occasionally used a glycol-based smoke simulant. Portable fog machines (High End FQ-100) generated the glycol-based smoke simulant. Glycol-based fluid was poured into the machine, heated, and aerosolized into the training room. The portable fog machines are less expensive to operate than the built-in oil-based fogging system; however, the portable units require longer periods to reach a smoke saturation point necessary for training exercises. After generating oil-based smoke simulant, glycol-based smoke simulant, or both, the fire department also occasionally (35%–40% of the time) used propane burners and heaters to generate rollover fire conditions inside the training room. This process was controlled remotely from the nearby classroom. Exercises involving heat and fire were intended to mimic conditions that a fire fighter may encounter in the field, including temperatures above 400°F.
Number of sites:	1

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	Uninformative	The data are for an occupational scenario for thermal degradation products which is not a COU within the scope (firefighter training).
	Metric 4: Temporal Representativeness	High	2013 - after PEL (1992) and less than 10 years
	Metric 5: Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	NIOSH report derived from site visit.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	qualitative information provided

Overall Quality Determination **Uninformative**

Study Citation:	Ferranti, M. M. (2001). Formaldehyde biological removal from exhaust air in the composite panel board industry - from pilot tests to industrial plant operation. :165-176.			
HERO ID:	5945201			
Conditions of Use:	Manufacturing of formaldehyde			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	annual formaldehyde production exceeds 15 million tons			
Life cycle description:	production of thermosetting resins, corrosion inhibitor and c~elating agent for industrial and domestic detergents, fungicide, disinfectant, textile industry, production of controlled release fertilizers			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.	
Overall Quality Determination		Medium		

Study Citation:	Fishbein, L. (1992). Exposure from occupational versus other sources. Scandinavian Journal of Work, Environment and Health 18(S1):5-16.
HERO ID:	200024
Conditions of Use:	Multiple

EXTRACTION

Parameter	Data
Production, import, or use volume:	3.21 million tons (1990) (60 % is used in plastics and resins, 22% in intermediates; 18% for misc applications (animicrobials, tissue presentation and embalming))

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Low	nothing was specified
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	Medium	Exposure at home and at work
	Metric 4: Temporal Representativeness	Low	Published 1989
	Metric 5: Sample Size	Low	no statistics were included
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Uninformative	no documentation was provided
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.

Overall Quality Determination	Uninformative

Study Citation:	Flaris, V., Singh, G., Rao, A.R. (2009). Recycling electronic waste. <i>Plastics Engineering</i> 65(5):10-15.			
HERO ID:	1479228			
Conditions of Use:	Recycling			
EXTRACTION				
Parameter	Data			
Process description:	General process flow diagram is given in figure 2. Also, general descriptions about different recycling techniques are in the article but formaldehyde is not specified anywhere except mentioning that formaldehyde might be a chemical used in any electronic equipment.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Information applies to the U.S.	
	Metric 3: Applicability	Low	Data are for recycling, an in-scope occupational scenario. But, the process descriptions are general and not for removal of formaldehyde containing equipment.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	N/A	Not applicable - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - process description.	
Overall Quality Determination		Medium		

Study Citation:	Flyvholm, M.A. (1997). Formaldehyde exposure at the workplace and in the environment. Allergologie 20(5):225-231.			
HERO ID:	1320916			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Manufacture of basic metals 0.52 tons; Manufacture of fabricated metal products 150 tons; Electric machinery and apparatus 4.1 tons; Manufacture of transportation equipment 2.5 tons; Painters and carpenters 2.6 tons; Construction 0.23 tons; Publishing and printing 1.9 tons; Wholesale trade (selected industries) 2.4 tons; Manufacture of textiles and leather 4.6 tons; Manufacture of wood and furniture 30 tons; Manufacture of paints, petroleum, and bitumen products 0.077 tons; Manufacture of non-metallic mineral products 4,300 tons; Manufacture of precision and optical instruments 0.0001 tons; Manufacture of plastic and boat building and repair 0.1 tons; Personal services, cleaning, and hair dressing 0.1 tons; Sewage and refuse disposal 0.0018 tons; Agriculture, hunting and forestry 0.62 tons; Health services and pharmacies 5.9 tons - Total for formaldehyde 4,500 tons			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The report uses data provided directly from industry groups that use formaldehyde in their products.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Denmark - an OECD member	
	Metric 3: Applicability	N/A	Provides an estimate of usage for a wide range of commercial and industrial applications.	
	Metric 4: Temporal Representativeness	Low	The study was derived from data compiled in 1989, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	N/A	only estimated usage is quantified.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources - Survey	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Fondelli, M.C., Costantini, A.S., Ercolanelli, M., Pizzo, A.M., Maltoni, S.A., Quinn, M.M. (2007). [Exposure to carcinogens and mortality in a cohort of restoration workers of water-damaged library materials following the River Arno flooding in Florence, 4 November 1966]. La Medicina del Lavoro 98(5):422-431.			
HERO ID:	1508862			
Conditions of Use:	Use of Water Treatment Products			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Use in restoration room from 1979-1993: 10 (L)			
Chemical concentration:	Fixative solutions (3%)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Italy, an OECD country.	
	Metric 3: Applicability	High	Data are for water treatment products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2007)	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Formaldehyde Institute, (1984). Letter from Formaldehyde Institute to USEPA regarding comments on ANPR for urea-formaldehyde resins.			
HERO ID:	6574573			
Conditions of Use:	manufacturing			
EXTRACTION				
Parameter	Data			
Chemical concentration:	There are at least several hundred uncured urea formaldehyde resins that have been used commercially. In general, the mole ratio of urea to formaldehyde is 1:1.1-1.25, % solids is 15-100, % free formaldehyde is 0.2-5 (wt/wt %), % free urea is 0-5.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The data sources used in the report are not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		Medium		

Study Citation:	Fregert, S. (1980). Irritant dermatitis from phenol formaldehyde resin powder. Contact Dermatitis 6(7):493-493.			
HERO ID:	1317355			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Electric insulation material was made of Bakelite®, a phenol-formaldehyde resin manufactured by heating and pressing the not completely condensed resin powder in molds. The yellow-brown powder in sacks was poured into open vessels, producing a heavy dust. The powder was then transferred by scoops to smaller vessels and then to the molds. This handling caused pollution. Wrongly made objects were ground to powder, forming dust which covered the machines and floor with Bakelite powder.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Sweden, an OECD country.
	Metric 3:	Applicability	High	Data are for plastic material and resin production, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1980)
	Metric 5:	Sample Size	N/A	Not applicable - process description
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - process description.
Overall Quality Determination			Medium	

Study Citation:	Friedman, D., Herrera-Moreno, V. (1996). Health hazard evaluation report HETA-95-0313-2589, University of Michigan Hospitals Ann Arbor, Michigan.				
HERO ID:	1317120				
Conditions of Use:	Use of Cleaning and Furniture Care Products				
EXTRACTION					
Parameter	Data				
Process description:	ESD employees reported that floor care products are aerosolized with hand-held chemical sprayers or diluted in water for use with mops or in automatic machines. Hand- held scrubbers are used in areas which are hard to reach using automatic equipment (such as baseboards). A blower is often used to dissipate vapors. In addition to daily floor care, floors are stripped and waxed at least once a year, using at least five coats of finish. High use areas (such as main corridors in the hospitals) are stripped/waxed two to three times a year. Recoating is performed more frequently.				
Chemical concentration:	<1%				
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH HHE	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	1995 - more than 20 years old	
	Metric 5:	Sample Size	N/A	No sample data.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Process description and factual information. No scope to address variability and uncertainty.	
Overall Quality Determination			High		

Study Citation:	Fur, X.L., Galhac, M., Zanetti, M., Pizzi, A. (2004). Recycling melamine-impregnated paper waste as board adhesives. Holz als Roh- und Werkstoff 62(6):424-428.			
HERO ID:	1963424			
Conditions of Use:	Use of Paper Products			
EXTRACTION				
Parameter	Data			
Life cycle description:	Melamine-formaldehyde (MF) and melamine-urea-formaldehyde (MUF) resins are used to impregnate paper for the manufacture of both high pressure and particularly low pressure laminates (Pizzi 1983, 1994). After the preparation either of the impregnated paper or of the final laminate at the hot press a considerable amount of paper impregnated with non-fully-cured melamine resins is produced by square-trimming the paper. The amount of this dry waste is considerable, running up to 400 tons/year in just a medium sized paper impregnating factory (Botcher 2002, personal communication).			
Chemical concentration:	This powder is composed of cellulose (~50%), melamine (~40–50%), some urea and some formaldehyde linked to the melamine.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from France, an OECD country.	
	Metric 3: Applicability	High	Data are for paper products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2004)	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	FWIC, (2020). Comments of the Federal Wood Industries Coalition regarding the draft scope of the risk evaluation for formaldehyde (comment submitted by Jackson Morrill).			
HERO ID:	10370211			
Conditions of Use:	Commercial Use, Building/ construction materials (wood and engineered wood products)			
EXTRACTION				
Parameter	Data			
Life cycle description:	"One common feature of these products is the requirement for use of moisture-resistant adhesive systems because of wide-scale usage in exposed construction environments. This has led to usage of resin binders other than conventional urea-formaldehyde adhesives. Phenol formaldehyde and polymeric diphenyl methane diisocyanate resins with minimal formaldehyde emissions are the most common adhesive systems used in these products" (page 13 of 17)			
Comments:	Various scoping comments are included in this document, particular requests to exclude certain products due to them already being covered by other regulations such as n TSCA Title VI and the Formaldehyde Standard Regulations			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Comment from Federal Wood Industries Coalition, who would be knowledgeable in this field, and several references cited.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	United States	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	Relevant reference from 2013	
	Metric 5: Sample Size	N/A	qualitative	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.	
Overall Quality Determination		High		

Study Citation:	Gagnon, Y. T., Kennedy, E. R., Seitz, T., Teass, A. W. (1992). Development and evaluation of a method to estimate potential formaldehyde dose from inhalable dust/fibers. 7(4):231-240.			
HERO ID:	6026019			
Conditions of Use:	Finishing agents in textile, apparel, and leather manufacturing (garment manufacturing, waterbed accessory production)			
EXTRACTION				
Parameter	Data			
Chemical concentration:	untreated cotton fabrics: <2 ppm (pg 3); ""To determine if there was irreversible adsorption of formaldehyde to untreated, cotton-based fabrics, several types of test fabrics were fortified with known amounts of formaldehyde solution (1 $\mu\text{g}/\mu\text{L}$). Average recoveries of formaldehyde from both mercerized, combed-cotton broadcloth samples and the control samples were 85.8 +/- 5.2 percent and 85.5 +/- 4.3 percent, respectively (6 samples per level; 3 levels), and were equivalent at all three concentration levels. The less than stoichiometric recovery for these samples, including the reference samples, is probably due to loss of formaldehyde into the headspace of the sample vial. With the polyester/cotton broadcloth, the recovery was dependent on loading. At 10.6 $\mu\text{g}/\text{sample}$, recovery was 0.6 & 0.7 percent. Recovery increased to 45 +/- 3.4 percent and 77.8 +/- 3.8 percent at 107 and 1186 $\mu\text{g}/\text{sample}$ "" (pg 5) ""The control samples contained 183.8 +/- 6.5 μg of formaldehyde, as determined by the chromotropic acid method. The same samples, when analyzed using the 2,4-DNP method, contained 174.8 +/- 3.6 μg of formaldehyde. The samples exposed to formaldehyde vapor contained 2137 +/- 250 μg (chromotropic acid method) and 2082 +/- 240 μg (2,4-DNP method).... [after exposure to ambient air for 1 hour to study loss of absorbed FA] The total amount of formaldehyde found for each sample was 1734 +/- 228 μg of formaldehyde"" (pg 6)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for fabric finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (mean, standard deviation) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by evaluating via multiple methods but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Garbassi, F., Po, R. (2001). Engineering thermoplastics. :168-228.			
HERO ID:	8486226			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Life cycle description:	Application of reaction product: "Applications range from gears, bearings and cranks in the automotive field, engineering components, appliance casings, cassette cartridges, containervelues, to pump components. PTFE filled grades are used for moving parts, where low friction is important." pdf pg. 17-18			
Process description:	"Acetal resin is the common name for homopolymersof formaldehyde. This material is also referred to as polyoxymethylene, or copolymers of formaldehyde and oxiranes (20). polyoxymethylene was obtained from the polymerization of trioxane (the cyclic trimer of formaldehyde). Du Pont began tocommercialize polyoxymethylene (trade name Delrin) and some years later Celanese started to produce formaldehyde–ethylene oxide copolymers (trade name Celcon). A key point in the homopolymerization process was the prevention ofdepolymerization at high temperatures; this was accomplished through an end-capping with suitable compounds." pdf pg. 17-18			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data, is a frequently used source (Kirk-Othmer) and associated information does not indicate any flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for processing as a reactant, an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is not addressed. Variability is discussed with the different processes for acetal resins.
Overall Quality Determination			High	

Study Citation:	Gelman Sciences (1989). Reports on 1,4-dioxane and polyethylene glycol in products with cover letter dated 011489. 890000081:#89-890000081.			
HERO ID:	195919			
Conditions of Use:	Unknown			
EXTRACTION				
Parameter	Data			
Chemical concentration:	4 ppm max (in Carbowax Polyethylene glycols)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	The techniques or methods used for data in the assessment or report are not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Low	Data does not readily relate to an occupational exposure scenario but may be useful depending on what Carbowax PEG may be used in.
	Metric 4:	Temporal Representativeness	Low	Published 1989, more than 20 years old
	Metric 5:	Sample Size	Low	no statistics were included
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	nothing on variance or uncertainty
Overall Quality Determination			Low	

Study Citation:	General Motors Co (1982). Die-cast operations benzo(a)pyrene plating operations asbestos nitrosamines with cover letter.			
HERO ID:	1231414			
Conditions of Use:	Processing aid			
EXTRACTION				
Parameter	Data			
Process description:	Three plating systems were located in two plant areas. An automatic barrel plating system in Department 2 was located just south of the aforementioned die-cast area. This system was installed in 1978 and consisted of 32 plating tanks. The parts were automatically loaded into rotating perforated barrels and the barrel doors were secured.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for application of surface treating agents, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - process description	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - process description.	
Overall Quality Determination		High		

Study Citation:	Gerberich, H. R., Seaman, G. C. (2013). Formaldehyde. 11:929-951.			
HERO ID:	626378			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Annual worldwide production capacity now exceeds 15 X 106 t (calculated as 37% solution). The United States, Canada, Europe, and Japan account for nearly 70% of the total capacity.			
Life cycle description:	Formaldehyde is a basic chemical building block for the production of a wide range of chemicals finding a wide variety of end uses such as wood products, plastics, and coatings.			
Process description:	Following World War II, as much as 20% of the formaldehyde produced in the United States was made by the vapor-phase, noncatalytic oxidation of propane and butanes. This nonselective oxidation process produces a broad spectrum of coproducts which requires a complex costly separation system. Hence, the methanol process is preferred. The methanol raw material is normally produced from synthesis gas that is produced from methane. Most of the world’s commercial formaldehyde is manufactured from methanol and air either by a process using a silver catalyst or one using a metal oxide catalyst. Reactor feed to the former is on the methanol-rich side of a flammable mixture and virtually complete reaction of oxygen is obtained; conversely, feed to the metal oxide catalyst is lean in methanol and almost complete conversion of methanol is achieved.			
Number of sites:	16 companies producing formaldehyde in 1992			
Chemical concentration:	37 wt % formaldehyde			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Ghasemkhani, M., Jahanpeyma, F., Azam, K. (2005). Formaldehyde exposure in some educational hospitals of Tehran. Industrial Health 43(4):703-707.			
HERO ID:	6117989			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Annual worldwide production of formaldehyde is 12 million tons. (1/5)			
Throughput:	The amount of formaldehyde consumption at surgery rooms was 500mL per 45m2 and at each endoscopy wards were 15-50 tablets (each tablet 1 mg) per day. (2/5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Throughput and PV information. No scope to address variability and uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Gibbins, J. D., Brueck, S. E., Sylvain, D., Oza, A. (2017). Health Hazard Evaluation Report: HHE-2010-0001-3295, November 2017. Evaluation of Occupational Exposures at an Insect Rearing Facility.			
HERO ID:	4794995			
Conditions of Use:	Other-Insect Rearing			
EXTRACTION				
Parameter	Data			
Process description:	The moths reared at this facility were sterilized by irradiating them with cobalt 60. Sterile moths were subsequently released from aircraft into cotton fields as the Sterile Insect Technique component of the International Pink Bollworm Eradication Program. At the time of evaluation, between 20 and 26 million moths were produced daily during the cotton growing season; the facility was designed to produce approximately 15 million moths daily. Smaller numbers of moths (approximately 300,000 per day) were reared during the off season to maintain a continuous supply of bollworms on the basis of the lifecycle shown in Figure 1. Moth production was divided into two areas: “dirty” and “clean.” The dirty area refers to the part of the PBWRF where scales from moth wings (moth scales) were released during operations. The dirty area was maintained under negative pressure relative to surrounding areas to contain moth scales. The clean area refers to locations within the PBWRF where adult moths and scales should not be found. This arrangement was necessary to protect the health of the moth colony and ensure adequate moth production. Appendix B provides long detailed process descriptions of all work areas.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used source	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data is for US.	
	Metric 3: Applicability	Low	Information is not clear on the function of formaldehyde in the process, it’s possible that the function is as a fungicide which would be outside of the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	Data is just over 10 years old (2009).	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Gockel, D.L., Horstman, S.W., Scott, C.M. (1981). Formaldehyde emissions from carbonless copy paper forms. American Industrial Hygiene Association Journal 42(6):474-476.			
HERO ID:	1317354			
Conditions of Use:	Use of Paper Products			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances in paper: Carbonless copy paper forms			
Chemical concentration:	Table 1 provides a summary of formaldehyde for 8 different forms range 33.6-858 ug/kg of forms			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	NIOSH methods were likely used as the authors noted that the samples were analyzed spectrophotometrically using the chromotropic acid method as in NIOSH P&CM No. 125.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for use of carbonless copy forms, which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The article was published in 1981 before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	Godby, M., Knutti, E. (1993). Health hazard evaluation report No. HETA-91-181-2307, Haddon Craftsmen, Inc., Scranton, Pennsylvania. NIOSH(HETA-91-181-2307):91-181.
HERO ID:	1320742
Conditions of Use:	Multiple

EXTRACTION	
Parameter	Data
Process description:	BookbindingThe printing of the pages is accomplished off-site. Signatures (the printed page sections) arrive at the facility from the printers. Six varieties of hot-melt glues are used in nine machines on threefloors of the main facility to produce finished volumes. The hot-melt glues arrive in solid pellet form and are preheated in gas-fired, pre-melt pots near the points of application.The liquified hot-melt glues are then piped to the respective points of application, where they are heated further and applied at approximately 350 F. Hot-melt glues are used in these machines:Kolbus Tipper, UB4 and UB5 binders, Compact 45, 3 Kolbus Liners, End Paper Combiner, and Crathern Casemaker. On the second floor, the Kolbus Tipper places end leaf pages onto the first and last signatures. The signatures are then loaded into gathering machines on the first floor which assembles them into sequential order. The ordered signatures pass through the UB4 or UB5 binder, where hot-melt glue is applied to bind them together. Combustion of natural gas is used to speed the drying of the hot-melt glues between operations. The bound signatures are trimmed to book size. A vacuum system picks up the scrap paper at the point of liberation and carries it to the baler area where the scrap is deposited into either one of two large rooms (about 300 yd3 each) above the baler. Other processes throughout the facility are involved with producing various types of covers. In the basement, two Cloth Cutter machine operators prepare cloth to selected widths; the Crathern Casemaker operator produces laminated cloth hardcovers; four Kolbus and Chandler-Price Stamper machine operators use heated plates (300 F) to apply metal foil designs onto covers; and the Dexter machine produce laminated paper covers. On the ground floor, three Kolbus Liner machines add reinforcement to hard covers. At the End Paper Combiner, liners for hard covers are cut. The Compact 45 machine places these covers and single-sheet "dust covers" onto the trimmed signature bundles as the final step in producing the finished volume. The finished books are stacked onto pallets for packaging and shipment.A shrinkwrap operation wraps clear plastic sheeting around pallets stacked with books, book boards (stiffeners which separate and reinforce signature bundles during shipment to the facility), and other materials before shipment from the facility. A propane torch is used to shrink the sheeting. The shrinkwrap operation is only performed on the day shift and requires about 20-30 minutes per day.Natural gas fuels the pre-melt pots and is also burned at the binding machines (UB4 and UB5) to speed the drying ofthe hot-melt glue between operations.
Throughput:	About 1,000 pounds of hot-melt glues are used to produce 100,000 hard cover and 25,000 paperback books each day.
Number of sites:	1

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	NIOSH Study
Domain 2: Representativeness		Metric 2: Geographic Scope	High	US
		Metric 3: Applicability	High	The report is for an occupational scenario (book Binding)within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	Low	1992 - more than 20 years old
		Metric 5: Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Low	qualitative information provided

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Study Citation:	Godby, M., Knutti, E. (1993). Health hazard evaluation report No. HETA-91-181-2307, Haddon Craftsmen, Inc., Scranton, Pennsylvania. NIOSH(HETA-91-181-2307):91-181.		
HERO ID:	1320742		
Conditions of Use:	Multiple		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Godderis, L., Deschuyffeleer, T., Roelandt, H., Veulemans, H., Moens, G. (2008). Exposure to metalworking fluids and respiratory and dermatological complaints in a secondary aluminium plant. International Archives of Occupational and Environmental Health 81(7):845-853.
HERO ID:	474862
Conditions of Use:	Use of Metalworking fluid

EXTRACTION	
Parameter	Data
Process description:	The production process, conditions and use of MWFd iVered between the departments. During the Extrusionprocess a thin Wlm of MWF was added to a cylindrical alu-minium billet of 450–500°C and to the ram. The billets were then pushed through shaped dies by means of the ram. In the Rolling Mill departments, MWF were used to cool the work rolls and provide lubrication for the cast ingot in contact with the work rolls. Before passing through the Hot Rolling Mill the cast ingots were pre-heated to about 500°C. At the entrance and in the Rolling Mill a 6–7% min-eral oil emulsiWed in water at 60°C is sprayed continuously during the rolling process. The ingot is rolled to a thickness of about 4–6 mm. The strip after Hot Rolling Mill was coiled for transport to the Cold Rolling Mill. During the Cold Rolling Mill process the thickness of the strip was reduced to about 0.05 mm under an aerosol of MWF. A detailed description of work processes within the secondary aluminium industry can be found on http://www.eaa.net .

		EVALUATION		
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Canada - OECD member
	Metric 3:	Applicability	Uninformative	Data are for formaldehyde as either a combustion byproduct or biocide byproduct, which is not in scope.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data are greater than 10 years old but no more than 20 years old - Published in 2008 but the data are from 2005
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination **Uninformative**

Study Citation:	Goldman, P., Flach, H. D., Hey, W., H, Hochadel, Petri, N., KU, Strassburger, Thiess, A. M. (1982). Formaldehyde morbidity study by Goldmann P et al (19).			
HERO ID:	5908864			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	"Formaldehyde is produced by reacting methanol with air oxygen at 700°C. in continuously operating automatically-controlled closed plants. The off gases are incinerated. The formaldehyde is further processed into condensation resins on a continuous and batch type basis in closed equipment. The facilities for the manufacture and processing of formaldehyde are predominately housed in buildings. Storage tanks, filters, and packaging plants are also in closed areas or are equipped with exhaust devices for vapors. Formaldehyde or formaldehyde hyde-containing products are removed from these areas by personnel only for the purpose of further processing. pg (6/20)"			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are form the U.S.
	Metric 3:	Applicability	High	Data are for the production of formaldehyde, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	Gonzalez-Garcia, S., Feijoo, G., Widsten, P., Kandelbauer, A., Zikulnig-Rusch, E., Moreira, M. (2009). Environmental performance assessment of hardboard manufacture. International Journal of Life Cycle Assessment 14(5):456-466.		
HERO ID:	1697561		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Life cycle description:	Incorporation into an article - hard board manufacture		
Process description:	Subsystem of wood preparation - The main raw material is green wood chips from mostly Norway spruce (Picea abies) and European beech (Fagus sylvatica) delivered by truck wood-based industries such as sawmills, satellite chip mills, etc. Initially, wood chips are washed to remove dirt and other debris. Clean chips and additional raw material from the plant (sanding dust, sawdust, trimmings, rejected hardboard etc.) are reduced into fibers and resinated (optional) and placed in a storage bin. Part of the wood material is burned in biomass boilers to produce thermal energy for the plant activities. Subsystem of board forming - Fibers (with or without resin) are transported from the storage bin to the forming machine where they are deposited onto a moving conveyor and formed into a mat. The mat is pre-pressed and trimmed before being loaded into the hot press. This press applies heat and pressure to cure the resin and bond the fibers into solid boards. Usually, the press uses a multi-opening batch press and is heated (to ~200°C) by steam produced at the thermal energy plant. Subsystem of board finishing - After pressing, the boards are placed in a conditioning room and then fabricated by sanding and sawing into final size. Finally, the boards are packaged and sent to the warehouse for delivery to consumers. Trimming residues are recycled back to board production or used for on-site energy production. Ancillary activities - Several auxiliary activities were included within the system boundaries. Phenolic resin, paraffin emulsion and other chemicals production were part of the subsystem of wood preparation.		
Throughput:	83000 m3 (2007)		
Number of sites:	1		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Austrian hardboard plant was studied. Austria is an OECD member country.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Medium	The data were published in 2009, after the most recent PEL (1992) and more 10 but less than 20 years old.
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
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Study Citation:	Gonzalez-Garcia, S., Feijoo, G., Widsten, P., Kandelbauer, A., Zikulnig-Rusch, E., Moreira, M. (2009). Environmental performance assessment of hardboard manufacture. International Journal of Life Cycle Assessment 14(5):456-466.		
HERO ID:	1697561		
Conditions of Use:	Compressed Wood Product Manufacturing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Goris, J.A., Ang, S., Navarro, C. (1998). Laboratory safety: Minimizing the toxic effects of formaldehyde. Laboratory Medicine 29(1):39-42.			
HERO ID:	1321428			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Life cycle description:	Formaldehyde is manufactured and made available as 30%-50% solutions. It may be refined or converted to a polymerized white powder or flake known as paraformaldehyde, which slowly releases gaseous formaldehyde.			
Chemical concentration:	Most formaldehyde is available as 30% to 50% solutions with buffers to inhibit intrinsic polymerization. Formalin, a commercial preparation, is a colorless 37% aqueous solution of formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for manufacture, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1998)	
	Metric 5: Sample Size	N/A	Not applicable - life cycle description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - life cycle description.	
Overall Quality Determination		Medium		

Study Citation: Goris, J.A., Ang, S., Navarro, C. (1998). Laboratory safety: Minimizing the toxic effects of formaldehyde. Laboratory Medicine 29(1):39-42.	
HERO ID: 1321428	
Conditions of Use: Laboratory Use	
EXTRACTION	
Parameter	Data
Number of sites:	11,000 laboratories in the US [according to OSHA]
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Methodology
Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
High	U.S. data
Metric 3:	Applicability
High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness
Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
Metric 5:	Sample Size
N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination	Medium

Study Citation:	Graves, G. (1999). Urea-formaldehyde resins: Yesterday, today, and tomorrow. :3-10.			
HERO ID:	5950827			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	UF resin produced ranged between 1,000 and 2,500 million pounds of resin solids per year for 1969 to 1982; 75% of UF resin produced is used for wood adhesives			
Process description:	Commercial production of UF resins and curing; takes place in 10,000-20,000 gal reactor vessels at elevated temperature; higher temperautre and lower pH speeds up curing process			
Chemical concentration:	Melamine-fortified UF resins typically 10-20% melamine (different than true MUF resins) to improve moisture resistance			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for processing as a reactant, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by temporal changes in industry but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Greeson, H. K., Jr, Browning, K. J., Farrell, J. D. (2012). Formaldehyde reduction for durable press cotton fabrics. AATCC Review 13(3):36-40.			
HERO ID:	5950815			
Conditions of Use:	Processing - textile finishing			
EXTRACTION				
Parameter	Data			
Chemical concentration:	In 2010, less than 2% of clothing items tested had formaldehyde concentrations over 100 ppm, compared to 67% of the items tested in 1984. In this study, a max concentration of about 245 ppm formaldehyde was observed in washed garments.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by using two types of formaldehyde scavengers, but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	Grzeskowiak, R., Jones, G.D., Pidduck, A. (1988). Identification and determination of volatiles derived from phenol-formaldehyde materials. Talanta 35(10):775-782.			
HERO ID:	1482559			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Schematic of cold trap apparatus shown in Figure 1 on PDF Pg. 2.			
Chemical concentration:	Table 5: ND-574 (umole/g), Table 6: NQ-2 (umole/g)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from the United Kingdom, an OECD country.	
	Metric 3: Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1988)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by testing multiple material types but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Gu, J., Kirsch, I., Schripp, T., Froning-Ponndorf, F., Berthold, D., Salthammer, T. (2018). Human exposure to airborne particles during wood processing. Atmospheric Environment 193:101-108.			
HERO ID:	5954949			
Conditions of Use:	Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The pilot plant consists of two enclosed production halls, A and B, where several machines are installed (see Figure S3). Hall A has a dimension of 30 m × 10 m × 7 m (L × W × H), and was used for sawing, flaking, cross hammer mill, chipping and sieving. Hall B has a size of 35 m × 15 m × 7 m (L × W × H). The processing’s including drying, refinery, gluing and pressing were carried out in Hall B. Particles were measured in the pilot plant for processing including sawing, flaking, cross hammer mill, chipping, sieving, drying, refinery, as well as gluing, forming and pressing. Four common woods of birch, oak, beech and pine were processed. Three types of wood board (medium density fiber board (MDF), oriented strand board (OSB) and particle board) were produced from each wood type. During a processing cycle, the particle instruments were placed next to the production site at a distance of about 1.5 m. It was chosen to represent the exposure situation of the machine operator. The online particle measurement was started before the processing to obtain the particle background concentration. Four types of woods were processed one after another. There was a break between processing each wood, which allows the emitted particles to disperse and the concentrations to decrease. When the processing finished, the instruments kept measuring for 30 min or until the concentrations decreased to the similar level as background concentration. A detailed protocol was kept recording the sequences ofprocesses (start, processing, end, break, cleaning etc.) and any other activities that may influence the particle concentrations. The pilot scale wood processing may reflect the situations in a carpentry or in a DIY workshop.In the wood-based panel factory, we carried out the measurements at five production sites including wood chipping, refinery hall, MDF form station, MDF press station, and MDF sanding & cutting station.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used source.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.
	Metric 3:	Applicability	Medium	The process description contains information relevant to a condition of use in the scope but does not contain any information specific to formaldehyde.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Process description.
Overall Quality Determination			High	

Study Citation:	Gunter, B. J. (1977). Health Hazard Evaluation Report No. 77-37-413, Gates Rubber Company, Denver, Colorado.			
HERO ID:	8488494			
Conditions of Use:	Synthetic rubber manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Rubber hose is fed into a braiding machine, and the hose is reinforced with rayon cord. This cord is braided around the rubber hose. The rayon cord has been pre-treated in another area of the plant by a rewinder. During rewinding, the cord is dipped into a solution containing formaldehyde. (2/10)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for synthetic rubber manufacturing, which is similar to the in-scope occupational scenario synthetic rubber manufacturing in transportation equipment.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Gunter, B. J., Klineciewicz, S., Daniels, W. J. (1989). Health Hazard Evaluation Report HETA 88-294-1974, Boeing Aircraft, Seattle, Washington, July 1989.			
HERO ID:	1320761			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Process description:	Frozen rolls of phenol-formaldehyde resin-impregnated fiberglass are taken from a deep-freeze and thawed. Strips of this material are cut, baking film is removed, and the material is laid up by hand and tools in multiple layers. Vacuum bags are applied over the lay-up and the air is evacuated from the layers. Under vacuum, the parts are oven cured at 250oF for 90 minutes. The parts are then cooled, debagged, and moved through trimming, deburring,sanding, and inspection stations. The surfaces of the parts are prepared, and the parts are painted, wrapped, and shipped.Phenol-formaldehyde resins obtain their commercially useful structural properties as a result of a polycondensation type of chemical reaction. "In polycondensation, two or more starting materials react with each other to build up the molecular structure. The initial polycondensation reaction is interrupted at a stage in which the prepolymer possesses properties that are desirable for further processing in the molding phase. The resins are sometimes referred to as "prepreg" materials at this stage of the process. The phenolic resins that were in use at Boeing are a class of resins known as thermosets, which means that they harden when heated and cannot be reformed after obtaining their desired shape. Because these resins are a "prepreg" material which has already gone through partial polymerization prior to being brought into the lay-up area, off-gassing from some of the unreacted starting materials may occur. Particulate exposures, however, are not of concern based on the physical properties of the material at this point. Particulate exposure may occur after the material has been cured and operations such as trimming and sanding begin.			
Number of sites:	1 location 2 buildings			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (aircraft manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1988 - more than 20 years old
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Gutierrez, R.C., Valenzuela, L., Wilson, H.P. (2018). Mechanical Properties and Formaldehyde Release of Boards Manufactured with Hygrothermally Treated Tapa (Laureliopsis Philippians Looser) Particles. Drvna Industrija 69(2):113-120.			
HERO ID:	5966866			
Conditions of Use:	Building and construction materials (particleboard)			
EXTRACTION				
Parameter	Data			
Process description:	Hygrothermally treated and untreated L. philippiana particles were employed. The percentage of wood in the outer layer was 30 % and in the inner layer 70 %. UF (50 % solid) produced by Georgia Pacific Corp. with a molar ratio of 1:1.22 was applied as adhesive. This is a high emission resin, and was used without formaldehyde scavenger and without hardener in order to best determine the variation in formaldehyde release due to hygrothermal treatment. Particleboards with nominal densities of 600, 625, 650, 675 and 700 kg-m-3, with dimensions of 53 x 53 cm and 15 mm thickness were produced. The adhesive was applied at 8 % loading (dry basis) spraying it in a Drais FSP-80 blender. Pressing was conducted in a Bürkle LA-160 press at a temperature of 180 °C for 180 s. The maximum pressure used was 3 N-mm-2 for 30 s and half pressure of 1.5 N-mm-2 for 150 s. Two boards were produced for each nominal density, a total of 10 boards with non-treated particles and 10 boards with treated particles. (pg 3)			
Chemical concentration:	UF (50 % solid) produced by Georgia Pacific Corp. with a molar ratio of 1:1.22 was applied as adhesive (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Ecuador and Chile, the latter being an OECD country
	Metric 3:	Applicability	High	Data are for building/construction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	process description/concentration data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	process description/concentration data
Overall Quality Determination			High	

Study Citation:	Gössler, E., Messner, M., Mühlhauser, M., Traussnig, H. (1998). Use of recycled fibers for paper and board in food contact. Roczniki Państwowego Zakładu Higieny 49(2):137-157.			
HERO ID:	6194980			
Conditions of Use:	Paper manufacturing (using recycled fibers)			
EXTRACTION				
Parameter		Data		
Production, import, or use volume:		Table on pg 1 presents data for paper and board production, consumption, and recovery for 14 European countries; Figures 1 and 2 on pg 2 present waste paper consumption in Austria 1981-1996 and waste paper collection % for 16 European countries, respectively; more similar data on following pages, nothing FA-specific		
Chemical concentration:		Figure 5 (pg 11) presents FA migration to cold water extract data for paper/board made with recycled fiber, in mg/kg, for various years		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Medium	Report uses high quality data/techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	Data are from Austria, an OECD country.
		Metric 3: Applicability	High	Data are for paper manufacturing, an in-scope occupational scenario
		Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
		Metric 5: Sample Size	Low	Sample distribution is described qualitatively (graphically).
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Medium	Variability addressed by evaluating data for various countries over multiple years but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Halperin, W.E. (1983). Nasal cancer in a worker exposed to formaldehyde. JAMA: Journal of the American Medical Association 249(4):510-512.			
HERO ID:	1512183			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Process description:	In the finishing of fabric, a textile is permeated with a formaldehyde-based resin to provide crease resistance. In the process, formaldehyde resin of either the urea or melamine type is mixed with catalysts, wetting agents, and other ingredients in a 50- to 300-gal agitated open tank. The mix or liquor is then piped to a trough that contains 25 to 75 gal. Fabric from a roll passes on rollers through the trough, through a set of squeeze rollers to remove excess liquid, through a drying oven, and is then rerolled.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for fabric, textile and leather products not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1983)
	Metric 5:	Sample Size	N/A	Not applicable - process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - process description.
Overall Quality Determination		Medium		

Study Citation:	Halvarsson, S., Norgren, M., Edlund, H. (2004). Manufacturing of fiber composite medium density fiberboards (MDF) based on annual plant fiber and urea formaldehyde resin. :131-147.			
HERO ID:	5972575			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing; plastic material and resin manufacturing (including structural and fire-worthy aerospace interiors); construction; paper manufacturing			
EXTRACTION				
Parameter	Data			
Chemical concentration:	15-19% UF			
Comments:	Production of fiber composite materials such as Medium Density Fiberboard(MDF) and particleboard (PB) is in general based on wood as a raw material.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Concentration data
Overall Quality Determination		Medium		

Study Citation:	Hansen, J., Schneider, T., Olsen, J.H., Laursen, B. (1993). Availability of data on humans potentially exposed to suspected carcinogens in the Danish working environment. Pharmacology & Toxicology 72(Supplement 1):77-85.			
HERO ID:	1010267			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	15,000 (tons) is the Approximate average amount imported and manufactured a year in Denmark during the 1980s			
Number of sites:	707 companies (the number of sites per company is not stated)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Scientific journal article	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Denmark, an OECD country.	
	Metric 3: Applicability	Low	The data pertain to use of formaldehyde in Denmark and does not pertain to particular conditions of use.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1993)	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Low		

Study Citation:	Harney, J. M., Tapp, L. (2016). Health Hazard Evaluation Report: HHE-2013-0075-3264, December 2016. Investigation of Dermal and Respiratory Exposures to Metalworking Fluids at an Automotive Parts Manufacturer.			
HERO ID:	4455212			
Conditions of Use:	Metal products not covered elsewhere			
EXTRACTION				
Parameter	Data			
Process description:	The plant produced diesel engine water pumps by machining cast iron with a soluble oil MWF. (more on Pg. 7)			
Number of sites:	1			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for metal products not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2016)
	Metric 5:	Sample Size	N/A	Not applicable - process description
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - process description
Overall Quality Determination			High	

Study Citation:	Harrison, G.A. (1968). The sterilization of the respiratory circuits of automatic ventilators using formaldehyde vapour. Medical Journal of Australia 2(5):212-216.
HERO ID:	1315176
Conditions of Use:	Non-TSCA

EXTRACTION

Parameter	Data
Process description:	Two methods can be used to sterilize a ventilator with formaldehyde. First, the whole ventilator may be introduced into a container (usually plastic) which has been filled with formaldehyde vapor. The container is usually filled with formaldehyde by running in a flow of oxygen or air which has bubbled through a bottle containing formalin solution. Second, the ventilator can be turned on to cycle regularly and the gas stream made to pass through liquid formalin. The formaldehyde vapor then passes into the ventilator, achieving a constant concentration. (2/5)
Chemical concentration:	A 40% formalin solution is used for sterilization. (2/5)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3: Applicability	Uninformative	Data are for sterilization, which is not in-scope or similar to an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination **Uninformative**

Study Citation:	Haz-Map, (n.d.). Haz-Map: Hazardous Agents: Formaldehyde.			
HERO ID:	10176929			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter		Data		
Life cycle description:		Used in the production of formaldehyde resins, plywood, particle board, paper, and ureaformaldehyde foam; embalmers and laboratory workers may be exposed to levels above 1 ppm;[LaDou, p. 502-3] The major industrial consumers of formaldehyde resins are molded plastic parts,decorative laminates, photographic film, and plywood paneling.		
Chemical concentration:		Formalin is an aqueous solution that is 37% formaldehyde by weight; inhibited solutions contain 6-12 % methyl alcohol. Sold as water solutions containing 37%, 44%, or 50% formaldehyde.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by formaldehyde concentrations in multiple products but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Hazleton Laboratories, (1982). Development document for effluent limitations, guidelines and standards for the pulp, paper, and paperboard, and the builders paper and board mills (final report) (epa 440/1-82/025).			
HERO ID:	1316234			
Conditions of Use:	Paper manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	"Polymeric Resin Treatment: Polymeric resin wastewater treatment processes make use of adsorption and ion exchange mechanisms to remove pollutants from the wastewater. Resin columns are commonly employed; they are reactivated after completion of the treatment cycle by means of acid or alkaline solutions. It has been reported that weakly basic ion exchange resins, based on a phenol/formaldehyde matrix, are superior in treating pulp and paper bleach plant effluents. Prior to resin treatment, it is advantageous to screen and filter the waste streams and adjust the pH to 2 or 3. The resin adsorption approach is being pursued by three companies: Billerud Uddeholm, Rohm and Haas, and Dow Chemical Company. The Rohm and Haas and the Dow Chemical processes are at the pilot plant stage. The Billerud Uddeholm color removal process has been operated as a full-scale batch process in Skoghall, Sweden, since 1973. Based on the experience gained through operation of the full-scale system in treating the caustic first extraction stage effluent (E1) treatment was expanded to include chlorination stage washer effluent (C1). The first full-scale continuous installation began in December of 1980 at Skoghall, Sweden. In this system, a full countercurrent wash is used, and the effluent from the E1 stage is reused on the C1 stage washer after color and toxicity removal through the application of resin adsorption. The pollutants may be removed from the resin by elution with caustic or oxidized white liquor. The eluate at 10 percent concentration is mixed with the weak black liquor to be evaporated and burned in the recovery boiler. The resin is reactivated with the chlorination effluent. The chlorination stage effluent reactivates the resin is simultaneously decolorized and detoxified. The total mill BOD5 load is reduced by 30 percent and the color load by 90 percent. The Rohm and Haas process involves the use of Amberlite XAD-B resin decolorize bleaching effluent after filtration. The resin can be reactivated without the generation of waste sludge. This reactivation may be accomplished by using mill white liquor."			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is greater than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Hazleton Laboratories, (1982). Development document for effluent limitations, guidelines and standards for the pulp, paper, and paperboard, and the builders paper and board mills (final report) (epa 440/1-82/025).			
HERO ID:	1316234			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	”Wet Strength Additives Chemicals such as urea and melanine formaldehydes used in papermaking to impart strength to papers used in wet applications.”(p.654)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is greater than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Hearn, D. (1995). Health Risks Due to Motor Vehicle Emissions in Melbourne. Clean Air 29(2):37.		
HERO ID:	5773789		
Conditions of Use:	emissions		
EXTRACTION			
Parameter	Data		
Life cycle description:	Formaldehyde is present in the exhaust of both petrol and diesel-fueled vehicles as a result of the incomplete combustion of the fuel. Formaldehyde is formed from the photochemical oxidation of many of the reactive hydrocarbon species emitted from motor vehicles. Formaldehyde is mainly removed from the atmosphere by photolysis and reaction with hydroxyl radicals. Neither dry nor wet deposition are important removal processes. Formaldehyde emission rates may decrease under cloudy conditions because the secondary formation from other organics is slowed.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	report uses high quality data and/or techniques or sound methods that are not from a frequently used source
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	data are from an OECD country other than the U.S.
	Metric 3: Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	report is more than 20 years old
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium	

Study Citation:	Heiden Associates, (1984). A survey of occupational exposure to uncured UF resins in seven industries.			
HERO ID:	6574574			
Conditions of Use:	Processing/Use			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Average uncured UF Resin Use data can be found in the appendix for each industry: urea-formaldehyde (UF) resin manufacturers and fertilizer producers, as well as manufacturers who used uncured UF resins in the particleboard, hardwood plywood, glass mat, wood furniture, and corrugated converter industries. Seven industries determined to be potentially significant producers/users: urea-formaldehyde (UF) resin manufacturers and fertilizer producers, as well as manufacturers who used uncured UF resins in the particleboard, hardwood plywood, glass mat, wood furniture, and corrugated converter industries. UF Resin Manufacturers: 51, Particleboard Manufacturer: 33, Hardwood Plywood Manufacturer: 52, Glass Mat Manufacturer: 5, Fertilizer Plant: 2, Wood Furniture Manufacturer: 32, Corrugated Converter: 9			
Life cycle description:				
Number of sites:				
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	Report is for occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.
Overall Quality Determination			High	

Study Citation:	Heitbrink, W., Cooper, T., Edmonds, M., Bryant, C., Ruch, W. (1993). In-depth survey report: control technology for autobody repair and painting shops at Valley Paint and Body Shop, Amelia, Ohio.			
HERO ID:	6558536			
Conditions of Use:	Autobody repair and painting			
EXTRACTION				
Parameter	Data			
Process description:	Before the cars are painted, structural damage to the cars is repaired elsewhere in the shop. This involves the repair and replacement of damaged parts. For some jobs, abrasive blasting with sand that contains crystalline silica is used for paint removal. This abrasive blasting was conducted in the open. After the cars have been repaired, they are brought to the paint shop. There is some sanding of areas to be painted. Parts of the car which are not to be painted are protected with masking. The car and autobody parts are painted in either the spray painting booth or in the vehicle preparation station. Generally, the vehicle preparation station is used only for small paint jobs or for primer painting. After the car or body part has been painted, the worker leaves the booth and the paint is cured at a temperature between 120 and 140°F. In this shop, spray painting is performed using gravity-fed, HVLP spray painting guns. The air pressure at this point is less than 10 PSI. In this shop, most painting jobs involve the application of a primer, base coat, and a clear coat.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			High	

Study Citation:	Hernon, J. T. (1981). Alum-formaldehyde tannage. III. Manufacture of New Zealand sheepskins all-white tanned grain or suede leather. Journal of the American Leather Chemists Association 76(2):80-82.			
HERO ID:	5947415			
Conditions of Use:	Processing: Leather Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	”The tanning process used on New Zealand sheepskin white tanned leather is described as, ””To the depickled skins... add commercial grade formaldehyde, 11.0 percent (140 lb) , full strength, through the drum door or drum gudgeon and run 1 hr. Leather Ts is about 175°F, pH 8.3 to 8.5. Allow the leather to remain in the tan in the drum overnight. Next morning cover the skins with water at 80F, wash well for 20 min at 80°F and slat down to a low float. ”” (2/3)”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Article is from the U.S.
	Metric 3:	Applicability	High	Data are for leather manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Process description.
Overall Quality Determination		Medium		

Study Citation:	Hernon, J. T. (1981). Alum-formaldehyde tannage. IV. White buck type shoe upper leather from limed cowhide splits. Journal of the American Leather Chemists Association 76(4):140-142.			
HERO ID:	5947426			
Conditions of Use:	Processing: Leather manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The tanning process used on leather cowhide splits is described as, ""To a cleaned drained drum, add through the door 17.0 percent borax (dry). On top add 100 percent water at 100°F. Put on the tight door and drum the borax and water for 10 min to mix well . Add the pickled [leather cowhide] splits to the borax solution in the drum. On top add through the door or gudgeon 7.0 percent formaldehyde (undiluted). Run the splits in the tan for 4 hr. The pH of the splits is 7. 7 throughout (Wulff pH kit) , and the shrinkage temperature of the leather (T,) is 194°F. The tanned splits are pulled down off the drum pins as required and are left in the tan float overnight with the tight door on.” (2/3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Process description.
Overall Quality Determination			Medium	

Study Citation:	Hernon, J. T. (1981). Alum-formaldehyde tannage V. with zirconium - domestic united-states sheepskins for all-white tanned reverse sueded shoe linings. Journal of the American Leather Chemists Association 76(6):223-224.
HERO ID:	5947429
Conditions of Use:	Processing: Leather Manufacturing

EXTRACTION

Parameter	Data
Process description:	A method to process pickled domestic lambskins into all-white tanned reverse or sueded non-slip shoe lining leather is given as follows. Material : Pickled domestic sheepskins : 25 lb per doz , selected for clean flesh and a minimum of slaughter cuts - pack of 50 doz - 1250 lb formula weight. Processing equipment: Drums : - 8 ft diam, 5 ft wide, 1 7 to 18 rpm . Flesh: Skins are drummed in brine to open up well. Flesh to clean off backs. Degrease : Standard drum degreasing with Stoddards Solvent. White pickle: Skins out of the degreasing run are left in a float of brine, about 7° Baume', at 90°F. Through the drum door on top of the skins add: (1) alum : - 3.0 percent - 37 .5 lb , and (2) Arkotan WHT* : - 3.0 percent - 37 .5 lb. Drum 30 min. White tan : On top of the skins in the white pickle add: (1) borax : - 25.0 percent - 312.5 lb - dry through the door. Put on the tight door and start the drum. Through the drum feed box add formaldehyde : - 10.0 percent - 125 lb - undiluted. Drum for 2 hours or until the float temperature is 100° - 105°F. Basify : Sodium bicarbonate : - 0.50 percent - 6.25 lb - dissolved in 20 .0 percent water - 250 lb - 30 gal - 90°F - add in 1 feed - drum in 30 min. Leather pH is 7 .1 ; shrinkage temperature , T., is 190°F. Neutralize and fat liquor : Cover with cold water. Drum 5 min with tight door on. Change to wash door. Wash out of formaldehyde tan - cold - 5 min; at 100°F - 5 min. Slat off to a low float. Through the drum door add : - (1) alum, dry, - 6.0 percent - 75 lb ; and (2) Arko Leather Oil C* : - 1.0 percent - 12.5 lb . Drum in 30 min. Leather pH is 4.5 to 5.0. Dump - Horse Up - Drain 24 hr - Flesh clean for sueded linings effect. Retan, whiten, fatliquor : Fleshed white skins are thrown into a clean white leather drum. Cover with cold water. Wash: 5 min - cold; 5 min - 100°F. Slat skins down to a low float. Add through the door on top of the skins : (1) alum, dry : - 3.0 percent - 37.5 lb; (2) Arko Leather Oil C* : - as is, 4.0 percent - 50 lb; (3) Arko Fatliquor MCA* : - as is , 2.0 percent - 25 lb; (4) Arko Colloidal White* : - as is, 2.0 percent - 25 lb ; and (5) Titanox OR 150, dry: - 1.0 percent - 12.5 lb. Put on tight door. Drum in 30 min. Neutralize: Borax, dry : - 2.0 percent - 25 lb - add through door - drum in 30 min. Leather pH is 4.3; T, is 190°F. Dump - Horse up overnight - Put out - Paste to dry in moderate heat - Damp - Samm - Stake as required for buffing - Buff for sueded reverse linings - Measure - Brush. Notes: Arkansas Co., Inc . white leather process materials Arkotan WHT; Arko Leather Oil C; and Arko Colloidal White are described in Alum-Formaldehyde Tannage IV of this series. Arko Fatliquor MCA is a nonionic emulsified mixture of neatsfoot and coconut oils ; pH in solution is 5 .5 to 6.0.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Unclear if peer reviewed but appears to be high quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data is for US.
	Metric 3: Applicability	High	Data is applicable to COU of processing, leather manufacturing.
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	This metric is not applicable to the data being extracted

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Formaldehyde

General Engineering Assessment

HERO ID: 5947429 Table: 1 of 1

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Study Citation:	Hernon, J. T. (1981). Alum-formaldehyde tannage V. with zirconium - domestic united-states sheepskins for all-white tanned reverse sueded shoe linings. Journal of the American Leather Chemists Association 76(6):223-224.		
HERO ID:	5947429		
Conditions of Use:	Processing: Leather Manufacturing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Hernon, J. T. (1981). Alum-formaldehyde tannage. I. Manufacture of jack deerskins white buck shoe suede upper leather. Journal of the American Leather Chemists Association 76(2):76-79.			
HERO ID:	5947430			
Conditions of Use:	Processing: Leather Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	""To a drained, clean drum add: (1) borax, commercial grade, dry through the door, 190 lb, about 17.0 percent on the dry weight of the skins, and (2) 150 gal, 1200 lb of water at 80°F. Put on the drum tight door and run 2 to 3 min to evenly wet up the borax. Add the alum pickled skins to the drum. On top of the skins, through the door, or drum gudgeon, add formaldehyde , commercial grade, 80 lb, about 7.0 percent on the weight of the dry skins. Put on the tight door and drum 4 hr. At the end of this run the float temperature generally can run up to about 120°F and the leather pH to 7. 2 or slightly higher. The skins now lie overnight in the tan in the drum. Next morning, drum 15 to 30 min. Leather pH is 7 .2. Cover with water at 80°F and wash 1 hr at 80°F. Slat off 10 min and adjust to a short float at 90°F. ""			
Throughput:	Vats have 1500 gallon capacity.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for leather manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Process description.
Overall Quality Determination		Medium		

Study Citation:	Higgins, F.B., Lee, J.A., Morris, R.B., Newirth, R., Pervier, J.W. (1975). Engineering and cost study of air pollution control for the petrochemical industry: Volume 4: Formaldehyde manufacture with the silver catalyst process.
HERO ID:	6023394
Conditions of Use:	manufacture

EXTRACTION	
Parameter	Data
Production, import, or use volume:	In 1975, formaldehyde production capacity exceeded seven and one half billion pounds per year. Total production capacity was 7,643 MM lbs/yr, with 5,914 MM lbs/yr via silver process and 1,729 MM lbs/yr via metal oxide process.
Process description:	Formaldehyde is produced principally from methanol. Two processes are dominant in the U. S. today, the mixed oxide catalyzed process and the silver crystal (or gauze) catalyzed process. In 1975, an estimated 77% of U.S. formaldehyde capacity is based on the silver catalyst process. It was predicted that the total formaldehyde production using silver catalyst process would increase to 1.2×10^{10} lbs/year in 1985. Description for the silver catalyst process is provided. Prior to its admixture with methanol vapors, air is caustic washed to remove CO ₂ and trace sulfur compounds - the latter of which will poison the silver catalyst. The air is then heated to about 150 deg F. Fresh methanol and recycle methanol are combined, vaporized and then superheated to approximately 170 deg F. Heat is supplied by either exchange with the converter effluent or medium pressure steam. The heated air and superheated methanol vapors are combined in such proportions that the oxygen/methanol mole ratio is about 1:4. Decreasing the percentage of methanol in the mixture decreases conversion while increasing yield. The air-methanol mixture is induced into a battery - sometimes about three of catalytic converters. Upon passing through the silver catalyst, the net exotherm generated heats the vapors to about 1175 deg F. This temperature is maintained either by varying the air/methanol ratio or by means of combination heating and cooling coils located within the converters. The hot effluent gases must be quenched to avoid decomposing the formaldehyde. This is generally accomplished solely within the primary absorber, which is close-coupled with the converters, but feed vs effluent heat exchange is utilized - in part - by some plants. The primary absorber is a packed tower. The primary absorption liquid and quench - for the formaldehyde and unreacted methanol vapors is the so-called "F-M Liquor". This liquor is an aqueous solution containing about 28 to 30 percent formaldehyde and 20 to 22 percent methanol. Part of the FM liquor is withdrawn from the bottom of the primary absorber, pumped through a water cooled exchanger, and recirculated to the top of the primary absorber. The remainder of the FM liquor is withdrawn from the bottom of the absorber and pumped to intermediate storage. Uncondensed vapors and non-condensibles are withdrawn from the top of the primary absorber and 'blown' into the secondary absorber. The secondary absorber recovers the major portion of the uncondensed vapor by providing the necessary contact between the vapors and cool distilled water, which is introduced onto the top tray of the secondary absorber. The top of the tower is maintained at about 75 to 80 deg F by providing additional cooling via secondary coolers for the upper tray section. This minimizes hydrocarbon loss via the relatively large noncondensable overhead vent. The weak formaldehyde/methanol solution withdrawn from the bottom of the secondary absorber is pumped to the primary absorber and used as make-up. The FM liquor in the intermediate storage or surge tank is pumped to the product fractionator - a vacuum column. Here pure (99 + percent) methanol is taken as overhead product and recycled to either methanol storage or to the vaporizer. The bottom product is a nominal 37 wt. % solution of formaldehyde, containing less than 1% methanol. This solution may be treated for removal of trace amounts of formic acid prior to storage. Polymer formation and precipitation in storage is prevented either by the addition of supplemental methanol, by providing heated storage, or by both.
Number of sites:	Production via the silver process is distributed among over thirty different plants, ranging in size from 25 to 1300 MM pounds per year.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	Low	characterized by no statistics

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Study Citation:		Higgins, F.B., Lee, J.A., Morris, R.B., Newirth, R., Pervier, J.W. (1975). Engineering and cost study of air pollution control for the petrochemical industry: Volume 4: Formaldehyde manufacture with the silver catalyst process.		
HERO ID:		6023394		
Conditions of Use:		manufacture		
Domain		Metric	EVALUATION	
			Rating	Comments
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Low	report provides results, but the underlying methods, data sources, and assumptions are not fully transparent
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	report does not address variability or uncertainty
Overall Quality Determination			Medium	

Study Citation:	Higgins, F.B., Lee, L.A., Morris, R.B., Newirth, R., Pervier, J.W. (1975). Engineering and cost study of air pollution control for the petrochemical industry: Volume 5. Formaldehyde manufacture with the mixed oxide catalyst process.
HERO ID:	6023376
Conditions of Use:	manufacture

EXTRACTION	
Parameter	Data
Production, import, or use volume:	In 1975, formaldehyde production capacity exceeds seven and one half billion pounds per year. In 1975, total process capacity via silver process was 5,914 MM lbs/year and via metal oxide process was 1,729 MM lbs/year.
Process description:	Formaldehyde is produced principally from methanol. Two processes are dominant in the U. S. today, the mixed oxide catalyzed process and the silver crystal (or gauze) catalyzed process. In 1975, an estimated 23% of U. S. formaldehyde capacity is based on the mixed oxide catalyst process. It was projected that the total formaldehyde production capacity using this process will expand to 3.5×10^9 lbs/year in 1985 from 1.73×10^9 lbs/year in 1975. In the mixed oxide catalyzed process, methanol is mixed with a combination of air and recycle vent gas and then heated to between 220 and 350 deg F in a steam jacketed vaporizer. The air/recycle gas mixture will normally contain about 10% (vol.) oxygen, but always less than 10.9%. The methanol will normally comprise about 9.5% (vol.) of the total converter feed, although it is limited to about 7% for non-recycle operations. The super-heated vapors from the vaporizer pass into the converter, where the oxidation reaction takes place, in a multiplicity of tubes filled with a mixed oxide catalyst, between 650 and 800 deg F. The heat of reaction is removed by the circulating Dowtherm fluid surrounding the catalyst tubes and is used to produce steam. The converter effluent gases are cooled from approximately 500 deg F to about 220 deg F in a heat exchanger prior to being quenched to near 100 deg F in the absorber. The absorber consists of a bubble cap column which may have two water-cooled heat exchangers in the upper portion. The converter effluent vapors are introduced into the bottom section of the column and flow counter-current to the dilution/scrubbing water, which is pumped onto the top tray and flows downward through the tower. The formaldehyde vapors are absorbed by the water, forming a 37 to 53% solution. This exits from the bottom of the tower. The non-condensibles are vented from the top of the absorber where part is recycled and part goes directly to the atmosphere.
Throughput:	In 1975, approximately two thirds of the production was utilized in the formulation of various synthetic resins.
Number of sites:	In 1975, number of plants using silver process was 35 and using metal oxide process was 19. The primary licensors of the mixed oxide process are Reichhold and Lummus.
Chemical concentration:	Formaldehyde is normally marketed in aqueous solutions containing from 36 to 50 weight percent formaldehyde. The standard (USP) solution is 37 percent, although large scale industrial users prefer a nominal 50 percent solution. Formaldehyde solutions usually contain sufficient methanol to prevent precipitation of polymer during storage and shipping, although precipitation may be prevented in solutions containing relatively small amounts of methanol by keeping the solution warm.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is more than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.

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General Engineering Assessment

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Study Citation:	Higgins, F.B., Lee, L.A., Morris, R.B., Newirth, R., Pervier, J.W. (1975). Engineering and cost study of air pollution control for the petrochemical industry: Volume 5. Formaldehyde manufacture with the mixed oxide catalyst process.		
HERO ID:	6023376		
Conditions of Use:	manufacture		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Low	report does not address variability or uncertainty
Overall Quality Determination		Medium	

Study Citation:	Hills, B. W., Kawamoto, M. M. (1992). Health hazard evaluation report no. HETA 90-029-2212; United Technologies Automotive, Port Huron, Michigan. NIOSH(HETA-90-029-2212):90-029.			
HERO ID:	3970662			
Conditions of Use:	Incorporated into an article: Source of formaldehyde was unknown, but the raw material is uncured fibrous glass wool impregnated with phenol-formaldehyde resin.			
EXTRACTION				
Parameter	Data			
Process description:	In the forming area at the beginning of the fibrous glass headliner production line, uncured fibrous glass is fed from 35-pound rolls into a hot forming press (mold), where the binder system is cured. Formed headliners are cut into individual sections by a guillotine cutter as they exit the forming press. In the pretrim area, individual sections are trimmed by a pretrim press. In the marriage area, sheets of fabric and polyethylene are cut with a hot wire, then bonded to pretrimmed headliners by another hot press. In thefinal trim area, water jet guns automatically cut and trim headliners. Finally, in the packing area, headliners are hand finished with a hot glue gun. Headliners are transferred by hand from each area to the next. Fibrous glass dust is generated in the forming press and wherever fibrous glass is cut or trimmed. Plant 1 has five fibrous glass headliner production lines and plant 2 has three.In plant 2, non-fibrous glass headliners are manufactured by cold lamination processes. Adhesives are used to bond paper to foam core, or fabric to cardboard core. Cores are then cold rolled, stacked to air dry, and die cut.			
Number of sites:	2			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses sound methods (IH site visits and interviews) from a frequently used source (NIOSH).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (automotive headliner production) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1990 - more than 20 years old.
	Metric 5:	Sample Size	N/A	qualitative data provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information from NISOH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative data provided
Overall Quality Determination			High	

Study Citation:	Hollett, B. (1983). Walk-through survey report: Control technology for adhesives at National Veneer Plant, Broyhill Furniture Industries, Inc., Lenoir, North Carolina.
HERO ID:	6558529
Conditions of Use:	Processing: Wood Product Manufacturing

EXTRACTION	
Parameter	Data
Process description:	The majority of the plys are alternate layers of gum and poplar with a maximum thickness of 1/8 inch. The resin used is Borden CR5H which is specified to contain no more than 5 percent free formaldehyde. The parts are layered in forms under approximately 200 psi applied pressure. The RF power is generated for a variable period, determined by the amount of glue line, ranging from 2 to 4 minutes followed by a cool-down/glue setting period of 1 to 2 minutes. The duties of the press crew are mixing, spreading, laying-up panels, loading, unloading, and separating. There is one glue mixer and one spreader operator who feeds the stock through the spreader. Two workers remove the glued layers and lay them in stacks according to the thickness desired. The same workers -then roll the stacks of panel stock on roller conveyors to the press input side. They load a prescribed number of layered panels in each form in the press. After the press has completed the heating and cool-down cycle, the unloading worker removes the hot panels. He places the stack on edge on the floor and leans over it, separating and checking each panel.
Throughput:	They produce about 1,500 square feet of panel per day per press (3 total presses). The production is divided about 40 percent, 13-ply and an equal percentage of 7-ply, with the remaining 20 percent ranging from 5- to 13-ply. There is one glue mixer and one spreader operator who feeds the stock through the spreader. Two workers remove the glued layers and lay them in stacks according to the thickness desired. The same workers -then roll the stacks of panel stock on roller conveyors to the press input side. They load a prescribed number of layered panels in each form in the press. After the press has completed the heating and cool-down cycle, the unloading worker removes the hot panels. He places the stack on edge on the floor and leans over it, separating and checking each panel. // During the day of sampling, Press No.1 processed 416 pieces of 9-ply, which equaled 1,433 square feet of plywood with 11,464 square feet of glue line. Press No.3 processed 375 pieces of 10-ply, which equaled 1,301 square feet of plywood with 11,709 square feet of glue line. A total of 881 pounds of glue was used that day.
Chemical concentration:	The resin used is Borden CR5H which is specified to contain no more than 5 percent free formaldehyde.

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
		Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
		Metric 5: Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.

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General Engineering Assessment

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Study Citation:	Hollett, B. (1983). Walk-through survey report: Control technology for adhesives at National Veneer Plant, Broyhill Furniture Industries, Inc., Lenoir, North Carolina.		
HERO ID:	6558529		
Conditions of Use:	Processing: Wood Product Manufacturing		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	Process description, throughput, and concentration information. No scope to address variability and uncertainty.
Overall Quality Determination		High	

Study Citation:	Hornung, R.W., Herrick, R.F., Stewart, P.A., Utterback, D.F., Feigley, C.E., Wall, D.K., Douthit, D.E., Hayes, R.B. (1996). An experimental design approach to retrospective exposure assessment. American Industrial Hygiene Association Journal 57(3):251-256.			
HERO ID:	1512313			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Process description:	Dissection and embalming of bodies			
Number of sites:	14			
Chemical concentration:	Embalming solution: 1.25-2.5%			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1996)
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Hovding, G. (1959). Free formaldehyde in textiles. A cause of contact eczema. Acta Dermato-Venereologica 39:357-368.		
HERO ID:	6117720		
Conditions of Use:	Textiles		
EXTRACTION			
Parameter	Data		
Process description:	Formaldehyde is used in the textile industry to improve the crease- and shrink-properties of cellulose fibers (rayon and cotton). It is used either alone, together with other reagents or in the form of simple formaldehyde derivatives. The process of formaldehyde resin treatment of textiles is as follows: (1) Impregnation of the textiles in a bath consisting of a catalyst and a pre-condensate and where the molecules are small enough to penetrate into the textile fiber; (2) Drying; (3) Condensation at a high temperature; (4) Washing to remove substances which have not reacted during the condensation process; (5) Drying.		
Chemical concentration:	Free formaldehyde in formaldehyde-treated fabrics should not exceed 50 ppm (0.005%). Samples of 256 different crease-resistance rayon and cotton textiles were examined for formaldehyde content. In 29 of the samples, no formaldehyde was detected (neither free nor combined). Out of the remaining 227 samples, 200 contained free formaldehyde and total formaldehyde in varying amounts. In 20 samples, only combined formaldehyde was found, and in remaining 7 samples traces of formaldehyde were found both in the free and the combined form. Only 7 samples contained less than 500 ppm. The majority of the samples, 132, show a content of free formaldehyde between 0.5-1.2 % . A single sample contains between 1.7 and 1.8 %. The majority of the samples, 150, contain between 3% and 7% of total formaldehyde. It is seen that rayon samples generally have a much higher content of free formaldehyde than the cotton samples. Majority of the rayon samples contain between 5000 and 12000 ppm of formaldehyde.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	data are from an OECD country
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	report is more than 20 years old
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources, assessment methods
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		Medium	

Study Citation:	Hovding, G. (1961). Contact eczema due to formaldehyde in resin finished textiles. Acta Dermato-Venereologica 41:194-200.			
HERO ID:	6117731			
Conditions of Use:	Processing: Finishing agents in textiles			
EXTRACTION				
Parameter	Data			
Process description:	”The usual principle for resin treatment is impregnation of the textile in a bath consisting of a resin pre-condensate and a catalyst, drying, curing at a high temperature, and washing to remove the catalyst and uncondensed resin which has not reacted during curing. The result of this process is the formation within the textile fiber of a thermosetting resin, which makes the fiber crease resistant, and in addition gives it other valuable properties such as decreased shrinking, easier drying, increased color fastness, improved draping and handling properties etc.” (1/7)			
Chemical concentration:	In unwashed samples the total formaldehyde showed approximate values between 4000 and 7000 ppm of fabric. Also, in sampled rayon, most samples contained 0.5-1.2% free formaldehyde. (2/7)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Norway, an OECD country.
	Metric 3:	Applicability	High	Data are for textile finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty. Mainly process description.
Overall Quality Determination			Medium	

Study Citation:	Hse, C. Y. (1998). Overview of the wood adhesives industry in China. :48-51.		
HERO ID:	5937019		
Conditions of Use:	Processing		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	In 1994, the wood industries in China consumed more than 330,000 tons of adhesives. The estimated demand for wood adhesives will be more than 560,000 tons in the year 2000. The main wood adhesive used is urea-formaldehyde resin. Its consumption in 1994. was approximately 90 percent of the total wood adhesives market.		
Life cycle description:	Formaldehyde is used in the production of resins such as urea-formaldehyde resin.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from a non-OECD country
	Metric 3: Applicability	High	Report is for an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Low	

Study Citation:	Huang, L., Anastas, N., Egeghy, P., Vallero, D.A., Jolliet, O., Bare, J. (2019). Integrating exposure to chemicals in building materials during use stage. International Journal of Life Cycle Assessment 24(6):1009-1026.			
HERO ID:	5964979			
Conditions of Use:	Use as chemical substance in wood products			
EXTRACTION				
Parameter	Data			
Chemical concentration:	One type of particleboard contains maximum content of 0.1% formaldehyde			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	Data are for use in resin for wood products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Article just states concentration of formaldehyde for one particleboard type. No scope to address variability and uncertainty.
Overall Quality Determination			High	

Study Citation:	Huff, J. (2001). Sawmill Chemicals and Carcinogenesis. Environmental Health Perspectives 109(3):209-212.			
HERO ID:	1328012			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Worldwide production: 15 million (tons)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are worldwide.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2001)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Hunninen, K. (1986). Health Hazard Evaluation Report HETA-85-323-1677 Cuyahoga Community College, Cleveland, Ohio.			
HERO ID:	8684550			
Conditions of Use:	Photographic supplies			
EXTRACTION				
Parameter	Data			
Process description:	The laboratory consists of two primary work areas, the black and white and the color film developing room (Room A) and the black and white print room (Room B). No color printing is done in this laboratory. Three full and three part-time employees work in these areas; employees can spend an average of 4 to 6 hours processing film. The majority of that time is spent in black and white developing and printing. In Room B the processing is done automatically with the Luth Mini 500. The processing chemicals are added manually and include Kodak Developer 55, and Kodak Rapid Fixer A and B. The Luth Mini operates at a temperature between 1100 and 120°F and exhausts directly into the work area. The spent chemicals are discharged through a hose into an open sink for disposal.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for photographic supplies, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Hunsucker, J.H., Sankey, C.F., Eckler, P.E., Tomasino, C., Livengood, C. (1982). Reduced formaldehyde release with nitro alcohols. Textile Research Journal 52(2):133-140.			
HERO ID:	5965784			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Process description:	A nitro alcohol, ReForm, textile reactant modifier, is added directly to the fabric pad bath. The established manufacturing procedure is not altered, and neither new equipment nor modification of existing equipment is necessary. The nitro alcohol is compatible with most of the finishing agents presently used. (1/8)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for textile finishing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	Background information	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Background information	
Overall Quality Determination		High		

Study Citation:	Hussain, M., He, Y.L., Mohamad, A.A., Tao, W.Q. (2015). A new hybrid algorithm for numerical simulation of VOC emissions using single-layer and multilayer approaches. Numerical Heat Transfer Part B: Fundamentals 67(3):211-230.			
HERO ID:	4714918			
Conditions of Use:	Building/construction materials – wood and engineered wood products			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Concentrations of formaldehyde in medium-density fiberboards used for modeling experiment [PDF Pg. 12]MDF3: 1.18*10^7 (ug/m^3)MDF4: 1.34*10^7 (ug/m^3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.	
	Metric 3: Applicability	High	Data are for Building/construction materials – wood and engineered wood products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by giving concentrations of formaldehyde in two different MDFs but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Use in Fabrics, Textiles and Leather			
EXTRACTION				
Parameter	Data			
Chemical concentration:	concentrations in 112 fabric samples ranged from 1-3517 ppm [mg/kg]; 18 samples had a free formaldehyde content greater than 750 ppm			
Comments:	Primary source of the data is Schorr, W.F., Keran, E. and Plotka, E. (1974) Formaldehyde allergy. The quantitative analysis of American clothing for free formaldehyde and its relevance in clinical practice. Arch. Dermatol., 110, 73-76.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	Data sources are provided but method for estimating concentration is not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and does not address uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Use in Construction Products (Insulation)			
EXTRACTION				
Parameter	Data			
Number of sites:	Urea-formaldehyde foam insulation used in 500,000 homes from 1975-1980			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The techniques or methods used in the assessment or report are not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	for the US: 2710 million kg (1979) as 37% aqueous solution, formalin; 2900 million kg (1978) imports negligible, 1979 exports 8.7 million kg.			
Life cycle description:	60% for plastics and resin manufacture; 22% for production of intermediates; and 18% for miscellaneous uses. Report contains extensive description of lifecycle of formalde (pp. 350-351))			
Process description:	"It is produced by the oxidation of methanol with air in the presence of a silver or an iron oxide-molybdenum oxide catalyst. Earlier processes no longer in use commercially include catalytic oxidation of propane and butanes (which produced a complex mixture of products from which formaldehyde was isolated) and oxidation of dimethyl ether (Gerberich et al., 1980)."			
Number of sites:	16 manufacturers (1978-79)			
Chemical concentration:	"Most formaldehyde is sold in the form of aqueous solutions containing 30-56% formaldehyde with 0.5-15% methanol (Gerberich et al., 1980) as an inhibitor of polymerization. "			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses high quality data that are from frequently used sources (i.e., IARC monographs) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated
	Metric 3:	Applicability	High	The data is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data provided are from the later 1970's
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Distribution in Commerce			
EXTRACTION				
Parameter	Data			
Process description:	"Shipments of formaldehyde solutions are subject to a variety of labelling, packaging, quantity and shipping restrictions consistent with the designation of formaldehyde as a hazardous material...Formaldehyde may also be emitted during the bleeding of storage tanks"			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The report is from IARC, which is a frequently used source and generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	Distribution in commerce is an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.			
HERO ID:	27010			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Life cycle description:	In 1978, formaldehyde production was 60% used for plastics and resin production and 22% for production of intermediates. Resins (in order of consumption of formaldehyde): urea-formaldehyde, phenolic resins, polyacetal resins, and melamine resins. Chemical intermediates of formaldehyde are acetylenic chemicals, pentaerythritol, hexamethylenetetramine and urea-formaldehyde concentrates, diphenylmethanediamine (4,4'-methylene dianiline), 4,4'-methylenediphenyl diisocyanate, chelating agents, trimethylolpropane. Urea formaldehyde resin (25% of PV) is then used as an adhesive for composite wood products, compound for moulding, paper treating and coating, textile treating, surface coating, and foams for insulation. Phenolic resins (20-25% of PV) then used for adhesive in plywood, binder in fibreglass insulation, moulding compounds, foundry resins, laminates, wood, abrasives, and ion exchange. Polyacetal resins are used in unreinforced thermoplastic resins and melamine resins used in surface coating, moulding compounds, laminates, paper, textile treating and coating. "Among the chelating agents produced from formaldehyde, trisodium nitriloacetate is believed to be the most important. The principal use for trimethylolpropane is as an intermediate in the manufacture of polyols (both polyester and polyether types), used to make polyurethane resins"			
Process description:	"Production of acetylenic chemicals from formaldehyde, which represented 5-10% of US consumption in 1978, is based principally on the reaction of two molecules of formaldehyde with acetylene to produce 2-butyne-1,4-diol, which is then hydrogenated to 1,4-butanediol. This diol is the basis of tetrahydrofuran (a widely used resin solvent, reaction medium and intermediate in the manufacture of SpandexR fibres and poly-urethane elastomers), polybutylene terephthalate resins, polyurethanes [see IARC, 1979b], and a.-butyrolactone, an intermediate in the production of a family of 2-pyrrolidone derivatives, including N-vinylpyrrolidone and its polymer [see IARC, 1979c]. Pentaerythritol, made by the alkaline condensation of formaldehyde with acetaldehyde, is an important polyol used principally in the manufacture of alkyd resins. It is also involved in the production of synthetic lubricants, rosin and tall-oil esters, and of pentaerythritol tetranitrate which is used as an explosive and as a vasodilator. Hexamethylenetetramine, the condensation product of formaldehyde and ammonia, is used principally in the manufacture of curing agents for phenolic thermosetting resins. Urea-formaldehyde concentrates are used mainly to produce slow-release nitrogen fertilizers, commonly called 'ureaforms'"			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (IARC) that are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty for the extracted data.
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Study Citation:	IARC, (1982). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: Some industrial chemicals and dyestuffs. IARC monographs on the evaluation of carcinogenic risks to humans 29:1-398.		
HERO ID:	27010		
Conditions of Use:	Processing as a reactant		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	ICFI, (1985). Production and use of formaldehyde containing resins and options for controlling formaldehyde release from durable-press fabrics.			
HERO ID:	5901058			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Of the approximately 5,700 million pounds of formaldehyde consumed in 1981, about 1.6 percent was used by the textile industry - mainly in the form of resins, which are used to impart durable-press properties to fabrics. In 1986, approximately 90 percent of the durable-press resin market was accounted for by one resin, dimethyloldihydroxyethyleneurea (DKDHEU) and its alkylated derivatives.			
Process description:	Wrinkle resistance imparted to fabric by the finishing agents is due to the cross linking of the resin with the fibers of the fabric. When the resin and fibers crosslink they hold the fabric in a rigid conformation. The greater the degree of crosslinking the better the durable-press properties. There are two major processes for the production of durable-press (DP) fabrics using formaldehyde or formaldehyde-derived resins . These are the pre-cure and post-cure processes. In the pre-cure process, final cure resulting in DP properties occurs at the mill, whereas in the post-cure process this final cure occurs after the fabric has been formed into a garment. The pre-cure process can be divided into four steps – fabric preparation, resin impregnation, drying, and curing.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	ICFI, (1984). Formaldehyde emissions from building products: cost-effectiveness of reduction strategies. Chapter II: formaldehyde-emitting wood products and alternatives for controlling emissions.				
HERO ID:	5901065				
Conditions of Use:	Manufacturing				
EXTRACTION					
Parameter	Data				
Production, import, or use volume:	Production of formaldehyde in 1983 was 5,398,012,000 lbs. Imports of formaldehyde in 1983 was 16,167,000 lbs and export was 17,174,000 lbs. Two highest formaldehyde use in 1978 was production of amino resins (includes urea and melamine) (29%) and production of phenolic resins (25%).				
Process description:	Formaldehyde is manufactured from methanol. There are two processes in commercial use at this time. The first and older of these utilizes a metal catalyst (usually silver) to form product formaldehyde from methanol, air , and steam. In this process a feed mixture of heated methanol, air, and steam is passed into the catalyst bed . The products are then passed into a condenser and through a countercurrent absorber . The top stream from the absorber is product formaldehyde while the bottom stream is distilled for methanol recovery and recycle. The second and newer process uses a metal oxide catalyst. In this process, air and vaporized methanol are passed through iron oxide-molybdenum oxide-filled tubes in a heat exchanger reactor. The product is cooled and passed to an absorber where the formaldehyde concentration of the resulting solution is controlled by the addition of water.				
Throughput:	In 1983, only about 63% of domestic capacity was utilized . See table 2				
Number of sites:	In 1984, there were 13 producers of formaldehyde. See table 1				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the United States	
	Metric 3:	Applicability	High	Report is for an occupational scenario within the scope of the risk evaluation	
	Metric 4:	Temporal Representativeness	Low	Report is more than 20 years old.	
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability	
Overall Quality Determination			High		

Study Citation:	Ihrig, D. F., Hanke, M., Ihrig, C., Tischer, M. (2004). Exposure to hazardous substances during electronic waste recycling. 6:3293-3298.			
HERO ID:	2167598			
Conditions of Use:	Use of electrical and electronic products			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	In Germany, 1.8 million tons/year of electric and electronic waste is produced. (2/6)			
Throughput:	The 81 sites had a throughput of 245,000 tons of electronic waste per year. (1/6)			
Number of sites:	81 enterprises in the electronic industry participated in the survey, but 550 were contacted. (1/6)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	Data are for electric and electronic products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (throughputs, production values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	IPC International, (2019). IPC presentation to EPA on formaldehyde in the electroless copper plating process.		
HERO ID:	10370204		
Conditions of Use:	electroless copper plating		
EXTRACTION			
Parameter	Data		
Process description:	Pgs. 4-9 provide detailed/illustrated process description		
Number of sites:	”According to EPA’s 2018 TRI survey, the electronics industry releases represent <0.014% of total reported on-site releases. Of the 715 facilities exceeding TRI’s formaldehyde reporting threshold: 9 were readily identified as associated with PCB manufacturing; combined off-site releases for these 9 facilities totaled 2,608 lbs.” pg. 9/10		
Chemical concentration:	”The formaldehyde concentration ranges from 3 and 6 g/L forelectroless copper processes” pg. 9/10		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		High	

Study Citation:	IPC International, (2020). Comment submitted by Kelly Scanlon, Director of Environment, Health and Safety Policy and Research, IPC regarding the draft scope of the risk evaluation for formaldehyde.			
HERO ID:	10370220			
Conditions of Use:	Non-incorporative uses- Process Aid			
EXTRACTION				
Parameter	Data			
Process description:		The electroless copper plates slowly and uniformly and the formaldehyde promotes controlled deposition of copper metal over all surfaces. The process yields excellent physical and metallurgical properties and it increases the reliability of the performance of the printed circuit board. Because formaldehyde is used in the deposition process as a reducing agent, at the end of the plating process there is no formaldehyde remaining in the deposited copper or in the end product.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses sound data that are not from a frequently used source and associated information does notindicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3:	Applicability	High	The report is for an occupational scenario(Industrial Use- Non-incorporative-Process Aid) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A-process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results and assumptions. Data sources are gen-erally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A-process description only.
Overall Quality Determination			High	

Study Citation:	Jenkins, M. F. (1980). Reducing occupational exposure to formaldehyde in the dialysis laboratory. Dialysis & Transplantation 9(11):1049-1050.			
HERO ID:	5944900			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Throughput:	1 gallon bottle, 5-gallon carboys, and 50-gallon drums (pg 1)			
Chemical concentration:	37-42% in formalin (pg 1)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for lab chemical, an in-scope occupation scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Concentration data and package capacity data.
Overall Quality Determination			Medium	

Study Citation:	Jiang, H., Yu, H.Q., Guo, Q.X. (2007). Extraction-oxidation-adsorption process for treatment of effluents from resin industries. Industrial and Engineering Chemistry Research 46(6):1667-1671.			
HERO ID:	2866133			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Life cycle description:	Formaldehyde finds many varieties of usage due to its high reactivity, colorless nature stability, purity in commercial form, and low cost. It serves as a resinifier curing agent, synthetic agent, disinfectant, fungicide, and preservative. Formaldehyde and phenol are also key raw materials in the industrial manufacturing of resins.			
Process description:	Figure 1 provides a schematic flow chart of the EOA process. Centrifugal extractors 1-6 rotated at about 3000 rev/min. The capacity of the system increased (from 1 to 2 m3/h) with the increasing rotating speed of the extractors. The detailed construction of the extractors and the extraction process equilibrium conditions were illustrated in our previous work. The main principle of EOA is illustrated in Figure 2. Step 1 was an extraction process, and step 2 was a reverse extraction with chemical reaction (reaction 1), by which extractant was recycled in the system. The DBD system for PFW shown in Figure 3 was set up in the mid-1990s, including an anaerobic reactor with a volume of 64 m3, an aerobic reactor of 22 m3, and a disinfection reactor of 2.2 m3. Although the system was running stably, long hydraulic retention time (HRT) and additional diluted water supply to keep a stable, low concentration of phenol and formaldehyde resulted in low efficiency and waste of resources.			
Throughput:	Study carried out in a factory with discharge capacity of 24 m^3 PFW (phenol and formaldehyde wastewater)/day, containing 1200 mg/L of formaldehyde.			
Chemical concentration:	Table 1 provides concentration of main pollutants (mg/L): original PFW - formaldehyde: 1200; one-stage extraction - formaldehyde: 965; two-stage extraction - formaldehyde: 860; three-stage extraction - formaldehyde: 620			
Comments:	Reactions 2 through 11 show the oxidation reactions.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Source is peer reviewed and likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data is from China, a non OECD country.
	Metric 3:	Applicability	High	Data is directly applicable to waste treatment of formaldehyde used in resin manufactur- ing.
	Metric 4:	Temporal Representativeness	Medium	Data is over 10 years old, form 2007.
	Metric 5:	Sample Size	Medium	Characterized by a range of data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Report documents data sources and assessment methods, results and assumptions and they are generally described.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Jiang, S., Yu, L., Cheng, J., Leng, S., Dai, Y., Zhang, Y., Niu, Y., Yan, H., Qu, W., Zhang, C., Zhang, K., Yang, R., Zhou, L., Zheng, Y. (2010). Genomic damages in peripheral blood lymphocytes and association with polymorphisms of three glutathione S-transferases in workers exposed to formaldehyde. Mutation Research 695(1-2):9-15.			
HERO ID:	626082			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Formadlehyde is used for the production of urea, acetal, melamine, phenol formaldehyde resins. Resins are then used in the production of adhesives and binders for wood(including plywood and furniture industries), plastics, textiles, and leather. Its also used as a tissue preservative.			
Number of sites:	2			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The report uses data sources that does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from China - not an OECD member	
	Metric 3: Applicability	High	Data are for plywood manufacture, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old - published in 2009	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		Medium		

Study Citation:	Jiang, T., Gardner, D.J., Baumann, M.G. (2002). Volatile organic compound emissions arising from the hot-pressing of mixed-hardwood particleboard. Forest Products Journal 52(11-12):66-77.			
HERO ID:	2863296			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Today, there are 48 particleboard mills in the United States with a total annual capacity of 9,606,000m3 (Anonymous 2000)			
Process description:	The resin was applied to the particle furnish in a drum blender with a spinning disk atomizer at 15,000 rpm. The target size of the particleboard was 305 by 305 by 19 mm (12 by 12 by 3/4 in.) All mats were hand formed in a 305-by 305-mm (12-by 12-in.) deckle box, and were pressed in the hot-press maintained at a temperature of ± 1°C around the target setpoint.			
Number of sites:	48			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Jokinen, K., Siren, K. (1995). Harmful residues in recycled fiber-metals and compounds. Paperi ja Puu 77(3):106-110.		
HERO ID:	1961946		
Conditions of Use:	Use of Paper Products		
EXTRACTION			
Parameter	Data		
Chemical concentration:	The formaldehyde concentrations in virgin pulps were negligible. In chemical pulps the formaldehyde concentration was below the detection limits. All the values for formaldehyde in the recycled pulps tested were very low and somewhat lower than the values measured in mechanical pulps.The formaldehyde concentrations in recycled pulps were fairlylow and comparable to the values measured in reference pulps.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Finland, an OECD country.
	Metric 3: Applicability	High	Data are for paper products, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1995)
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Low	

Study Citation:	Jr, M.V. (1981). Walk-Through Survey Report: Monsanto Plastics and Resins Company, Phenolormaldehyde Resin Facility, Port Plastics Plant, River Road, Addyston, Ohio, Report No. CT-108-11a. NIOSH(CT-108-11a):108-111.			
HERO ID:	1320858			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Life cycle description:	Site manufactures formaldehyde then resinox*, a family of formaldehyde-phenol resin products available as liquid resins, laminating varnishes, and solid or lump resins processed into powdered resin compounds.			
Process description:	The unit processes and operations for producing the solid and liquid resins start out similarly, with the components being charged into the reactors according to the formulation required to meet the customers specifications. The list of component substances includes phenol, formalin, sodium hydroxide, concentrated sulfuric acid, hexamethylenetetramine, methanol, ethanol and xylene. Not all these substances are present in each product. for example HMT is a curing agent added only to the solid resin batches. The principal liquid ingredients are piped form storage tanks outside the building into weigh-cases for proportioning, then siphoned into the reactors.When fully reacted, the material destined to become solid resin may either be dumped directly onto the ”cooling floor” below the reactor or transferred to a holding tank for deposition onto a cooling belt. The hardened resin may be milled, blended , and screened before bagging. the liquid resins are transferred to holding tanks, then passed through filters before being placed in refrigerated tank cars or trucks is recommended to prevent hardening of the liquid resin.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data and/or techniques or sound methods that are from frequently used sources (NIOSH study)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 - more than 20 years old
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative, site specific information provided
Overall Quality Determination		High		

Study Citation:	Kao, Y. M. (2012). [A review on safety inspection and research of plastic food packaging materials in Taiwan]. Journal of Food and Drug Analysis 20(4):734-743.			
HERO ID:	5956748			
Conditions of Use:	Use in food packaging			
EXTRACTION				
Parameter	Data			
Life cycle description:	The common plastic food packaging materials includes polyethylene, polypropylene, polyethylene terephthalate, polystyrene, polyvinylchloride, polycarbonate and plastics with formaldehyde as raw materials for synthesis.			
Chemical concentration:	BFDA has conducted the sanitation inspection for atotal of 194 formaldehyde-made plastic products includingplates, bowls, spoons and children’s tableware in 1986 and1997. The results are shown in Table 13. Among thesesamples, 8 of them were found with lead or cadmium, whoselevels failed to meet the standard limits, and 23 of themwere found with illegal colorants, consumption of potassiumpermanganate, heavy metals, residues after evaporation orformaldehyde, which were not in line with the regulation. Because melamine is used to produce the formaldehyde-melamine resin, BFDA conducted a study on its migration test of 52 melamine-madetableware in 2009. Except the testing method of melaminebeing developed, the results as also shown in Table 13 indicated only one sample were found to release melamine at a level of 4.8 ppm into 4% acetic acid, and those released from the rest of 51 samples were all less than 1. 7 ppm.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from Taiwan, a non-OECD country.
	Metric 3:	Applicability	Low	Data are for consumer use of food packaging, which is similar to commercial use of food packaging, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Most of the data used in the report is more than 20 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by analyzing 52 types of packaging.
Overall Quality Determination			Low	

Study Citation:	Katovic, D., Soljadic, I., Orji, G., Piljac, I. (1996). Polarography determination of free formaldehyde on treated cotton fabrics. Croatia Chemica Acta 69(1):1-8.			
HERO ID:	5944049			
Conditions of Use:	Fabric Finishing			
EXTRACTION				
Parameter		Data		
Chemical concentration:		0.02 µg/ml free formaldehyde in treated textiles (pg 2)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Medium	Report uses high quality data/techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	Low	Data are from Croatia, a non-OECD country.
		Metric 3: Applicability	High	Data are for fabric finishing, an in-scope occupational scenario.
		Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
		Metric 5: Sample Size	N/A	concentration data
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	N/A	concentration data
Overall Quality Determination			Medium	

Study Citation:	Kauppinen, T.P., Niemelä, R.I. (1985). Occupational exposure to chemical agents in the particleboard industry. Scandinavian Journal of Work, Environment and Health 11(5):357-363.			
HERO ID:	6148710			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Free formaldehyde in the glue has decreased from 0.10% (before 1970) to 0.03% (in 1979). (6/8)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Finland, an OECD country
	Metric 3:	Applicability	High	Data are for adhesives and sealant chemicals in wood product manufacturing, am in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Monitoring data were collected prior to the most recent PEL.
	Metric 5:	Sample Size	N/A	Concentration data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling at different plants that use the same technology.
Overall Quality Determination			Medium	

Study Citation:	Kawamoto, M. M., Echt, A., Reh, C. M. (1999). Health hazard evaluation report HETA 96-0016-2777, Eagle-Picher Industries, Joplin, Missouri, March 1999.			
HERO ID:	1577133			
Conditions of Use:	Other Byproduct			
EXTRACTION				
Parameter	Data			
Life cycle description:	The plant develops and produces highperformance special purpose battery systems,especially for military or aerospace applications.Products manufactured at the plant includethermal batteries, lithium-metal sulfide batteries,sodium-sulfur batteries, lead fluoroboric batteries,nickel-iron batteries, electroexplosive devices(e.g., squibs, wire cutters, matches, etc.), andmechanical actuators.			
Process description:	Powder for the pills is mixed in the process room. The pill room, located in building 108, houseseight large hydraulic presses (six 175-ton presses,one 350-ton press, and one 410-ton press) thatproduce battery pills. Batteries are assembled by hand in dry room 108.Utility battery builders stack and wrap batterycomponents. These are loaded in casings by abattery loader. Welders seal the casings. Someparts fabrication, such as Fiberfrax cutting, takesplace in dry room 108 as well. In the potting area for thermal battery production,potting compounds are mixed in hoods and heatedbefore use to make them pourable. The mixedpotting compounds are poured over parts (batteryheaders) held in jigs on tables in the work area.Ovens are used to cure the potting compounds. Contacts are soldered on batteries using solderingirons, 70/30 tin lead solder, a rosin flux, and smallamounts of isopropanol. The mercury treatment processconsists of dipping negative battery plates into amercuric chloride solution. After dipping, theplates are soaked and rinsed, and thesoaking/rinsing cycle is dependent on the type ofbattery being built. Finally, the plates are dried inan oven. The oven operator wears an airpurifyingrespirator with mercury canisters.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses high quality data that are from frequently used sources (e.g., NIOSH HHEs)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Kennedy, E.R., Teass, A.W., Gagnon, Y.T. (1985). Industrial-hygiene sampling and analytical methods for formaldehyde - Past and present. Advances in Chemistry Series :3-12.			
HERO ID:	5942071			
Conditions of Use:	manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume: Comments:	Formaldehyde production in 1983 was approximately 5.45 billion lbs and has averaged around 5 billion lbs over the past 3 years. Several analytical methods for formaldehyde is presented			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data is greater than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	report does not address variability or uncertainty
Overall Quality Determination		Medium		

Study Citation:	Kilburn, K.H., Seidman, B.C., Warshaw, R. (1985). Neurobehavioral and respiratory symptoms of formaldehyde and xylene exposure in histology technicians. Archives of Environmental and Occupational Health 40(4):229-233.			
HERO ID:	69078			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Life cycle description:	Other uses: histology lab			
Process description:	Tissues are fixed in formaldehyde, trimmed, dehydrated, infiltrated with fat solvents, and embedded in paraffin. Slices are cut, mounted on slides, cleared of paraffin with solvents, stained, dried, and covered with balsam and thin glass slips.			
Number of sites:	25			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for Histology laboratories which are an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1985, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		High		

Study Citation:	Kim, E.A., Lee, H.E., Ryu, H.W., Park, S.H., Kang, S.K. (2011). Cases series of malignant lymphohematopoietic disorder in Korean semiconductor industry. Safety and Health at Work 2(2):122-134.			
HERO ID:	1508886			
Conditions of Use:	Use of Ink, Toner, and Colorant Products			
EXTRACTION				
Parameter	Data			
Process description:	Production of silicon wafers from very pure silicon ingots; fabrication of integrated circuits onto these wafers (FAB); assembly of every integrated circuit on the wafer into a finished product (AS) and testing of the finished products.			
Number of sites:	2			
Chemical concentration:	formaldehyde was found in a resin at a level of 0.1% in an ink in another company			
Comments:	OSHRI investigated 7 cases of malignant LHP disorder from 2 plants of a semiconductor company in Korea			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Korea, an OECD country.
	Metric 3:	Applicability	High	Data are for ink, toner and colorant products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on current industry conditions and data no more than 10 years old. (2007-2010)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Kim, S. (2010). Control of formaldehyde and TVOC emission from wood-based flooring composites at various manufacturing processes by surface finishing. Journal of Hazardous Materials 176(1-3):14-19.			
HERO ID:	1512513			
Conditions of Use:	Use of Floor coverings			
EXTRACTION				
Parameter	Data			
Process description:	Urea–melamine–formaldehyde (UMF) resin was used to manufacture HDF. The molar ratios of the resin was 0.95 (F/M + U). Before the HDF was manufactured, 3 parts (to resin) of 25% ammonium chloride as a hardener and 13 parts of 44% wax solution for water-proofing were added. The wood fiber distributed from Dongwha Enterprise was made from Korean pine (P. densiflora) with amoisture content of 4%. TheMDFwas manufactured using the above adhesives, in order to have a specific gravity of 0.8. The mixture was then hot pressed, to form composite boards, at a peak pressure of 40 kgf/cm2 and a temperature of 180 °C. The main pressing time was 4min and the pressure was then released in two steps of 1min each. Overlay paper, deco paper and valance paper were impregnated with melamine-papers pressed at about 200 °C and called low pressure melamine (LPM) as shown in Fig. 1a. The resin for impregnation is shown in Table 1. Finally, the edges of the product aremachined to produce a tongue and groove profile. In the case of engineered flooring, 0.5 mm-thick fancy veneer of maple is glued to a 7.2 mm-thick plywood sheet and pressed at about 160 °C.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Korea, an OECD country.
	Metric 3:	Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	Not applicable - process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - process description.
Overall Quality Determination		Medium		

Study Citation:	Kimmelman, B. B., Hillman, E. E. (1983). Formaldehyde vapor in the dental environment: Absence of potential hazard. ASDC Journal of Dentistry for Children 50(1):55-57.			
HERO ID:	5951811			
Conditions of Use:	Laboratory chemicals			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Sargenti N2 powder contained 4.5% paraformaldehyde. Buckley’s Formocresol contained 37% formaldehyde. A standard tissue-fixing solution contained 4% formaldehyde within a 10% formalin solution.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	King, B.S., B. S., Musolin, K., Choi, J. H. (2013). Evaluation of potential employee exposures during crime and death investigations at a county coroner’s office.			
HERO ID:	2995043			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Process description:	In the autopsy suite, official autopsies were conducted for deaths from homicide, suicide, fires/ burns, certain accidents, and other suspicious or unusual deaths. During a typical autopsy, a pathologist and forensic assistant opened the decedent’s chest cavity to remove and examine the internal organs. Organ tissue samples were removed and placed in open containers of a formalin solution. This solution was used to fix and preserve the tissue specimens for histologic examination. To gain access to the brain tissue, the skull cap of the decedent was removed with a hand-held oscillating Clean Cut Autopsy Saw system, model 04-NS3 (Leica Microsystems, Buffalo Grove, Illinois [formerly Surgipath Medical Industries, Richmond, Illinois]). Tissues collected during autopsies were fixed, processed, embedded in paraffin wax, sectioned, mounted on a slide, and stained for microscopic examination of the tissue cells in the histology laboratory. Following autopsies, these tissues were delivered to the laboratory in containers of 100–300 milliliters of formalin solution. The tissues, contained in small cassettes, were removed from the containers and loaded into a tray for further processing. Typically, this work was done near a hood on the wall directly above the sink into which the formalin waste was poured after the cassettes were removed. Processing of the tissues sequentially removed the tissue fluids and replaced them with alcohol and paraffin so that the tissue was fixed in a block of paraffin. Chemicals used in the tissue processing included dehydrants such as ethyl, isopropyl, and methyl alcohol, and aliphatic hydrocarbons. The total time for loading tissue cassettes and tissue processing was 1–1.5 hours; this occurred once every other week at a minimum to twice a week at a maximum. After processing, the block was sliced, and the tissue specimens were mounted on a slide, stained, and viewed under a microscope			
Number of sites:	1			
Chemical concentration:	Organ tissue samples were removed and placed in open containers of a formalin solution containing 37% formaldehyde in water and methanol.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment uses high quality data and sound methods that are from frequently used sources (NIOSH HHEs) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	U.S.	
	Metric 3: Applicability	High	The report is for an occupational scenario (Mortuary Lab Use) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	2013 - less than 10 years old	
	Metric 5: Sample Size	N/A	Qualitative information provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Information provided was derived from NIOSH site visit.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	qualitative information provided	
Continued on next page ...				

Formaldehyde

General Engineering Assessment

HERO ID: 2995043 Table: 1 of 1

...continued from previous page

Study Citation:	King, B.S., B. S., Musolin, K., Choi, J. H. (2013). Evaluation of potential employee exposures during crime and death investigations at a county coroner’s office.		
HERO ID:	2995043		
Conditions of Use:	Laboratory Use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Kinnes, G. M. (1990). Health Hazard Evaluation Report No. HETA-88-279-2026, Kardon Industries, St. Paris, Ohio. :88-279.			
HERO ID:	1320756			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Process description:	An application of wax is sprayed by the auto wax unit into the back, or open end of the composite can. This is done so that when Kardon Industry customers insert a closing device after the composite can is filled at their facility, air and moisture penetration is reduced. The composite cans are automatically fed from the production lines to the auto wax operation. Two duplex spray heads operate simultaneously, spraying wax into the open end of the composite cans. During our first visit, the wax was preheated with mineral oil in a drum and then hand carried in open buckets to two melt tanks (reservoir) on the auto wax machine. This process was modified before our second visit so that the wax was automatically pumped directly from the heated 55 gallon drum to the reservoir. This eliminated the need to hand transfer the wax from the drum to the reservoir.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for paints and coatings of use.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - process description.
Overall Quality Determination			High	

Study Citation: Kinnes, G. M. (1993). Health hazard evaluation report no. HETA 89-162-2331, Growth International, Bennett Industries Division, Peotone, Illinois.	
HERO ID: 3970579	
Conditions of Use: Plastic Material and Resin Manufacturing; Plastic Product Manufacturing	
EXTRACTION	
Parameter	Data
Process description:	Plastic containers are manufactured from polyethylene. Two molding processes are used to make the containers from the raw plastic pellets. Injection molding is used to make most of the containers that require covers, while blow molding is used to make containers with special shapes and specifications. Several container molding machines, including machines that mold the covers, are located throughout the facility. Before molding, the plastic pellets are melted and color dyes can be added. The molded containers are processed by trimming, shrinking, or attaching handles. Many of the containers also require silk screening to apply customer logos and special labels. The silk screening operations are performed on a manually operated machine or an automatic (offset) machine. Similar silk screening inks are used in both areas. For containers being silkscreened by the offset machine, handles are attached after the logos are allowed to dry. The finished plastic containers are inspected and prepared for shipment.
EVALUATION	
Domain	Metric
Domain 1: Reliability	
Metric 1:	Methodology
	High
	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used source- NIOSH Study
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Metric 3:	Applicability
	High
	US
Metric 4:	Temporal Representativeness
Metric 5:	Sample Size
	High
	The data are for an occupational scenario (silk screening onto plastic containers) within the scope of the risk evaluation.
	Low
	1990 - more than 20 years old.
	N/A
	Qualitative information provided.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	High
	Assessment or report clearly documents its data sources (based on NIOSH site visit).
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	N/A
	Qualitative information provided.
Overall Quality Determination	High

Study Citation:	Kinnes, G. M., Mortimer, V. D. (1999). Health hazard evaluation report, HETA 97-0106-2770: Sommer-Allibert Industries, USA, Inc., Kansas City, Missouri, December 1999.
HERO ID:	1317228
Conditions of Use:	Use of Paints/Coatings

EXTRACTION

Parameter	Data
Life cycle description:	Processing
Process description:	After being molded, the fascia are placed on a robotic paint line. The robotic paint line sprays the parts with three different coats. The first coat applied is an adhesive promoter, which increases the surface area on the part to promote adhesion of the subsequent coats. The second coat is the base coat which provides the coloring to the fascia. The paint line can apply one of 26 different colors which are all mixed in the paint kitchen. The third coat is a clear coating that provides the finish to the parts. After the bumpers are painted, they are cured in an oven, allowed to cool, and then prepared for shipment to an automotive assembly facility. The paint kitchen is a separate rectangular building attached to the main facility where the various coatings are stored, prepared, and distributed to the robotic paint line. All the coating materials are pneumatically conveyed and continuously recycled to the robotic paint line through carrier lines from pneumatic mixing totes located in the paint kitchen. The paint kitchen is physically separated by walls and automatic fire doors into three areas: storage, preparation, and distribution. The largest of these three areas is the storage area. Many of the various coatings and numerous solvents for the coatings are shipped in 55 gallon drums and are stored in this area. The second or middle area is the preparation area where drums of the various coatings and solvents are kept for easy access. Many of these drums are tapped, electrically grounded, and kept on horizontal racks. The third area is the distribution area which houses all of the pneumatic mixing totes and components of the recirculation system. All the coating carrier lines are connected to the main facility in this area. There are approximately 26 pneumatic mixing totes for the various colored base coats, adhesive promoter, and finishing clear coat.
Throughput:	During full production, the plant capacity is 3,000 fascia (painted parts) per day. The fascia are manufactured in one of four injection molding machines (300 ton presses) that can produce parts at the rate of 45 parts per hour each for a total facility capability of 180 parts per hour. Each of the parts weigh approximately ten pounds.
Number of sites:	1

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The report is from a frequently used source (NIOSH Study) and generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	High	The report is for an occupational scenario (painting operation) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1997 - After the PEL (1992) but more than 20 years old
	Metric 5: Sample Size	N/A	This report provided qualitative information
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	This report provided qualitative information

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Study Citation:	Kinnes, G. M., Mortimer, V. D. (1999). Health hazard evaluation report, HETA 97-0106-2770: Sommer-Allibert Industries, USA, Inc., Kansas City, Missouri, December 1999.		
HERO ID:	1317228		
Conditions of Use:	Use of Paints/Coatings		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Knowles, L. (1993). Evolution of formaldehyde control through the use of wet scavengers, dry scavengers, and dual resin systems in an operating board plant. :243-253.			
HERO ID:	5943864			
Conditions of Use:	Incorporation into Article- Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	no information provided			
Process description:	Boise Cascade operated two production lines, built in 1966 and 1971, respectively. The process is fairly standard for the era; that is, a storage area, followed by a milling and drying department, followed by a production building that contains two Bison forming stations, two Washington Iron Works prepresses, and two 14-opening Washington Iron Works hot presses. Both lines have a fiberglass reinforced plastic caul that carries the loosely formed mat through the prepress and then is stripped away and sent back under the forming line to receive a new mat. Both lines are operationally independent from each other. Production in 1992 was 185 M ft2 (3/4 in. basis), or 327,000 m3. In the mid-1970s the product mix on the 4 by 24 ft line was heavy to underlayment because that was what the line was designed to build. The five foot wide panels were almost exclusively cut to industrial sizes. Dependence on underlayment was reduced and by 1992 none have been made. As early as 1975, Boise Cascade reviewed emission reduction, working principally with the former Chembond, Inc. (now Neste), because they offered low fuming resins. Boise Cascade added a liquid urea scavenger in 1982 to the face and core of the low fuming resins. By 1983 board emissions were averaging below 0.2 ppm with the combination of low mole ratio resins and liquid urea scavenger. By the use of new resin technology, formaldehyde scavengers, substitution of small amounts of other resins, and combi resins, it has been possible for the Boise Cascade plant to meet the ever decreasing emission standards.			
Number of sites:	1 (Boise Cascade, La Grande, Oregon)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	report uses high quality data that are not from a frequently used source
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	report is less than 10 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Clear and transparent
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Kominsky, J. R., Stroman, R. E. (1977). Health Hazard Evaluation Determination, Report No. HHE-77-15-421, Leed and Northrup Corporation, Expend- able Devices Division Ellwood City, Pennsylvania. NIOSH:77-15.			
HERO ID:	1322862			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Process description:	The body of Tectips(R) are made from a phenol-formaldehyde resin sand mixture. The operation consists -of two basically standard shell core machines, with automation adaptation to this product. Coated phenolic resin sand is blown into a pneumatically controlled metal mold pre-heated to 400 to 500°F. held for 15-30 seconds to allow the binder to polymerize, t hen the formed cores are automatically discharged onto a conveyor belt and transported to a temporary packing station. (Page 3 of 25)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	From USA
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	1977
	Metric 5:	Sample Size	N/A	This is a process description
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Uncertainty and variability not relevant to process description
Overall Quality Determination		High		

Study Citation:	Kominsky, J. R., Wilcox, T., Lucas, C. (1987). Health Hazard Evaluation Report HETA 83-015-1809, Wellman Dynamics Corporation, Creston, Iowa, July, 1987.			
HERO ID:	1271641			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Process description:	The furnaces consists of a cylindrical metal shell, lined with refractory brick; a crucible, cup-shaped container that holds the metal is placed in the furnace. The refractory crucible containing the molten metal is lifted from the furnace by an overhead crane and positioned in a bruggy ladle, which is supported on a wheeled carriage, and transported to pouring area. The ladles are managed by a crane, and a geared mechanism tilts them for pouring. The metal is poured into sand molds on an open pouring floor. Fluxes composed of chlorides or fluorides of the alkaline earth metals are used to flux the molten magnesium and aluminum alloys, respectively. In addition to the fluxing procedure, the aluminum alloys are de-gassed by the addition of hexachloroethane tablets to the molten metal. When the molten metal in a mold has solidified, the casing is separated from the mold, and the core is removed from the casting in an operation known as knockout. An automated or manual abrasive blasting process is used for mold and core separation. The automated process, termed "new knockout", involves a rotary table bleating machine. The sand mold is placed on a table that carries it through a chamber where an air blast or centrifugal wheel projects a metallic abrasive against the mold with resultant removal of the sand. The manual process, termed "old knockout", involves the manual sand blasting of the casting by a worker.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH HHE	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	1983 - more than 20 years old	
	Metric 5: Sample Size	N/A	Qualitative information	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Process description.	
Overall Quality Determination		High		

Study Citation:	Konopinski, V.J. (1983). Formaldehyde In Office And Commercial Environments. American Industrial Hygiene Association Journal 44(3):205-208.			
HERO ID:	1316673			
Conditions of Use:	Office Environment			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances in furnishings, treatment/care products: Office/shops			
Process description:	Case A: formaldehyde emissions from urea-formaldehyde foam insulation installed in outer and main inner walls of a building. Case B, C, & D: the source of exposure is particleboard or plywood and therefore these cases are out of scope.			
Number of sites:	4			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The data are for office workers which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The data were published in 1983, before the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Kopf, P. W. (2003). Phenolic resins.
HERO ID:	6549167
Conditions of Use:	Processing-Incorporation into a formulation-Plastic material and resin manufacturing

EXTRACTION	
Parameter	Data
Production, import, or use volume:	In 2000, worldwide consumption of phenolic resins exceeded 4 106 t; slightly less than half of the total volume was produced in the United States (59). The largest-volume application is in plywood adhesives, an area that accounts for &49% of U.S. consumption (Table 8). All wood bonding applications accountfor about two-third of phenolic resin use. During the early 1980s, the volume of this application more than doubled as mills converted from urea–formaldehyde (UF) to phenol–formaldehyde adhesives because of the release of formaldehyde from UF products.
Process description:	Phenolic resins are prepared by the reaction of phenol or substituted phenol with an aldehyde, especially formaldehyde, in the presence of an acidic or basic catalyst.In one form or another, formaldehyde is used almost exclusively in the production of phenolic resins, regardless of the type of phenol (Table 3). It is frequently produced near the site of the resin plant by either of two common processes using methanol (qv) as the raw material. In the silver catalyst process, the reaction takes place at 600–6508C and produces water and hydrogen as by-products. The more common metal oxide process operates at 300–4008C. The gaseous formaldehyde is absorbed in water, and the final product is a formalin solution containing 36–50% formaldehyde. Of the various chemical forms of formaldehyde, the aqueous form is preferred for making phenolic resins, even though at least half of this form is water. The water serves to moderate the reaction and is readily removed in processing equipment.Hexa, a complex molecule with an adamantane-type structure, is prepared from formaldehyde and ammonia, and can be considered a latent source of formaldehyde. When used either as a catalyst or as a curative, hexa contributes formaldehyde-residue-type units as well as benzylamines.In the range of pH 4–7, formaldehyde substitution of the phenolic ring is possible, using divalent metal catalysts containing Zn, Mg, Mn, Cd, Co, Pb, Cu, and Ni; certain aluminum salts are also effective. Organic carboxylates are required as anions in order to obtain sufficient solubility of the catalyst in the reaction medium, as well as to provide a weak base. Alkaline catalysts are also effective in the polymerization–depolymerization of methylene glycol. The mechanism of the formaldehyde addition to the phenolate is still not completely understood. The most likely mechanism involves the contribution of phenol hemiformals.In a conventional novolak process, molten phenol is placed into the reactor, followed by a precise amount of acid catalyst. The formaldehyde solution is added at a temperature near 908C and a formaldehyde-tophenol molar ratio of 0.75:1 to 0.85:1. For safety reasons, slow continuous or stepwise addition of formaldehyde is preferred over adding the entire charge at once. Reaction enthalpy has been reported to be above 80 kJ/mol (19 kcal/mol) (30,31).The heat of reaction is removed by refluxing the water combined with the formaldehyde or by using a small amount of a volatile solvent such as toluene. Toluene and xylene are used for azeotropic distillation. Following decantation, the toluene or xylene is returned to the reactor.The process for high ortho novolaks is similar to the one used for those catalyzed by strong acid. Zinc acetate is used at concentrations higher than the acids, typically 2% or more. The formaldehyde/phenol ratio is similar (0.75–0.85) but yields are 5–10% lower than those produced with strong acids, and reaction times are longer. Problems with gel particles and bulk gelation occur more frequently because small amounts of reactedibenzyl ether groups are present. Overall, the process is more expensive because of higher raw material costs, lower yields, and longer cycle times.Like the novolak processes, a typical resol process consists of reaction, dehydration, and finishing. Phenol and formaldehyde solution are added all at once to the reactor at a molar ratio of formaldehyde to phenol of 1.2–3.0:1. Catalyst is added and the pH is checked and adjusted if necessary. The catalyst concentration can range from 1 to 5% for NaOH, 3 to 6% for Ba(OH)2, and 6 to 12% for hexa. A reaction temperature of 80–958C is used with vacuum-reflux control. The high concentration of water and lower enthalpy compared to novolaks allows better exotherm control. In the reaction phase, the temperature is held at 80–908C and vacuum-refluxing lasts from 1 to 3 h as determined in the development phase. Benzoxazine resins are prepared by the reaction of phenol, formaldehyde, and an amine. In one particular example abenzoxazine is prepared from bisphenol A, formaldehyde, and aniline to give 2,20-bis(3-phenyl-4-dihydro-1,3,2-benzoxazine) propane. When heated to about 2008C the methylene bond to oxygen breaks and reforms onto the available ortho positions of adjacent moieties to give dibenzylamine structures.
Number of sites:	U.S. phenolic resin manufacturers include Ashland, Borden Chemical, Cytec Fiberite, Durez, FiberCote Industries, H.B. Fuller, P.D. George, GeorgiaPacific, International Paper, Lockport Thermosets, Maruzen America, Plastics Engineering, Resinoid, Sumitomo America, TriQuest, and Vantico.

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability			
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Study Citation:	Kopf, P. W. (2003). Phenolic resins.
HERO ID:	6549167
Conditions of Use:	Processing-Incorporation into a formulation-Plastic material and resin manufacturing

Domain		Metric	EVALUATION	
			Rating	Comments
Domain 2: Representativeness	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Source clearly documents its data sources.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination

High

Study Citation:	Korhonen, K., Liukkonen, T., Ahrens, W., Astrakianakis, G., Boffetta, P., Burdorf, A., Heederik, D., Kauppinen, T., Kogevinas, M., Osvoll, P., Rix, B.A., Saalo, A., Sunyer, J., Szadkowska-Stanczyk, I., Teschke, K., Westberg, H., Widerkiewicz, K. (2004). Occupational exposure to chemical agents in the paper industry. International Archives of Occupational and Environmental Health 77(7):451-460.			
HERO ID:	1321973			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Formaldehyde was the main component of several chemicals used in the paper and recycled-paper industry and the concentrations that exceeded the present TLV value were measured during the re-pulping of waste pulp. Microbes may cause problems because of the warm and wet conditions in many departments, and high concentrations of bacteria were measured, especially in the de-inking processes, in wastewater.			
Comments:	This article summarizes the results of 3,873 measurements carried out in the production departments of paper and paperboard mills and recycling plants in 12 countries.... a team of industrial hygienists has integrated the measurements in the database with mill-specific information from the questionnaires answered by the participating companies, to create a pulp and paper department-exposure matrix (PAPDEM) for 25 major exposure agents... A description of this matrix and a summary of exposure estimates have been published elsewhere (Kauppinen et al. 2002).			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from 12 countries, each are in the OECD.
	Metric 3:	Applicability	High	Data are for pulp and paper industry, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Most of the measurements were from 1980 to 1994, therefore most monitoring data were collected prior to the most recent PEL (1992). Publication 2004.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Kralj, A.A. (2015). The re-usages of wastewater within industry: the positive impact of contaminants. Journal of Cleaner Production 95:124-130.			
HERO ID:	5952003			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	"Formaldehyde is produced industrially by the catalytic oxidation of methanol (McKetta and Cunningham, 1985b). The more common catalysts are silver metal or a mixture of an iron oxide with molybdenum and vanadium. During the more commonly used FORMOX® process, methanol and oxygen react at ca 250-400 °C in the presence of iron oxide in combination with molybdenum and/or vanadium to produce formaldehyde, according to the chemical equation: 2 CH3OH + O2 -> 2H2CO + 2H2O (R9) Another possibility for formaldehyde production is the metal oxide process. The main differences compared to the silver process are: •working with excess air •type of catalyst •a lower temperature level The metal oxide process can be described as a two stage oxidation reaction during the vapourization phase, which involves an oxidised (Kox) and a reduced (Kredox) catalyst. Methanol (inlet stream M) is fed into the heated vaporiser (V; Fig. 7). The process gas, a mixture of fresh air (inlet stream air) from the atmosphere, is drawn through a filter and compressed in a blower (B). The methanol and air mixture are heated in a vaporiser (V) and pre-heater (H) before entering the reactor (R). The conversion of methanol to formaldehyde takes place in tubes filled with a metal oxide catalyst. The reaction’s heat is removed by using steam production or for electricity cogeneration. The reactive gases are cooled (C) and enter the absorption tower (A), where the absorption of the formaldehyde takes place by using 5478 kg/h (1.52 kg/s) fresh water. This fresh water would be replaced by using wastewater from the methanol process. (pg 5)"			
Chemical concentration:	sold as a 37% solution in water known by trade-names like formalin or formol (pg 5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Slovenia, an OECD country.	
	Metric 3: Applicability	High	Data are for manufacturing, an in-scope occupational scenario	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	N/A	PD info	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	PD info	
Overall Quality Determination		High		

Study Citation:	Kullman, G. J. (1989). Health Hazard Evaluation Report HETA 88-269-1993, Meyersdale Manufacturing Co., Meyersdale, Pennsylvania, October 1989.			
HERO ID:	1317472			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Process description:	The facility receives pre-cured, finished fabric from a textile-finishing plant. The shirt fabric is treated with formaldehyde-based resins, which give the fabric crease-resistant characteristics (permanent press). The resin-treated fabric is cured before it is received. The first step in the shirt manufacturing process is cutting of shirt parts from the fabric (cutting area). Many layers of fabric must first be spread out on a long table. All of the layers are then cut simultaneously with hand-held saws (cutters) or with dies. When a hand-held cutter is used to perform this step, a pattern is first laid over the top layer and the operator cuts according to the pattern. Cutting operations were done during the first industrial hygiene survey at the time of the second survey cutting operations were discontinued. After the cutting operations, the shirt parts are assembled. Parts of the cuffs, collars, and fronts are assembled into complete pieces (small parts area), then the major pieces, such as yokes, sleeves, collars, cuffs, and fronts are assembled into complete shirts (assembly area). Most of the various assembly operations require sewing with sewing machines appropriately modified for each type of operation. Some assembly operations (collar and cuff making) make use of heat to form or fuse together (in conjunction with a heat-sensitive adhesive) Various parts (fusing area).The finished shirts are inspected (trim/inspection area and moved to the apparel pressing operations where conventional hand irons are used to press the shirts (Pressing area). The shirts are then folded (folding area) and packaged in bags and boxes for shipping (boxing area).Finished shirts that become soiled during manufacturing are taken to the cleaning area where the dirt/stains are treated manually with chlorinated dry-cleaning solvent.			
Number of sites:	1			
Chemical concentration:	Post office blue 400(08/10/88), 700 ppm(02/02/89), 760 ppm(02/02/89)Post office whit 370 ppmMacDonalds Tatersall 520 ppmMacDonalds Blue/brown 560(02/02/89), 890 ppm(08/10/88)Unitog 180 ppmMetro bus 160 ppmGoodyear 350 ppmDan River 300 ppmAdhesive material 1 810 ppmAdhesive material 2 24000 ppmAdhesive material 3 5800 ppmLining material ND			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH Study	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The report is for an occupational scenario (apparel manufacture) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	1988-89: more than 20 years old.	
	Metric 5: Sample Size	High	Results from individual sampling events were provided which could be used to develop statistics. As this is a NIOSH study, it is assumed that uncertainty was considered in Methods 239.1	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Information provided was derived from NIOSH site visit.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Results from individual sampling events were provided which could be used to assess variability between fabrics and batches. As this is a NIOSH study, it is assumed that uncertainty was considered in Method 239.1.	
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Study Citation:	Kullman, G. J. (1989). Health Hazard Evaluation Report HETA 88-269-1993, Meyersdale Manufacturing Co., Meyersdale, Pennsylvania, October 1989.		
HERO ID:	1317472		
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Ladou, J. (2006). Printed circuit board industry. International Journal of Hygiene and Environmental Health 209(3):211-219.			
HERO ID:	491238			
Conditions of Use:	Use of electrical and electronic products			
EXTRACTION				
Parameter	Data			
Process description:	The main processes, common to all PrCBs, are drilling, image transfer, and electroplating. Holes are drilled into PrCBs to provide layer-to-layer interconnections on double-sided and multilayer circuits. These holes are subsequently “plated through” or made conductive by plating copper onto the hole barrels (the vertical, cylindrical surface of the hole). Because most rigid PrCB substrates consist of epoxy resin and glass, direct electroplating of hole barrels is not possible since this material will not conduct electricity. Therefore, a seed layer or coating of conductive material (usually electroless copper) must be deposited into the barrels of the holes before the electrolytic copper plating can occur. Chemical products utilized in the electroless copper process contain formaldehyde or dimethylformamide.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for electrical and electronic products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2005)
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	Lee, S. A. (1988). Health Hazard Evaluation Report HETA 87-309-1906, Louisiana-Pacific Corporation, Missoula, Montana, June 1988.			
HERO ID:	1317215			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Process description:	Boards are manufactured at an adjacent particle board plant and sent to the painting department where they are conveyed through machines that apply the paint with rollers. There are three solvent based painting stations and one water-based painting station.			
Number of sites:	1			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (industrial use of plywood) in which hard-wood plywood is outside of the scope of the risk evaluation due TSCA 6 Formaldehyde in Composite Wood Products. However, the industrial practices are not expected to be different from use of other engineered wood.
	Metric 4:	Temporal Representativeness	Low	1987 - more than 20 years old
	Metric 5:	Sample Size	N/A	This report provided qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	This report provided qualitative information
Overall Quality Determination			High	

Study Citation:	Leslie, G.B. (1998). Aldehydes in the hospital environment - an overview. Advances in Air Pollution :637-647.			
HERO ID:	1320090			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	>4,000,000 (tonnes)			
Chemical concentration:	Used as a 37% solution known as formalin.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from the United Kingdom, an OECD country.	
	Metric 3: Applicability	High	Data are for manufacture, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1998)	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Low		

Study Citation:	Li, Y., Shao, S. X., Shi, K. Q., Jiang, L. (2006). Release of free formaldehyde in THP salts tannages. :94-99.			
HERO ID:	1963870			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Process description:	Preparation of THPC/THPS tanned leather: Pickled skins were washed with 12% sodium chloride dissolved in 200% water for 20min. Subsequently, 8% THPS/THPC (percentages based on pickled skin weight) was offered and the drum was run for 60min. Then, basification was carried out by the addition of 1.0%-1.5% sodium hydroxide and 10% water in four to six instalments at an interval of 15min until the pH was adjusted from 2.0 to 10.0 respectively. Finally, the temperature was raised to 40 C and the drum was run for another 60min. Then, the leathers were piled for 12h. Next day, the hydrothermal stability of the wet tanned leathers was measured using a shrinkage tester. The formaldehyde contents in the leathers tanned at different pH were determined after 48h hanging in the air.			
Chemical concentration:	The content of HCHO in the raw solution of THPC is 27.49 ug/mL.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	non OECD country	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	data between 10 and 20 years old	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Liang, R.,ui, Liu, M., Wu, L.,an (2007). Controlled release NPK compound fertilizer with the function of water retention. Reactive and Functional Polymers 67(9):769-779.			
HERO ID:	5969949			
Conditions of Use:	Chemical substances in agriculture use products: Fertilizer			
EXTRACTION				
Parameter	Data			
Throughput:	Five grams of dried UF powder (<90 mesh) and 5 g PAK powder (<90 mesh) were placed into 50 ml 2 wt% sodium alginate solution.			
Chemical concentration:	Urea formaldehyde was made from urea and 37% formaldehyde aqueous solution.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S., or the country of origin is not specified.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.
Overall Quality Determination			High	

Study Citation:	Lim, H.H., Shin, H.S. (2017). Sensitive Determination of Volatile Organic Compounds and Aldehydes in Tattoo Inks. Journal of Chromatographic Science 55(2):109-116.			
HERO ID:	3491065			
Conditions of Use:	Non-TSCA			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Formaldehyde concentrations in tattoo inks range from 0.4 to 308mg/kg. Formaldehyde was found in 13 of the 16 analyzed tattoo ink samples. Mean concentration of formaldehyde determined in commercial tattoo were 42.7 +/- 95.8 mg/kg.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	data from an OECD country other than the U.S.	
	Metric 3: Applicability	Uninformative	The report is from an occupational or non-occupationalscenario that does not apply to any occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	High	report is no more than 10 years old	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty	
Overall Quality Determination		Uninformative		

Study Citation:	Lindskov, R. (1982). Contact urticaria to formaldehyde. Contact Dermatitis 8(5):333-334.			
HERO ID:	1314820			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances in products not described by other codes: Pathology laboratories			
Number of sites:	1			
Chemical concentration:	10% and 20% formaldehyde solutions			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Sampling or analytical methodology is not specified though it was noted that formaldehyde concentration at the fume hood was measured with a Drager Tubes.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Denmark - and OECD country	
	Metric 3: Applicability	High	The data are for a pathology worker which is an occupational scenario within the scope of the risk evaluation. variability. Information about uncertainty was not provided.	
	Metric 4: Temporal Representativeness	Low	The data were published in 1982 before the most recent PEL (1992) and more than 20 years old. Range data provided	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The study provided range data that can be used to evaluate variability. Information about uncertainty was not provided.	
Overall Quality Determination		Low		

Study Citation:	Liu, M., Wang, Y., Wu, Y., He, Z., Wan, H. (2018). "Greener" adhesives composed of urea-formaldehyde resin and cottonseed meal for wood-based composites. Journal of Cleaner Production 187(Elsevier):361-371.
HERO ID:	5956691
Conditions of Use:	Processing (UF resin/adhesive)

EXTRACTION	
Parameter	Data
Production, import, or use volume:	The current global production of urea-formaldehyde (UF) resins exceeds 5 million metric tons annually.
Life cycle description:	UF resins are widely used in particleboard, medium density fiber board, and interior plywood manufacturing. The source of free formaldehyde from UF resins is believed mainly from un-reacted formaldehyde and the reversibility of amino-methylene link in the cured resin network. Life cycle assessment (LCA) analysis is an established method to study, to estimate, or to evaluate the possible impacts of manufacturing processes or products on the environment. To compare the "greenness" of normal UF resin and the adhesive composed of UF resin and cottonseed meal, the LCA analysis was conducted. The impact assessment was carried out using TRACI (v2.1, February 2014). In this analysis, the lifecycle impact of cotton production to this by-product and the impact to the LCA analysis of the adhesives composed of UF resin and cottonseed meal was not considered. Based on the LCA analysis, the replacement of cottonseed meal adhesive in a UF resin could make the adhesive manufacturing process "greener". In this point of view, adhesives composed of cottonseed meal and UF resin are "greener" adhesives compared to pure UF resins. But this LCA analysis was based on a very simple model. It was also simplified with many assumptions.
Process description:	The UF resin with a 1.45 formaldehyde to urea (F/U) molar ratio was prepared by following three steps of urea addition. First, paraformaldehyde was dissolved in distilled water at a basic condition (pH ¼ 8.0, adjusted by 8% NaOH). The formaldehyde solution was heated and maintained at 70 C. Then, the first (32.2% of total urea) and second part (31.3% of total urea) of urea were added with a 10 min interval into the formaldehyde solution for the methylation reaction to occur. Next, the reaction was followed by a poly-condensation or polymerization reaction under an acidic condition (pH ¼ 4.8, adjusted by 8% H2SO4) until the reactants reached a target viscosity of LMN. The solution pH value was adjusted to a basic condition (pH ¼ 8.0) followed by the addition of the third part of urea (36.5% of total urea). After cooled down naturally, the UF resin was obtained.
Comments:	Note: This is a new method to produce UF Resin using cottonseed meal which is supposed to be "greener"

			EVALUATION	
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	report is no more than 10 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination	High

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Study Citation:	Liu, M., Wang, Y., Wu, Y., He, Z., Wan, H. (2018). "Greener" adhesives composed of urea-formaldehyde resin and cottonseed meal for wood-based composites. Journal of Cleaner Production 187(Elsevier):361-371.		
HERO ID:	5956691		
Conditions of Use:	Processing (UF resin/adhesive)		
		EVALUATION	
Domain	Metric	Rating	Comments

Study Citation:	Liu, R., Liu, M., Qu, Y., Huang, A., Ma, E. (2018). Dynamic moisture sorption and formaldehyde emission behavior of three kinds of wood-based panels. Holz als Roh- und Werkstoff 76(3):1037-1044.			
HERO ID:	5952097			
Conditions of Use:	Building and Construction Materials (MDF, particleboard, plywood)			
EXTRACTION				
Parameter	Data			
Chemical concentration:	The formaldehyde concentrations of these panels tested by the perforator according to European standard EN 120 (1992) were 2-4 mg/100 g (pg 2; data in Table 1)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.	
	Metric 3: Applicability	High	Data are for building and construction materials, an in-scope occupational scenario	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	N/A	concentration data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by comparing MDF, particleboard, and plywood but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:		Low, I., Mitchell, C. (1985). Respiratory disease in foundry workers. British Journal of Industrial Medicine 42(2):101-105.		
HERO ID:		1314720		
Conditions of Use:		Foundries		
EXTRACTION				
Parameter		Data		
Life cycle description:		Chermical Substances in Metal products: Foundary		
Process description:		Copied from source: "The study was undertaken at a steel foundry that specialises in producing castings for heavy industry and rolling stock. Castings are produced by pouring molten metal into a mould cavity. The mould that is formed in a box determines the external shape of the casting. Cores are placed into the mould cavity anddetermine the internal shape of the casting. There are two separate major casting areas within the foundry. When a small number of castings is required these are produced in the general foundry by a jobbing mould method using the Furane process. For a large number of castings a semimechanised method uses a high pressure greensand moulding process (hereafter called the line). In both areascors of varying composition are placed in the mould cavities. Workers in the casting areas are exposed to fumes arising from the various core and mould materials after metals at high temperatures have been poured into the mould cavities. After the castings have cooled they are transferred to the aftercast section where they are subjected to various finishing procedures such as shot blasting,grinding, and cutting. Those working in the aftercast area were not exposed to any of the resin fumes or vapours found in the rest of the foundry. Nevertheless,they were clearly exposed to some fumes-for example, from welding-and to dusts from the finishing procedures. The aftercast section was the only area in the foundry that could provide sufficient workers with whom we could compare thoseexposed to resin fumes and vapours elsewhere. In a separate area cores are produced by several different processes, which include the following: Furane process-" Chemrez 204" (urea formaldehyde resin condensed with furfuryl alcohol) is mixed with phosphoric acid (as a catalyst) and sand. Isocure process-A complex polyurethane resin is formed by mixing methylene diphenyl di-isocyanate(MDI) dissolved in petroleum hydrocarbon solvents and phenol formaldehyde resin dissolved in petroleum solvents with dimethylethylamine (DMEA)as a catalyst. Shell process-Phenol formaldehyde resin is used with a catalyst, hexamethylenetetramine. Carbon dioxide process-Sodium silicate is mixedwith either various glycerol acetates or carbon dioxide gas under pressure.Oil sand process-" Maidex" (acid hydrolysed starch and drying oil) is mixed with sand. The cores are baked in an oven at between 350°C and 550°C for several hours."		
Number of sites:		1		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness		Metric 2: Geographic Scope	Medium	Australia - an OECD member
		Metric 3: Applicability	High	The data are for foundry workers which is an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	Low	The data were published in 1985, before the most recent PEL (1992) and more than 20 years old.
		Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
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Study Citation:		Low, I., Mitchell, C. (1985). Respiratory disease in foundry workers. British Journal of Industrial Medicine 42(2):101-105.			
HERO ID:		1314720			
Conditions of Use:		Foundries			
Domain		Metric		EVALUATION	
				Rating	Comments
	Metric 7:	Metadata Completeness		N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination				High	

Study Citation:	Lu, H., Tian, J., Cai, Q.Y., Wen, S., Liu, Y., Li, N. (2016). Levels and Health Risk of Carbonyl Compounds in Air of the Library in Guangzhou, South China. Aerosol and Air Quality Research 16(5):1234-1243.			
HERO ID:	3259031			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	The production of formaldehyde in China is 12,000 kt, accounting for about 34% of the total global output.			
Life cycle description:	Formaldehyde is used extensively in construction, wood processing, furniture, textiles, carpeting, and in the chemical industry.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	report is generally no more than 10 years old
	Metric 5:	Sample Size	Low	Data is not characterized by statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium		

Study Citation:	Löfstedt, H., Westberg, H., Seldén, A.I., Bryngelsson, I.L., Svartengren, M. (2011). Respiratory symptoms and lung function in foundry workers using the hot box method: A 4-year follow-up. Journal of Occupational and Environmental Medicine 53(12):1425-1429.		
HERO ID:	1313413		
Conditions of Use:	Foundries		
EXTRACTION			
Parameter	Data		
Life cycle description:	Chemical Substances in metal products: foundry workers using the hot box method		
Process description:	Hot Box method is used in foundries to produce cores for hollow castings. The method involves a binder based on a furfuryl alcohol or phenol resin, urea, and formaldehyde. The liquid binder and a curing agent containing nitrate or chloride are mixed with dry sand and blown into a heated core box. The acid released upon heating induces rapid curing. The cores are used in casting and removed after the metal has solidified. ¹ During the process, formaldehyde and low-molecular-weight monoisocyanates (ie, isocyanates containing only one NCO-group) such as isocyanic acid (ICA) and methyl isocyanate (MIC) are formed.		
Number of sites:	3		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden - an OECD member
	Metric 3: Applicability	High	The data are for brass foundry workers which is an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The study was derived from data compiled in 2005 after the PEL (1992) and more than 10 but less than 20 years old
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium	

Study Citation:	Löfstedt, H., Westberg, H., Seldén, A.I., Lundholm, C., Svartengren, M. (2009). Respiratory symptoms and lung function in foundry workers exposed to low molecular weight isocyanates. American Journal of Industrial Medicine 52(6):455-463.			
HERO ID:	1313574			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances in metal products: Foundry hot box biner technique			
Process description:	The Hot Box method is used in foundries to produce cores for hollow castings. The method involves a binder that is based on a furfuryl alcohol or phenol resin. the binder also contains urea and formaldehyde. The liquid binder and a curing agent are mixed with dry sand and blown into a heated core box. The acid release upon heating induces a rapid cure. The cores are used in casting and removed after the metal has solidified.			
Number of sites:	Three brass foundries and one gray iron foundry.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden - an OECD member	
	Metric 3: Applicability	High	The data are for foundry workers, which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The report was published in 2009, after the most recentPEL (1992) and more than 10 and less than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Löfstedt, H., Westberg, H., Seldén, A.I., Rudblad, S., Bryngelsson, I.L., Ngo, Y., Svartengren, M. (2011). Nasal and ocular effects in foundry workers using the hot box method. Journal of Occupational and Environmental Medicine 53(1):43-48.			
HERO ID:	1313473			
Conditions of Use:	Foundries			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical Substances in metal products: foundry workers using the hot box method			
Process description:	The “Hot Box” method is used by foundries to produce cores for hollow castings. In this method, a liquid binder based on a furfuryl alcohol or phenol resin is mixed with a curing agent that contains nitrate or chloride and dry sand. Heating this mixture in the core box induces a rapid cure. The cores are used in casting and removed after the metal has solidified. The operations were manual or automated.			
Number of sites:	3			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Sweden - an OECD member	
	Metric 3: Applicability	High	The data are for bronze foundry workers which is an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The study was published in 2011 after the latest PEL (1992) and less than 10 years old	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Malin, N. (1994). Carpeting, Indoor Air Quality, and the Environment. Environmental Building News 3(6):1.			
HERO ID:	5708617			
Conditions of Use:	Use- Floor Coverings & Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Throughput:	Carpets were tested for formaldehyde emissions. In 1993 Americans purchased 5.5 square yards of carpet per person, or nearly 1.5 billion square yards total—enough to cover nearly 40% of Rhode Island. Between 1960 and 1993, carpet purchases grew by 654%, while the average cost of carpets in real dollars dropped dramatically. 70% of floors in the US			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	report uses high quality data but data sources are not readily transparent	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data	
	Metric 3: Applicability	High	report is for an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	data is more than 20 years old	
	Metric 5: Sample Size	Low	characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		Medium		

Study Citation:	Mantanis, G.I., Athanassiadou, E.T., Barbu, M.C., Wijnendaele, K. (2018). Adhesive systems used in the European particleboard, MDF and OSB industries. Wood Material Science and Engineering 13(2):104-116.			
HERO ID:	6118093			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	”The overall level of particleboard production (2016), in the European federation of the particleboard member countries, amounted to 30.25 million m3 . In respect to the final applications of particleboard, the furniture market remains the largest user of particleboard in Europe (EPF 2017) with 66% in 2016. The building sector accounted for a share of 22% including doors and flooring applications. The remaining 12% of particleboard consumption, distributed to other applications such as packaging, paneling and frames.(4/14) (A production breakdown by every European country is also available in the report.)”			
Life cycle description:	Adhesives and sealant chemicals in wood product manufacturing			
Throughput:	Particleboard production for each European country per site per year for each type of adhesive is given in a table. (4/14)			
Number of sites:	The EPF member countries altogether have 98 operating particleboard plants. (4/14)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from all over Europe, but the report was compiled in Greece, an OECD country.
	Metric 3:	Applicability	High	Data are for adhesive and sealant chemicals used in wood products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		High		

Study Citation:	Manufactured Housing Inst, (1985). Letter from manufactured housing institute to US EPA commenting on the two ICF draft reports with attachments.			
HERO ID:	5901016			
Conditions of Use:	Building and construction materials (manufactured homes)			
EXTRACTION				
Parameter	Data			
Number of sites:	170 firms in over 400 factories (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for building and construction materials, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	number of sites data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	number of sites data	
Overall Quality Determination		Medium		

Study Citation:	Marlow, D. A. (1995). Health hazard evaluation report HETA 94-0309-2514, Homecrest Industries Incorporated, Wadena, Minnesota.			
HERO ID:	1317814			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Process description:	The fabric is rolled out in layers on long tables and cuts the layered fabric using a Greber fabric cutter. The cut fabric is sewn into cushions and coverings, sometimes using a PVC coated polyester yarn backing called Phifertex®. The cushions and coverings are filled with polyester filling and then completes the sewing.			
Number of sites:	1			
Chemical concentration:	FabricShenandoah: Melody 170 ug/gWellington-Sears: Callaway 540 ug/gWellington-Sears: Savanna nondetectableCovington Fabrics: Antique Rose nondetectableCovington Fabrics: Calypso-Phlox nondetectableAmetex: Lanai 290 ug/gArtistic Design: Cachet 350 ug/gDickerson-Elderton Mills: NottinghamDickerson-Elderton Mills: Tapis nondetectableDickerson-Elderton Mills: Queen Anne nondetectableDickerson-Elderton Mills: Thames nondetectableDickerson-Elderton Mills: Hana 340 ug/g Phifer: Phifertex backing nondetectable			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	1995 more than 20 years old
	Metric 5:	Sample Size	Medium	Results of formaldehyde content of fabrics were provided for individual fabrics which could be used to develop statistics. Uncertainty was not discussed
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual bulk sampling were provided which could be used to evaluate variability between fabrics. Uncertainty was not discussed but as this is a NIOSH study it is assumed that it was considered in the sampling method.
Overall Quality Determination		High		

Study Citation:	Marsal, A., Cuadros, S., Cuadros, R.M., Font, J., Manich, A.M. (2018). Dyestuffs and formaldehyde content in split leather treated with formaldehyde resins. Dyes and Pigments 158:50-59.			
HERO ID:	5959225			
Conditions of Use:	Finishing agents in textile, apparel, and leather manufacturing (leather dyes)			
EXTRACTION				
Parameter	Data			
Chemical concentration:	”The formaldehyde content in the resins were analysed in accordance with the method described in Section 2.2.3 (EN ISO 17226 Standard, pg 3), providing the following mean values ± 95% confidence intervals of five replicates: MF (A): 4514 ± 326 mg/kg; DCDF (A): 6428 ± 466 mg/kg and MF (B): 23481 ± 369 mg/kg (pg 2) Tables 3-4 (pg 4) present regression lines for formaldehyde content as a function of time for various leathers/dyes”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Spain, an OECD country.
	Metric 3:	Applicability	High	Data are for fabric finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (regression lines) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by evaluating multiple leathers and dyes but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Marsh, G.M. (1982). Proportional mortality patterns among chemical plant workers exposed to formaldehyde. British Journal of Industrial Medicine 39(4):313-322.		
HERO ID:	21248		
Conditions of Use:	Processing as a reactant		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	6.4 billion pounds of aqueous formaledehyde in 1978. half of the produced formaldehyde was used in urea-formaldehyde and phenol-formaldehyde resins		
Life cycle description:	chemical manufacture: phenolic and urea resins		
Number of sites:	1		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or reportare not specified.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from Springfield, Massachusetts and may be representative of the industry being evaluated, though equipment and operations may be significantly different today than in 1950 -1976 which is the period for this study.
	Metric 3: Applicability	High	The data are for chemical plant workers which is an occupational scenario within the scope of the risk evaluation, though equipment and operations may be significantly different today than in 1950 -1976 which is the period for this study.
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1982 and includes the perios from 1950 to 1976; before the most recent PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty
Overall Quality Determination		Low	

Study Citation:	Marsh, G.M., Morfeld, P., Zimmerman, S.D., Liu, Y., Balmert, L.C. (2016). An updated re-analysis of the mortality risk from nasopharyngeal cancer in the National Cancer Institute formaldehyde worker cohort study. Journal of Occupational Medicine and Toxicology 11:8.			
HERO ID:	3129860			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Production in the U.S. and the European Union exceeds 10 million tons per year.			
Life cycle description:	Adhesives and binders are produced from resins based on formaldehyde (e.g., for the manufacture of particle board, paper, and vitreous synthetic fibers) to make plastics and coatings. Formaldehyde is used in textile finishing. Formaldehyde is an intermediate in the production of many chemicals, and as formalin it is used as a disinfectant and preservative. In addition, formaldehyde is produced in combustion, e.g. in vehicle exhausts and tobacco smoke. In 2004, the International Agency for Research on Cancer (IARC) reclassified formaldehyde from a probable to a known human carcinogen.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu- ated.
	Metric 3:	Applicability	High	Report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	No sample data.
Overall Quality Determination		High		

Study Citation:	Masamoto, J., Iwaisako, T., Chohnno, M., Kawamura, M., Ohtake, J., Matsuzaki, K. (1993). Development of a new advanced process for manufacturing polyacetal resins. Part I. Development of a new process for manufacturing highly concentrated aqueous formaldehyde solution by methylal oxidation. Journal of Applied Polymer Science 50(8):1299-1305.			
HERO ID:	1203582			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Process description:	Process diagram shown in Figure 2 on PDF Pg. 3.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Japan, an OECD country.	
	Metric 3: Applicability	High	Data are for manufacture, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1993)	
	Metric 5: Sample Size	N/A	Not applicable - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - process description.	
Overall Quality Determination		Medium		

Study Citation:	Mason, R., Sweeney, S. C. (1976). A literature survey oriented towards adverse environmental effects resultant from the use of AZO compounds, brominated hydrocarbons, EDTA, formaldehyde resins, and o-nitrochlorobenzene - Final report.
HERO ID:	6005198
Conditions of Use:	FA resin production and multiple COUs

EXTRACTION	
Parameter	Data
Production, import, or use volume:	Production figures of urea resins go from 190,000 metric tons in 1964 to 321,000 metric tons in 1970. Melamine resins ranged from 69,000 metric tons in 1964 up to 117,700 metric tons in 1970. Acetal resins had 20,000 metric tons in 1965 and 39,000 in 1970. Phenol formaldehyde had 263,400 metric tons in 1962 and 462,200 in 1970. Urea resin consumption in closeres was 6900, 6800 and 7900 for 1971, 1972 and 1973; Urea resin consumption in electrical devices was 11,400, 10,900 and 12,600 for 1971, 1972, and 1973. For 1971 through 1973 melamine resin consumption in buttons was 900, 800, and 900; for dinnerware it was 19,100, 18,200 and 19,100; for sanitaryware it was NA, 500, and 600; Bonding and adhesives resins for the years 1971 to 1973 for fibrous and granulated wood were 199,000, 232,000, and 262,000; for laminating 22,000, 24,000 and 24,000; for plywood 31,000, 40,000 and 40,000; for paper treating and coating 14,000, 16,000 and 22,000; for protective coating 19,000, 28,000 and 33,000; for textile coating and treating 23,000, 23,000 and 26,000; Consumption for acetal resins in metric tons for 1971 to 1973 were for appliances - 4,820, 5,600, and 5900; for consumer products - 3090, 3500, and 3800; for electrical/electronics - 1910, 2100, and 2500; for machinery parts - 2550, 2800, and 3900; for plumbing and hardware - 2550, 2800 and 4000; for sheet, rod, tube - 1320, 1500, and 1800; and for transportation - 6050, 5700, and 6500; consumption of phenol formaldehyde resins from 1971 to 1973 in metric tons: bonding and adhesive resins for coated and bonded abrasives - 8000, 9100, and 11,200; for fibrous and granulated wood - 30,000, 40,000 and 42,000; for friction materials - 14,000, 13,400, and 14,700; for foundry and shell moldings - 39,000, 43,600 and 50,000; for insulating materials - 88,000, 107,000 and 112,000; for laminating buildings - 31,500, 26,100, 26,200; for electrical/electronics - 7000, 7300, and 7300; for furniture - 12,000, 16,000, and 17,000; for plywood - 152,000, 163,000, and 125,000; for protective coatings - 10,000, 9600, and 10,100; molding compounds for appliances - 17,500, 31,800, 41,400; for business machines - 4400, 6100, and 6800; for closures - 9100, 4500, and 4100; for electrical controls and switches - 40,400, 56,000, and 61,000; for telephones - 9800, 9300, and 9500; for wiring devices - 15,600, 15,900, and 16,300; Housewares for utensils and handles - 11,200, 14,300, and 14,700; for machine parts - 4000, 4800, and 5100; for transportation - NA, 27,700 and 30,270
Life cycle description:	The versatile formaldehyde resins have usually wide application ranges. The amino resins are used in closures and wiring devices, large and small appliance housings, dinnerware, buttons, ash trays, and utensil handles. They are used as adhesives in plywood and in laminating. In textile treating, they are used for greasproofing, water repellantcy, and flame retardance. In paper treating, they are used for improving wet strength, rub resistance, and dry tensile values. The acetal homopolymer is used to replace metal parts in the plumbing industry. It is used in truck-trailer connectors and in such a variety of items as furniture casters, hardware items, bodies of lighters, replaceable cartridges in shavers, toy components, telephone pushbuttons, and stereo-tape and cassette components. The acetal copolymer is used in automotive gears and fuelemmission systems. It is also used to give satiny surfaces and hardness to pen barrels and other items where an attractive appearance is desired. Its dimension stability qualifies it for use in aerosol containers under continuous pressure. The phenolics are used as adhesives in the wood particle board used in building panels and furniture, and as a water-resistant glue for exterior grade plywood. They are used extensively as automotive components in transmissions, distributor caps, coil towers, rotors, fuse blocks, for brake linings, clutch parts, and transmission bands.

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Data is from a report by EPA so contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is for US.
	Metric 3:	Applicability	High	Data is applicable to multiple COUs
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old.
	Metric 5:	Sample Size	Medium	Characterized by a range of data.

Continued on next page ...

General Engineering Assessment

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Study Citation:	Mason, R., Sweeney, S. C. (1976). A literature survey oriented towards adverse environmental effects resultant from the use of AZO compounds, brominated hydrocarbons, EDTA, formaldehyde resins, and o-nitrochlorobenzene - Final report.		
HERO ID:	6005198		
Conditions of Use:	FA resin production and multiple COUs		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 3: Accessibility/ Clarity			
Metric 6:	Metadata Completeness	Medium	Provides PV data and life cycle description
Domain 4: Variability and Uncertainty			
Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at multiple years and multiple industries. Does not address uncertainty.
Overall Quality Determination		Medium	

Study Citation:	Massachusetts OTA, (2013). A report on barriers to reducing the use of asthma-related chemicals.			
HERO ID:	8724621			
Conditions of Use:	Other- Lab Use- Embalming			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	A 1994 TURI report on mortuaries estimated that 249,920 gallons of embalming fluids containingapproximately 180,163 pounds of formaldehyde were used in the state.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	The data is for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Medium	Data used in the report reference 2009, which is more than 10 years old but no more than 20 years old.	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability is not applicable for extracted data but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Massachusetts OTA, (2013). A report on barriers to reducing the use of asthma-related chemicals.			
HERO ID:	8724621			
Conditions of Use:	All COUs			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	In 2004, U.S. production was 9,534,992,839 pounds and consumption was 9,507,960,000 pounds; TURA Data Formaldehyde 2009 Usage- Boremc Specialty Chemicals- 1, Dow- 5365, Ineos Melamines (claims trade secret), MW Custom Papers-44879, Raytor Compunds, Inc- 1001513, Suddekor LLC- 42400, The Dodge Company- 889402; TURA Data Formaldehyde 2009 Byproduct-Boremc Specialty Chemicals- 72905, Dow- 307347, Ineos Melamines (claims trade secret), MW Custom Papers-44879, Raytor Compunds, Inc- 1726, Suddekor LLC- 2290, The Dodge Company- 6161			
Life cycle description:	Formaldehyde is generally produced for local consumption, with world trade accounting for only two percent of production in 2003, as it is easy to make but costly to transport. Its primary use is to make urea-, phenol- and melamine-formaldehyde resins. Particle-board and plywood using urea- and phenol - formaldehyde resins account for more than one-third of demand.The majority of applications are in wood and construction-related industries as urea-formaldehyde, phenol-formaldehyde and melamine-formaldehyde glues, resins and stiffeners; followed by uses as a chemical intermediate (e.g. pentaerythritol, hexamethylenetetramine, butanediol) to manufacture another chemical of commerce. Some is used in specialty thermoplastic resins, in the textile/apparel industry as a whitener/finisher/stiffener for items of clothing and an additive for wrinkle-resistance and crispness of appearance, and for preservative additives in soaps, lotions, shampoo, etc.			
Number of sites:	Nineteen companies reporting during the nine years examined, only six were still reporting in 2009 (to TURA).			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data used in the report reference 2009, which is more than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability is not applicable for extracted data but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	Material Research, (2019). Formaldehyde: Technical report on the conditions of use.			
HERO ID:	10369883			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	2011 volume manufactured in US: 3,942,831,539 lbs [PDF Pg. 3]			
Process description:	There are two common methods of manufacturing formaldehyde. Both result in the catalytic oxidation of methanol. One method uses silver catalyst, the other uses a modified iron molybdenum-vanadium oxide catalyst. Sometimes methanol is added to formaldehyde solutions; this is called Formalin. [PDF Pg. 3]			
Number of sites:	55 (listed on PDF Pg. 4-5)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		High		

Study Citation:	Material Research, (2019). Formaldehyde: Technical report on the conditions of use.			
HERO ID:	10369883			
Conditions of Use:	Processing as a reactant			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Formaldehyde has been identified as an impurity in glyphosate technical concentrates (maximum 1.3g/kg) [PDF Pg. 6]			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for processing as a reactant, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		High		

Study Citation:	Mauer, M. P., Cook, C. K. (1999). Health hazard evaluation report HETA 97-0242-2725, Delphi Chassis Systems, Dayton, Ohio, February 1999.			
HERO ID:	1317810			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The brake manufacturing process begins in the mixing room where large vats are filled with a metallic disk brake lining compound (brake dust) to create pad stock. The brake dust contains a blend of steel wool, resins, coke, rubber, colloids, barytes, synthetic graphite, magnesia, and fiberglass. After mixing, vats containing pad stock are transported via forklift trucks and conveyor transports to heat ejection integral molding (HEIM) machines located in departments 2 (rotary HEIMs) and 37 (square HEIMs). Pad stock is transferred into dies of HEIM machines where brake pads are formed by mechanical pressure, then initially cured attemperatures ranging from 290-455 degrees Fahrenheit (°F). Each HEIM machine is equipped with local exhaust ventilation exhausting to dust collector hoppers. After brake pads are formed and initially cured, they are deposited into unloader bins to cool and for temporary storage. Local exhaust ventilation is also provided at each unloader bin. Brake pads go through a grinding process and a final cure in department 40. The curing ovens indepartment 40 are located adjacent to department 2, and are served by a direct exhaust ventilation system.Insulator parts and brake shoes for brake pads are cut and formed by a steel press. Adhesive is applied to brake shoes with roll coating machines (department 40), and the brake shoes are attached to the brake pads. The brake pads are transported to paint lines in departments 2 and 12, where they undergo abrasive blasting (with glass beads) and an electrostatic application of epoxy powder paint. The pads enter a paint cure oven (380-420 °F), have an insulator applied, and are then transported to aninsulator cure oven to complete the paint line process. The assembly process (department 40) involves attaching wear sensors onto brake pads.Several other processes occur in the departments of concern. Dye wash areas are located in departments 2 and 37, where the molds used in the HEIM machines are cleaned in alkali baths equipped with local ventilation. Additionally, a cold-mold machine, also used to produce brake pads, is located in department 37 adjacent to department 2.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH study	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The report is for an occupational scenario (brake parts manufacture) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	1997 - more than 20 years old	
	Metric 5: Sample Size	N/A	qualitative information provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Information provided was derived from NIOSH site visit.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	qualitative information provided	
Overall Quality Determination		High		

Study Citation:	Mccammon, C. S., Tubbs, R. L., Reh, B. D., Reh, C. M. (1997). Health Hazard Evaluation Report HETA 97-0084-2669, Woodward Governor Company, Fort Collins, Colorado.
HERO ID:	3042078
Conditions of Use:	Use of Metalworking fluid

EXTRACTION

Parameter	Data
Process description:	The machining area of the Woodward Governor plant covers approximately 33,500 square feet and contains about 95 machines. Just prior to the NIOSH survey, Woodard had renovated the machining area and relocated machines within the space. Each machine is self-contained and does not share its metal working fluid (MWF) with any other machines through any kind of central system. None of the machines contain local exhaust ventilation (LEV), but many are partially or totally enclosed when operating. The majority of machines use water-based MWFs, either a Blasocut® water-soluble oil or a Syntilo® synthetic fluid, but a few use one of two of Hansterfer's Hard Cut® straight oils. None of the MWF suppliers has onsite personnel at this plant; the plant's maintenance department is responsible for all MWF maintenance. Each individual operator is responsible for adding new fluid (make-up fluid) as needed based on the automatically monitored fluid concentrations, and they can also request a complete change-over of fluid from the maintenance department. The maintenance department also performs scheduled fluid change-overs, which vary by machine and fluid type. The machines that use straight oils are only changed-over once a year or on request, during which time the machine is drained, rinsed out, wiped out, and refilled with new fluid. The filters on these machines are changed only as needed. The machines that use the water-based fluids are changed-over more frequently (depending on the machine, every one to several months), and this change-over involves pumping the fluid out of the machine, cleaning out the metal chips, rinsing, using a cleanser (Cimclean® 30) and brush, a final rinsing of the tanks and lines, wiping the inside and outside of the machine, and refilling it with new fluid. During this process the machine must be shut-down for two to eight hours (varies by size of the machine). The responsible maintenance person keeps the records of maintenance in his notebook and on updated stickers on each machine. The only machines without scheduled change-overs are the Hitachi and Citizen lathes; the fluids in these machines are only changed upon operator request because the operators do not want any scheduled shut-downs. A MWF recycling system was installed for the Blasocut® fluids. The fluids in the machines that use Blasocut® are scheduled to be recycled (emptied from the machine, recycled in the Blaser Swiss Lube filtration system, and returned to the machine) every three weeks by the night maintenance personnel. The total cleaning and change-over of fluids for these machines was anticipated to be every six months.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old (1997)
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted

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Study Citation:	Mccammon, C. S., Tubbs, R. L., Reh, B. D., Reh, C. M. (1997). Health Hazard Evaluation Report HETA 97-0084-2669, Woodward Governor Company, Fort Collins, Colorado.		
HERO ID:	3042078		
Conditions of Use:	Use of Metalworking fluid		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Mccleery, R. E. (2000). Health Hazard Evaluation Report: HETA 99-0185-2787, Wonder Industries, Wyoming, Minnesota.			
HERO ID:	4678855			
Conditions of Use:	Other- Thermal degradants in Plastic Product Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	WI is involved primarily in the manufacture of plastic cornerguards and handles for mattresses, pallet legs and diaper pales.			
Process description:	The injection–molding process starts with the suctioning of plastic resin material into a feed chamber of the injection–molder. The different resins are held in large cardboard boxes with the suction hose inserted into the box. Additives (regrind or color additives) can be inserted into the original resin box with mixing equipment in the warehouse section of the facility. The injection–molding machines have a horizontal heating chamber where the resin is inserted and melted. The molten resin is forced into the mold where the material cools. The mold pressure is decreased thereby releasing the newly formed plastic part. The mold is then closed and the process repeats itself. Workers stand by their machines and collect and stack the plastic parts prior to packaging and shipping. Other than break/lunch times, workers stand for the entire work period. Plastics that are over–heated during the injection–molding process can release various thermal decomposition products. The products formed are potentially many and depend upon the polymer constituents and the process temperature. For polypropylene and polyethylene, the thermal decomposition products include CO and formaldehyde.			
Throughput:	This facility currently has 14 injection–molding machines; 5 to 7 of which are operating on a day–to–day basis.			
Number of sites:	investigated 1 site in Wyoming, minnesota			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., NIOSH HHEs)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The process information is not specific for a processes that uses formaldehyde but is general for plastic product manufacturing, which is in scope.
	Metric 4:	Temporal Representativeness	Low	More than 20 years ago.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and no discussion on uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	McDonald, L. (1989). Blood exposure and protection in funeral homes. American Journal of Infection Control 17(4):193-195.			
HERO ID:	1320553			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Process description:	Typically, a single incision is made to locate the femoral artery and vein through which the embalming fluid is infused and blood is drained. A trocar is inserted in the thoracic and abdominal cavities. To embalm the viscera a bottle that contains a concentrated solution of formaldehyde (and that may contain phenol) is attached by hose to the trocar, and the contents are instilled into the thorax and abdomen. Aspiration and embalming of the body cavities are accomplished in several minutes. The small abdominal puncture wound that results from the insertion of the trocar is closed by means of a screw-in plastic button.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1989)	
	Metric 5: Sample Size	N/A	Not applicable - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - process description.	
Overall Quality Determination		Medium		

Study Citation:	Merkle, S.E. (1985). Ambient concentrations of formaldehyde and ammonia in a screwworm fly rearing facility. American Industrial Hygiene Association Journal 46(6):336-340.
HERO ID:	1318482
Conditions of Use:	Non-TSCA

EXTRACTION	
Parameter	Data
Process description:	Adult male flies are confined in cages for egg production, the egg masses are removed. the eggs hatch and young larvae begin to develop in large vats lined with acetate blanket saturated with food media. Larvae migrate to water channel where they are mechanically separated and placed in trays of sawdust where they develop into pupae. the Pupae are mechanically separated and transferred to pupae maturation area. The pupae are irradiated using cesium -137. The pupae are stored in a cold room to delay fly emergence. The flies are packaged and shipped in refrigerated trailers. Operates 7 days/week, 24 hours/day
Throughput:	500 million flies per week
Number of sites:	1

EVALUATION					
Domain		Metric	Rating	Comments	
Domain 1: Reliability		Metric 1:	Methodology	High	Appears NIOSH methods were used - used two glass bubbler in series. Each bubbler contained sodium bisulfite absorbing solution, Samples were analyzed using the chromotropic acid-spectrophotometric method (P&CAM no. 125) recommended by NIOSH.
Domain 2: Representativeness		Metric 2:	Geographic Scope	Low	Mexico - not an OECD member
		Metric 3:	Applicability	Uninformative	The data are for formaldehyde used as a bactericide and fungicide which is an occupational scenario not within the scope of the risk evaluation (non-TSCA).
		Metric 4:	Temporal Representativeness	Low	This study was published in 1985 using data from 1981-84, before the most recent PEL (1992) and more than 20 years old.
		Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination **Uninformative**

Study Citation:	Methner, M. M., Tapp, L., Ramsey, J. (2014). Health Hazard Evaluation Report: HETA-2012-0025-3207, May 2014. Evaluation of Metals, Solvents, Formaldehyde, Ventilation, and Ergonomic Risks During the Manufacture of Electrical Cable Accessories.
HERO ID:	2452612
Conditions of Use:	Rubber Product Manufacturing

EXTRACTION

Parameter	Data
Process description:	Rubber Injection Molding - In the rubber insulation molding press area, coiled rubber strips were heated in a die molding machine to produce electrical connector parts. Plastic Injection Molding - Plastic parts were injection molded using nylon or polybutylene terephthalate resins. Bulk resins were gravity-fed from a hopper to an electrically-heated extrusion screw. The melted resin was extruded under pressure into a die. The molded parts were ejected and carried by conveyor for further processing. In the past, extruders were purged (cleaned) between resin changes by increasing the temperature and pressure for approximately 30 minutes. This generated a substantial amount of smoke that was released to the plant atmosphere. However, the purge procedure was recently changed by lowering the temperature and pressure and shortening the purge time. The new purge process now takes about 10–15 minutes and produces much less smoke. In addition to the new purge cycle, a portable snorkel-type local exhaust ventilation unit equipped with a high efficiency particulate air filter and carbon sorbent material was available to capture smoke and organic compounds released if there was a need to run longer purge cycles. Paint Application - Four Spray Tech Inc. spray booths exhausted into the paint department. The booth openings were 42 inches square, and each spray booth was supported by four legs approximately 42 inches above the floor. Each booth had a paint-arresting prefilter, a pleated secondary filter, and an activated carbon final filter to absorb organic solvents. The company followed the spray booth manufacturer's recommendation of weighing the carbon filters monthly and replacing them when the weight of the carbon filter reached 12 pounds. Each booth had a manometer that indicated when the paint-arresting and pleated filters needed changing. Painters placed parts onto rotating spindles to spray a bonding paint containing carbon black pigment, toluene, xylene, and ethylbenzene. Electrical Testing and Small Component Assembly - Employees used naphtha to lubricate plastic and rubber parts during assembly. The naphtha was applied onto the parts with a trigger-type spray bottle. Once assembled, the parts were electrically tested prior to packaging and shipping. Cable Dipping and Hand Soldering - In cable dipping, employees manually dipped the end of bare copper cable into molten tin solder then placed it on a rack to cool. The ladle of molten tin was enclosed on three sides by a ventilated exhaust hood. A flexible metal duct connected the hood to an exhaust fan that discharged to the surrounding air after passing through a high efficiency particulate air filter. The company changed from a lead-based solder to a tin-based solder between our first and second site visits. In the Fisher-Pierce department employees assembled printed circuit boards using a hand-held electric soldering iron to melt the solder (60% lead, 40% tin) and complete electrical connections. A fume extractor containing an activated carbon filter operating at a flow rate of 300 cubic feet per minute was positioned directly behind the circuit board being soldered to capture smoke generated during the process. Deflashing - Deflashing removes excess plastic material from parts following molding. Employees manually loaded plastic parts into the top of the deflasher machine. The employees then removed, inspected, and sorted deflashed parts.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH HHE
Domain 2: Representativeness	Metric 2: Geographic Scope	High	data are from the United States
	Metric 3: Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	High	The report is no more than 10 years old.
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions

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Study Citation:	Methner, M. M., Tapp, L., Ramsey, J. (2014). Health Hazard Evaluation Report: HETA-2012-0025-3207, May 2014. Evaluation of Metals, Solvents, Formaldehyde, Ventilation, and Ergonomic Risks During the Manufacture of Electrical Cable Accessories.				
HERO ID:	2452612				
Conditions of Use:	Rubber Product Manufacturing				
Domain		Metric	EVALUATION		Comments
			Rating		
Domain 4: Variability and Uncertainty					
	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination			High		

Study Citation:	Meyer, B., Carlson, N.L. (1983). Formaldehyde emission from particleboard post-cured by radio-frequency heating. Holzforschung 37(1):41-45.			
HERO ID:	5946053			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:		The finished board contains traces of incompletely cured resin fragments, residual formaldehyde. A number of factors play a role (e.g., resin does not form a uniform glue line).		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The report uses high quality data and techniques that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for chemical substances in construction, an in-scope occupational scenario and is general.
	Metric 4:	Temporal Representativeness	Low	Data were greater than 20 years old.
	Metric 5:	Sample Size	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	Meyer, B., Hermanns, K. (1986). Formaldehyde release from wood products - an overview. ACS Symposium Series 316:1-16.			
HERO ID:	5946044			
Conditions of Use:	Wood panel products bonded with formaldehyde derived resins			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	During the past year, approximately 300,000 metric tons of UFR have been used for panel manufacturing in the U.S. In 1984 the annual production of UF-bonded particleboard was 5.5 mil cubic meters (3.1 billion square feet on a 3/4 inch base) in the U.S. alone. In 1984 1.1 million m3 MDF was produced in the U.S.			
Life cycle description:	70% of particleboard was used in furniture, cabinet construction and fixtures; 20% was used in conventional home construction, and 10% in the manufacture of mobile homes.			
Process description:	The most widely used wood panel products are particleboard, softwood plywood, hardwood plywood, medium density fiberboard (MDF) and waferboard.			
Throughput:	0.2 to 1 m^2 of product surface per 1 m^3 of indoor air volume			
Number of sites:	The production of UF-bonded particleboard involved 48 plants in the US. Only two plants made phenolic particleboard and only one plant produced isocyanate bonded particleboard. Production of MDF occurred in 12 plants			
Chemical concentration:	Particelboard contains between 6-8 wt% UFR. MDF contains 8-10 wt% UFR. Hardwood plywood contains 2.5wt% UFR.			
Comments:	This article talks about the factors considered when modeling air concentrations and emissions.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			High	
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Study Citation:	Meyer, B., Hermanns, K. (1986). Formaldehyde release from wood products - an overview. ACS Symposium Series 316:1-16.		
HERO ID:	5946044		
Conditions of Use:	Wood panel products bonded with formaldehyde derived resins		
		EVALUATION	
Domain	Metric	Rating	Comments

Study Citation:	Meyers, A.R., Pinkerton, L.E., Hein, M.J. (2013). Cohort mortality study of garment industry workers exposed to formaldehyde: Update and internal comparisons. American Journal of Industrial Medicine 56(9):1027-1039.			
HERO ID:	1998382			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Number of sites:	3 garment manufacturing facilities – 2 in Georgia and 1 in Pennsylvania			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The report is no more than 10 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Michanicki, A. (1997). Recovery of fibers and particles from wood-based products. :115-119.		
HERO ID:	1965315		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	30,000 tons of dry recovered particles with a planned increase to 50,000 tons by 1997.		
Process description:	Figures 1 and 2 provide visual depiction of process description along with materials flows. Wood-based panels from old wooden furniture, interior fitments, and production rejects are first broken into pieces 15 to 20 cm long. This can easily be done with a slow-rotating breaker, which is normally used for size reduction of bulky refuse. The pieces can be longer, but should not be shorter: this will minimize damaging effects on fibers and particles as well as surface and edge coatings which are shortened by the breaking. The furniture pieces are put into a pressure reactor which is then closed and evacuated to remove air from the panel pieces. The wood is then easily impregnated with a liquor consisting of water, formaldehyde bonding chemicals like urea and ammonia, and other chemicals to keep the pH constant. Excess liquor which not has been absorbed after 1 to 10 minutes is removed from the reactor and used for the next cycle. The impregnation also can be described as a soaking process. To achieve optimum disintegration, it is necessary that the panel pieces absorb 70 percent or more of their own weight of the impregnating solution. The impregnation can be accelerated by increasing the temperature of the impregnation liquor. After removing the excess impregnating liquor, the material is heated to about 110°C for about 20 minutes. The resin is mainly dissolved by hydrolysis. The remaining wood structure is destroyed by thickness swelling. Coatings, fasteners, hinges, and other pieces are separated from the wood fibers and particles. The pressure container can be opened and emptied for the next disintegration cycle. The disintegrated material can be machine-screened or wind-sifted. Optimum screening results will be achieved with a screening drum. The screening itself is very easy because the wood fibers and particles are very small and are easily separable from the coatings, hinges, and fasteners. The recovered wood fibers and particles have a moisture content comparable to fibers and particles of fresh wood. They can be dried and processed separately or together with fresh material using the same procedures as in a usual production line. The separated rejects also can be partly recycled. Metals can be separated, and solid wood pieces and undisintegrated panel pieces can be chipped for particleboard production.		
Throughput:	Throughput is described in Figures 1 and 2 but does not provide use rates.		
Number of sites:	2 industrial plants		
Comments:	MDF is medium density fiberboard.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Unclear if source is peer reviewed but likely appears high quality data.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data is from Britain, an OECD country.
	Metric 3: Applicability	High	Data is directly applicable to manufacture of wood products.
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old (1997)
	Metric 5: Sample Size	N/A	Not characterized by statistics. Mainly process description.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not characterized by statistics. Mainly process description.
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Study Citation:	Michanicki, A. (1997). Recovery of fibers and particles from wood-based products. :115-119.		
HERO ID:	1965315		
Conditions of Use:	Compressed Wood Product Manufacturing		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Mihlan, G.J. (1983). Preliminary control technology survey on Datel Intersil Corporation, Mansfield, Massachusetts.			
HERO ID:	5471613			
Conditions of Use:	Process Aid- Electroless Copper Plating			
EXTRACTION				
Parameter	Data			
Process description:	The operation Electroless Copper Plating, an integral part of printed circuit board fabrication processes, uses formaldehyde as one the chemicals. Printed circuit fabrication: (1) tooling, drilling, and sanding fiberglass laminated boards, (2) copper fluoborate electroplating, (3) tin/lead fluobate electoplatinig, (4)photoresist lamination, (5) photoresist stripping, (6) wet chemical stripping, (7)tin stripping, (8) nickel sulfamate, and (9) gold cyanide electroplating. [More extensive details in report]			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data and/or techniques	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data	
	Metric 3: Applicability	High	report is for an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	report is greater than 20 years old	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Milton, D.K., Wypij, D., Kriebel, D., Walters, M.D., Hammond, S.K., Evans, J.S. (1996). Endotoxin exposure-response in a fiberglass manufacturing facility. American Journal of Industrial Medicine 29(1):3-13.			
HERO ID:	1314209			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Incorporation into a formulation: Fiberglass			
Process description:	Fiberglass is formed by melting sand in a furnace. The glass is then spun into fiber, cooled, and coated with a phenol-formaldehyde resin binder in the forehearth. Powerful fans pull spun fiber onto the forming chain to produce a continuous batt, which is then pulled through an oven to cure the resin before it is packaged. Beneath the forehearth is the wool basement area, where large quantities of recirculated water are used to remove fiber and resin overspray from the forming machinery. Some mist from the basement is pulled through the forehearth by the airflow used to form the batt.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for Fiberglass manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 1996, after the most recent PEL (1992) but more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		High		

Study Citation:	Mirabelli, M.C., Holt, S.M., Cope, J.M. (2011). Anatomy laboratory instruction and occupational exposure to formaldehyde. Occupational and Environmental Medicine 68(5):375-378.			
HERO ID:	5955573			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Human donor specimens used in laboratories are preserved in formalin, an aqueous solution of 37% (w/v) formaldehyde. (1/4)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is more than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			High	

Study Citation:	Moezzi pour, B., Abdolkhani, A., Doost-Hoseini, K., Ramazani, S.A., Tarmian, A. (2018). Practical properties and formaldehyde emission of medium density fiberboards (MDFs) recycled by electrical method. Holz als Roh- und Werkstoff 76(4):1287-1294.			
HERO ID:	5957969			
Conditions of Use:	Recycling			
EXTRACTION				
Parameter	Data			
Process description:	To release fibers from the resin matrix, resin bindings mustbe broken. With regard to sensitivity to moisture and heatof the utilized resin in MDF, MDF wastes can be exposedto both factors (heat and moisture) as a solution to destroyresin bindings and to recycle fibers. Most of the methods studied in latest researches on recycling of wood panels are based on hydrothermal treatment. Usually, recycled fibers lose their quality as a result of these methods. When recycling MDF wastes by hydrothermal methods, first fibersare heated using steam treatment (hydrothermal) and thenthey are separated by utilization of refiner. Continuous heating at high temperatures and mechanical defibrillation cause fiber degeneration and destruction of lignocellulosic mass as well as degradation of wood polymers and decreased efficiency			
Chemical concentration:	Table 1 provides content of MDF boards: 12% UF resin content			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses data that has been peer-reviewed and expected to be sound.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for Germany, an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	Monsanto Research Corp, (1984). A survey of health hazard control systems for formaldehyde production facilities.			
HERO ID:	8728027			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Commercial capacity for producing formaldehyde in the United States during 1980 was over 8.5 billion pounds.			
Life cycle description:	Most of the formaldehyde produced is used on-site to produce resin for plywood, particle board, or plastics. Over 61 percent of the formaldehyde produced is used in resin production.			
Process description:	Methanol, normally received from offsite, is transferred from storage tanks and vaporized in a vaporizer. vaporized methanol, mixed with preheated air, enters the converter and is oxidized (or dehydrogenated and oxidized if silver catalyst is used) to formaldehyde. Typically, the converter has a packed tower configuration, but catalyst beds are also used. Efficiency of conversion of methanol to formaldehyde range from 65 to 90 percent for the silver process and is approximately 99 percent for the metal oxide process [22].After conversion, the hot formaldehyde gas (the reactor is generally operated at approximately 635QC [22]) is cooled in anaftercooler to a temperature of about 70°C and then absorbed inwater. Aqueous formaldehyde solution is recirculated through the absorption tower until the desired concentration 1s achieved. If a silver catalyst is used in the converter, the product is concentrated in a distillation column, a step in which methanol 1s also recovered. Formaldehyde is generally stared as a 50 percent solution at 50°C (which helps prevent its spontaneous polymerization to form paraformaldehyde).Diagrams given on PDF Pg. 6			
Number of sites:	Fifty-two plants representing fifteen companies.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A
Overall Quality Determination			High	

Study Citation:	Monsanto Research Corp, (1983). Detailed industrial hygiene survey: formaldehyde production, Georgia-Pacific Corporation, Albany, Oregon.		
HERO ID:	8728033		
Conditions of Use:	Manufacture		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	120*10^6 lb/year.		
Life cycle description:	Most of the formaldehyde is used to make resin but unused formaldehyde is sent via truck or rail to customers.		
Process description:	Formaldehyde is manufactured by oxidation of methanol using aniron/molybdenum oxide catalyst. The production process takes place in two identical parallel trains as shown in Figure 2. Figure 3 is a photograph of the formaldehyde production unit inAlbany.Methanol is unloaded from a rail car to a bulk storage tank and then is pumped to the vaporizer. Air is simultaneously drawn through a primary filter and combined with the methanol. The methanol-air mixture 1s vaporized and fed to the converter, which consists of vertical catalyst-filled tubes. Dowtherm A®, a coolant, is pumped through the outside of the converter and removes the heat of oxidation from methanol conversion. Dowtherm vapor iscondensed and recirculated to the Dowtherm separator, and then to the converter. Hot formaldehyde gas, produced in each converter tube, is fed to the aftercooler. Cooled gas from the two parallel aftercoolers is united at the base of a single atmosphericabsorber column. Liquid effluent from the absorber, containing50-51 percent formaldehyde by weight, is stored in storage tanks.Gas emitted from the top of the absorber column, consisting mostlyof nitrogen and oxygen, passes through a demister and is recycledto the methanol vaporizer through the compressor. An oxygenganalyzer is used in-line to control the oxygen content of the airfeeding the vaporizer to reduce the explosion hazard. The entireprocess has not been modified since initial startup in 1973.		
Chemical concentration:	The site produces 37% formaldehyde solution.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium	

Study Citation:	Monsanto Research Corp, (1983). Detailed industrial hygiene survey: Formaldehyde production, Reichhold Chemicals, Incorporated, Hampton, South Carolina.			
HERO ID:	8728034			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	This plant uses a metal silver catalyst to convert methanol to formaldehyde at a rated capacity of 50 million pounds per year.			
Process description:	Formaldehyde is produced by a silver catalyst process. This process is based on the dehydrogenation-oxidation reaction of methanol as it passes through a silver catalyst bed. Conversion efficiency of the process can range from 65% to 90%, depending on the age and retention time of the catalyst bed. Methanol recovery and concentration of the formaldehyde solution is normally necessary to yield a usable product. Methanol, delivered by rail tank car and stored in a large bulk storage tank, is mixed with filtered air and vaporized. The methanol-air mixture is fed through manifolds to individual tubular reactors containing the silver catalyst and is converted to formaldehyde. The hot gases are quenched with a weak formaldehyde solution, in a spray box, producing a 40% formaldehyde, 20% methanol solution. This solution is cooled in a heat exchanger and stored in interim storage tanks. The scrubbed gas from the spray box passes through two spray towers and a packed tower. It flows countercurrent to laboratory wastewater and fresh water introduced in the packed tower. The water flows from the packed tower back through the spray towers and becomes the weak formaldehyde solution which is fed to the spray box. The residual gas from the packed tower is then released to the atmosphere. This exhaust gas contains approximately 73% nitrogen and 20% hydrogen, but little or no formaldehyde. The 40% formaldehyde solution from the spray box is stored in a set of interim product tanks and is concentrated to 50% formaldehyde in a distillation column. A scrubber is located on this tank to condense and hence control formaldehyde emissions from it. Methanol removed to concentrate this solution is recovered and recycled to the methanol shift tank, and product (50%) formaldehyde solution is sent to steam-heated storage tanks. Formaldehyde shipments are prepared in a blending tank where the formaldehyde content is adjusted to meet the customer specifications. The product is then piped directly to an adjacent plant or loaded onto tank trucks or rail cars for delivery.			
Chemical concentration:	The plant produces 50% formaldehyde solution which is blended with water or methanol to meet customer specifications.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Monsanto Research Corp, (1982). Preliminary plant visit industrial hygiene report: Formaldehyde production facility, E. I. DuPont de Nemours and Company, Grasselli Plant, Linden, New Jersey.			
HERO ID:	8728036			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	The plant has a rated capacity of 160 million pounds per year (on a 37 percent basis).			
Process description:	Formaldehyde is made in this plant by a combination oxidation-dehydrogenation process, using silver oxide as a catalyst: [Figure on PDF Pg. 11]. Figure 2 is a block flow diagram of the process used in this plant.As shown in the figure and the equations above, methanol and air are the raw materials for the process. Air is brought in with a positive displacement blower and passes through a scrubber, which conditions and cleans the air prior to entering the reactor.Methanol is brought from off-site in tank trucks (Figure 3) andstored onsite in a tank. It is piped into the vaporizer, mixedwith air and enters the reactor (Figure 4). The preheated mixtureis not in the explosive limit envelope for methanol-air mixtures.The temperature of the reaction is controlled to optimize yields.Since the oxidation reaction is exothermic, waste heat is recoveredas shown in the block diagram. The reactor system contains thesilver catalyst. The product gas contains a considerable amount ofhydrogen and unreacted methanol.The product gases are passed directly to a series of countercurrentscrubbers that comprise the absorber. This cools the gasesand dissolves the formaldehyde in water (Figure 5).The off-gas from the absorber contains hydrogen and nitrogen withtraces of formaldehyde and methanol. This is burned and the heatrecovered (Figures 6 and 7) and used in the process (vaporizer).The effluent gas from the burner is primarily nitrogen, watervapor, and carbon dioxide. The burner is designed to give a99 percent combustion efficiency.The product stream from the absorber is an aqueous solution offormaldehyde (up to 50 percent, as desired). It also containssome methanol and formic acid.Products of varying strength are blended to create products required for specific sales. The blended products are loaded intotank trucks (95 percent) (Figures 8 and 9) or railroad tank cars(5 percent).			
Chemical concentration:	The product stream from the absorber is an aqueous solution offormaldehyde (up to 50 percent, as desired). It also containssome methanol and formic acid.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for manufacture, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A	
Overall Quality Determination		High		

Study Citation:	Monsanto Research Corp, (1982). Preliminary plant visit: Industrial hygiene report, formaldehyde production facility, Reichhold Chemicals Incorporated, Moncure, North Carolina.			
HERO ID:	8728037			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	This plant was selected for a preliminary industrial hygiene surveybecause of its moderate production of about 100 million pounds of formaldehyde per year, its use of metal oxide catalyst, and its southeastern location.			
Process description:	Formaldehyde is manufactured by the patented Formox process, shown in Figure 2, using a metal oxide catalyst. Methanol, delivered daily to the plant by rail or truck and stored in a bulk storage tank, is pumped into the vaporizer and vaporized. The vaporized methanol is mixed with filtered air and combined with the absorber offgas, then enters the converter where it passes through tubes filled with iron-molybdate oxide catalyst and is oxidized with up to 99% conversion efficiency according to the following exothermic reaction: [PDF Pg. 11].Dowtherm®, circulated through the converter jacket to control theconverter temperature, is used to remove the heat of reaction andproduce low pressure steam for on-site consumption. Formaldehyde vapors exit the converter, are cooled in the aftercooler and absorbed in a 25-stage absorber. After formic acid is removed in a purification step, the liquid formaldehyde is transferred to a shift tank. The contents of the shift tank are transferred into the blend tank once per shift to adjust the formaldehyde concentration. The product formaldehyde is stored in one of the tanks in the formaldehyde tank farm. The process has been operating as described since plant startup in 1970.			
Chemical concentration:	The plant, constructed in 1970, produces 50 percent formaldehyde which is used onsite to produce resins.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			Medium	

Study Citation:	Monsanto Research Corp, (1981). Preliminary plant visit industrial hygiene report: Formaldehyde production facility, Monsanto Plastics and Resins Company, Eugene, Oregon.			
HERO ID:	8728039			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	100 million lbs/year/site			
Life cycle description:	Site manufactures and also produces resin that it sold to local plywood and particleboard manufacturers			
Process description:	Formaldehyde is manufactured by methanol dehydrogenation. Hydrogen gas and residual methanol produced in the process and oxidized with air provides heat needed for the dehydrogenation reaction.Initially, methanol is pumped from a rail car to a bulk storage tank and then to a vaporizer, where it is vaporized. Air, after passing through a primary filter and water wash cleaner, is preheated and combined with vaporized methanol just prior to a converter containing crystalline silver catalyst. The formaldehyde gas from the converter is fed to an absorber where the formaldehyde and unreacted methanol are cooled and absorbed in water. The resulting solution is pumped from the bottom and middle of the absorber through heat exchangers to cool the solution which is partially recycled to the absorber. The liquid effluent from the bottom of the absorber is pumped through another heat exchanger prior to being fed into a distillation column. Off-gas from the absorber consisting of 80 percent nitrogen and 20 percent hydrogen is used as fuel in an incinerator. Excess methanol is removed and a 50 percent formaldehyde solution (50% formaldehyde, 49 percent water and 1 percent methanol) is produced in the distillation column. This product solution is passed through a product cooler and stored at 55°C in a bulk storage tank. Methanol vapors off the top of the distillation column are condensed and recycled to the methanol bulk storage tank when not recycled to the distillation column forrefluxing.			
Chemical concentration:	50 percent formaldehyde solution (50% formaldehyde, 49 percentwater and 1 percent methanol) is produced in the distillation column.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Mortimer, V. (1982). Preliminary survey report: Particleboard plant, Timber Products Company, Medford, Oregon.			
HERO ID:	6558525			
Conditions of Use:	Processing: Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Description of ProcessesThe wood particles are first graded, coarse particles for the core and the finer particles for the face. The resin is sprayed onto the particles as they fall through a blending chute. The resin-coated particles are then conveyed to bins from which layers are coated onto large, metal caul plates; two core layers between two face layers.Using an indexing mechanism, the caul plates carrying unformed boards are loaded into a magazine from which the press will be loaded with a stack of particle-laden caul plates. At the conclusion of the press cycle, the stack is pulled out of the press and automatically unloaded one at a time onto a conveyor belt. A blast of compressed air blows loose particles from the press at the end of the cycle.Having been separated from the caul plates, the newly formed boards are conveyed to the cooling wheel. This apparatus is like a paddle-wheel with theboards resembling fins. The boards are picked up on one side and passedthrough a 1800 arc to the other side where they are mechanically unloadedand stacked.After initial cooling on the wheel, stacks of boards are taken to a stagingarea to await sanding, sizing and shipping. For all operations, the boardsare either moved in stacks with forklift trucks or transported singly onmechanical conveyors.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	N/A	No sample data - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Process description.	
Overall Quality Determination		High		

Study Citation:	Mortimer, V. (1982). Preliminary survey report: Fiberboard Plant, Medford Corporation, Medford, Oregon.			
HERO ID:	6558530			
Conditions of Use:	Adhesives and sealant chemicals in: Plastic and resin manufacturing; Wood product manufacturing; All other basic organic chemical manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	To make fiberboard, heat and pressure are applied to a thick layer of wood fibers and resin. After cooling, the panels are sanded and trimmed to the desired size. The wood particles are first blended with the resin and wax. Then the mixture is conveyed to bins from which it is deposited in layers (two core layers between two face layers) on a conveyor belt. Two preliminary press operation impart sufficient rigidity to the unformed boards to enable them to be individually placed in a loader. During the time the press is applying heat and pressure, the loader is being refilled, and the boards most recently discharged from the press are being passed through the cooling wheel. A blast of compressed air blows loose particles from the press at the end of the cycle. The cooling wheel is like a paddle-wheel with the boards resembling fins. The boards are picked up on one side and passed through a 1800 arc to the other side where they are mechanically unloaded and stacked. Initially the boards are oversize and somewhat rough. Before being shipped, they are sanded, sized, and usually stored for some period of time. For all operations, the boards are either moved in stacks with forklift trucks or transported singly on mechanical conveyors.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data directly from industry, and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	he report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:		Mortimer, V.D. (1984). In-depth survey report: Control technology for formaldehyde emissions at Hillcrest Veneer Plant, High Point, North Carolina.		
HERO ID:		6019678		
Conditions of Use:		manufacture		
EXTRACTION				
Parameter		Data		
Process description:		The simplest veneered panel consists of three plies, a face and a back veneer glued to each side of a core. Additional plies may be added to make a panel which is stronger and more stable dimensionally. An established way to achieve a high rate of production is to reduce the glue-curing time by heating the glue while pressure is being applied to the panels. One way to do this is to heat the metal plates which apply the pressure, generally referred to as a "hot-press" process. Another way is to generate heat in the glue-line with radio-frequency (R/F) radiation in much the same way that food is cooked in a microwave oven. In this "R/F-press" process, the hydraulic press only applies pressure. "Cold-press" processes, those for which pressure is applied while the boards are maintained between 60 and 100 deg F, require much longer periods of time for the glue to cure. For most applications, the glue which currently provides the best performance for the least cost is a urea-formaldehyde (U/F) resin adhesive.		
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is greater than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Moseley, C. L., McConnell, R. (1985). Health hazard evaluation report: HETA-85-108-1593 - Carey Plastics Division, Toledo Molding and Die Corporation, Carey, Ohio.			
HERO ID:	4058540			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Plastic parts for automobile parts. The type of plastic used is polypropylene, operating temperatures range from 400-450 degrees Fahrenheit, however, during start up, it is not uncommon for the operator to raise the temperature up 100 to 200 degrees in order to rapidly melt and force out any residue left or in the feed cylinder. On a normal day, 16 to 19 machines are running. Equipment cleaning is done using solvent mixture using spray and brushes.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH HHE used sound methods (site interviews) and are generally accepted by the scientific community and no indications of flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data on a U.S. site
	Metric 3:	Applicability	High	Process description describes plastic and resin manufacturing for the eventual use in cars, which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Report published in 1985, more than 20 years ago. Process descriptions and associated equipment and worker activities may be outdated.
	Metric 5:	Sample Size	N/A	N/A- process description
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A- Process information directly from on site interviews and observations.
Overall Quality Determination		High		

Study Citation:	Moseley, C. L., Singal, M., Murphy, L. (1979). Health Hazard Evaluation Determination, Report No. HHE-78-116-557, Commonwealth Trading Company, Stoughton, Massachusetts.			
HERO ID:	1318499			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Process description:	The warehouse operations consist of the following stepwise process: Clothing is received from the manufacturer (over 400 manufacturers supply Commonwealth Trading) either in boxes or hanging racks and brought into the warehouse through 10 shipping and receiving doors. The shipment is forklifted from the receiving area to the "T" area, where it is unpacked and placed on hangers and placed in the conveyor system. Clothing is manually pushed through the conveyor system to the temporary storage area "A". In the "B" & "C" areas, the clothing is arranged by size and ticketed. The stamping of tickets is done in an adjacent area. The ticketed garments are then moved to the upper floor where they are further arranged by size, color. etc. If not needed for immediate shipment, the garments are placed in holding area "Y". When ready for distribution to retail stores, the selected clothing is conveyed back to the first level. coded for distribution and boxed. First shift is primarily concerned with the receiving aspects of the operation; second shift concentrates on packing and shipping to retail outlets .			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (NIOSH)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	From US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Over 20 years old, from 1979
	Metric 5:	Sample Size	N/A	n/a to process description
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	n/a for process description
Overall Quality Determination			High	

Study Citation:	Mourant, D., Yang, D.Q., Riedl, B., Roy, C. (2008). Mechanical properties of wood treated with PF-pyrolytic oil resins. Holz als Roh- und Werkstoff 66(3):163-171.
HERO ID:	2867023
Conditions of Use:	Processing as a reactant

EXTRACTION	
Parameter	Data
Process description:	For the resin synthesis procedure, aqueous formaldehyde at a concentration of 37% by wt and phenol were loaded in a ratio of 2.5 in a kettle equipped with a mechanical stirrer. After homogenization, a 50% by wt NaOH solution was added drop-wise so as to obtain a phenol :NaOH ratio of 1:0.15. The mixture was heated up to 65 deg C in 15–20 min and kept at this temperature for 100 min. The mixture was then cooled to 30–40 deg C and a determined amount of formaldehyde scavenger (NH4OH at 28% by wt) was added. The final viscosity of the PF-resin was of 20±1 cP at 25 deg C. The various treating resins were obtained by mixing the PF-resin with pyrolytic oil at different ratios of substituted phenol. Phenol substitutions tested were 50%, 75% and 85% on a weight basis; hereafter the treating resins were named as R350, R375 and R385 according to the percentage of pyrolytic oil present. The resins were stored at 4 deg C until use.
Chemical concentration:	concentration of formaldehyde was 37% by wt

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium report uses high quality data and associated information does not indicate flaws or quality issues
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium Canada, OECD country
	Metric 3:	Applicability	High The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High Assessment or report clearly documents methods, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A N/A - This metric is not applicable to the data being extracted

Overall Quality Determination	High

Study Citation:	Myers, G.E., Koutsky, J.A. (1990). Formaldehyde liberation and cure behavior of urea-formaldehyde resins. Holzforschung 44(2):117-126.			
HERO ID:	5962165			
Conditions of Use:	Processing (UF resin)			
EXTRACTION				
Parameter	Data			
Chemical concentration:	9 resins were tested. The formaldehyde/urea molar ratios of the resins ranged from 1.2-1.7. The % free formaldehyde of the resins ranged from 0.2-2.3%. (2/10)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesives and sealant chemicals in resin manufacturing, am in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in the explanation of sampling procedures. Variability is addressed by using 9 different resins in the study.
Overall Quality Determination			Medium	

Study Citation:	Mäkinen, M., Kalliokoski, P., Kangas, J. (1999). Assessment of total exposure to phenol-formaldehyde resin glue in plywood manufacturing. International Archives of Occupational and Environmental Health 72(5):309-314.			
HERO ID:	1314048			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Throughput:	Phenol-formaldehyde glue consumption: 20,000 (kg/day)			
Chemical concentration:	Resins contain <0.4% free formaldehyde			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Finland, an OECD country.	
	Metric 3: Applicability	High	Data are for use as a plasticizer, additive and impurity in adhesives, sealants and lubricants, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1996-1997)	
	Metric 5: Sample Size	Medium	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	NAIMA, (2019). Comment submitted by Angus E. Crane, Executive Vice President, General Counsel, North American Insulation Manufacturers Association (NAIMA) regarding initiation of prioritization under the Toxic Substances Control Act.			
HERO ID:	10369864			
Conditions of Use:	Insulation Manufacturing			
EXTRACTION				
Parameter		Data		
Process description:		Most fiber glass and rock and slag wool (mineral wool) insulation and acoustical products come in the form of rigid batts, rolls, boards, or panels. Since glass wool and mineral wool fibers are inorganic and chemically inert, that rigidity is achieved through the application of a binder, essentially a thermosetting polymer that holds the fibers together to form a continuous network. Atypical process for manufacturing fiber glass and mineral wool insulation involves spraying aqueous solutions of binder precursors (silane, resins, de-dusting oil, and, in some cases phenolformaldehyde resins) on fibers immediately after those fibers are formed and attenuated. The combination of fibers, water, and binder precursors are then conveyed to the curing oven where the water is driven off and the binder is thermally set, forming the final rigid bonded product...It is important to note that the binder does not uniformly coat the fiber surface; instead, the process is designed to deliver only isolated binder droplets at the junctions of fibers in order to achieve the desired mechanical properties. pg. 3		
Chemical concentration:		3% to 6% by weight cured binder.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
		Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
		Metric 5: Sample Size	N/A	N/A- no sampling
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	N/A	N/A- process description.
Overall Quality Determination			High	

Study Citation:	(1989). Formaldehyde. AMA Council on Scientific Affairs. Connecticut Medicine 53(4):229-235.			
HERO ID:	1986544			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Number of sites:	studies at numerous site have been referred			
Comments:	The article gives some background about various settings/sites but all the info given is very vague and only gives the number of sites that various other studies may have looked at.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for several occupational scenarios within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data is greater than 20 years old
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability and uncertainty are addressed by looking at multiple settings
Overall Quality Determination			Medium	

Study Citation:	(1983). Historical prospective mortality study of past and present employees of the celanese chemical and plastics plant located in bishop texas.			
HERO ID:	3648021			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Annual industrial production in the US is approximately 6 billion pounds. Largest consumption of FA is in amino acid resins which are used extensively in particleboard, laminates, plywood, molding compounds, and textile resins. Other uses include phenolic resins in molding materials, binders for thermal insulation, acetal engineering resins in automotive and other industries, flame retardants, fertilizers, embalming fluids, preservatives in toothpaste and shampoo, and other proudcts.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NATL PARTICLEBOARD ASSOC, (1985). Letter from National Particleboard Association to USEPA submitting product emission information with attachments.			
HERO ID:	5901010			
Conditions of Use:	Particleboard Production			
EXTRACTION				
Parameter	Data			
Number of sites:	45 particleboard manufacturing sites; 3 medium density fiberboard manufacturing sites			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.	
Overall Quality Determination		Medium		

Study Citation:	Nazaroff, W. W., Coleman, B. K., Destailats, H., Hodgson, A. T., Liu, D.,-L, Lunden, M. M., Singer, B. C., Weschler, C. J. (2006). Indoor air chemistry: Cleaning agents, ozone and toxic air contaminants.		
HERO ID:	4682850		
Conditions of Use:	Reactant Products - Prominent products of the reaction of terpenes with ozone included formaldehyde		
EXTRACTION			
Parameter	Data		
Chemical concentration:	Reactive chemistry was observed in a bench-scale chamber when volatile components of pine-oil based cleaning products GPC-1 were combined with ozone. 27% moles of formaldehyde produced for a concentration of 35 ppb of volatile oxidation products.Additionally:Experiment Surface cleaning with general-purpose degreaser GPD-1, full strength (3A-3C) 8 ppb HCHO with no ozone and 20 ppb with Ozone.Floor mopping with general-purpose cleaner GPC-1, dilute (3D-3H)7 ppb HCHO with no ozone and 13 ppb with ozone.Air freshener, scented-oil plug-in, AFR-1 (3J-3K) 5 ppb HCHO with no ozone and 20 ppb with ozone.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHES, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	Medium	The data are for a bench study of an occupational scenario (Janitors/maids) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	2006 - after the PEL (1992) more than 10 years but less than 20
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized
Overall Quality Determination		High	

Study Citation:	Nemli, G., Ayan, E., Ay, N., Tiryaki, S. (2018). Utilization potential of waste wood subjected to insect and fungi degradation for particleboard manufacturing. Holz als Roh- und Werkstoff 76(2):759-766.			
HERO ID:	5957459			
Conditions of Use:	Building and construction materials (particleboard)			
EXTRACTION				
Parameter	Data			
Process description:	Sound and degraded logs were chipped using a ring type flaker. A hammer mill was then used to reduce the chips into smaller particles. The wood particles were dried to moisture content (MC) of 3%. The dried particles were classified into suitable sizes by a screen for use in the core and face layers. After that, 9 and 11 wt% urea formaldehyde resin with a solid content of 55% was applied to particles used in the core and surface layers by a pneumatic spray gun. As a resin hardener, 1 wt% ammonium chloride with a concentration of 25% was used in the blending process depending on the solid content of the adhesive. Handformed mats with dimensions of 600 mmx600 mm were pressed in a hot press at 150°C with a pressure of 2.5 MPa for 6 min to obtain a thickness of 12.0 mm. The average target density of all the particleboards was 0.65 g/cm3 . As a result of the production process, a total of 12 panels, 2 for each type of particleboard, were manufactured. All the panels were then acclimatized at 20°C and 65% relative humidity until they reached equilibrium MC. (pg 2)			
Chemical concentration:	9 and 11 wt% urea formaldehyde resin with a solid content of 55% was applied to particles			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Turkey, an OECD country
	Metric 3:	Applicability	High	Data are for building/construction materials, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	process description data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	process description data
Overall Quality Determination			High	

Study Citation:	Nethercott, J.R., Albers, J., Guirguis, S., Ching, G., Hofstader, S., From, L. (1982). Erythema multiforme exudativum linked to the manufacture of printed circuit boards. Contact Dermatitis 8(5):314-322.			
HERO ID:	2801581			
Conditions of Use:	Processing aid			
EXTRACTION				
Parameter	Data			
Process description:	The process that used formaldehyde in a factory which made printed circuit boards is the metalization step. After a thin coating of copper has been applied to sheets of fibrous glass, they are placed in a palladium chloride solution which deposits palladium on the exposed fiberglass-epoxy board at the sites where the holes have been drilled. Immersion in a copper deposition solution containing copper sulfate and formaldehyde follows, resulting in copper being deposited onto the palladium-covered epoxy fiberglass as well as the copper coating of the board...[description cont'd]			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from Canada, an OECD country	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		Medium		

Study Citation:	Neuschutz, H. (1977). Process for the purification of industrial effluent.			
HERO ID:	6115384			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Process description:	The patent states: Effluents from textile, paper and leather industries and in the manufacture of dyestuffs often contain water-soluble, anionic dyestuffs or optical brighteners. A water-soluble formaldehyde condensation product is added to industrial effluent, which subsequently removes the occurring flocculate from the effluent. (1/8)			
Chemical concentration:	The patent states: "In one example, concentrations reported range from 0.4-4.0 grams of formaldehyde precipitant per gram of dyestuff. (3/8) In another example, 80 kg of 37.4% aqueous formaldehyde solution was added to the effluent. (6/8) In the last example, water-soluble condensation product from dicyandiamide, formaldehyde, ethylene diamine and ammonium chloride in a ratio of 2.2 moles of formaldehyde, 1.3 moles of ethylene diamine and 0.8 moles of ammonium chloride per mole of dicyanide amide, in an amount corresponding to 0.03 to 3 grams of said condensation product per gram of dyestuff and optical brightener. (8/8)"			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The patent only contains references to other patents.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for the use of water treatment products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Newman, M., Klein, M. (1990). Health Hazard Evaluation Report HETA 88-068-2077, Schmidt Cabinet Company, New Salisbury, Indiana. :40.			
HERO ID:	1510135			
Conditions of Use:	Furniture Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The constructed cabinets are finished by spraying them with a series of stains, sealers, and/or paints. Stain is usually applied with compressed air sprayers. All of the spraying is done in ventilated booths manufactured by DeVilbiss. For smaller parts, such as doors, the employee would mount the part to be sprayed on a jig inside a booth, spray the part, and then remove it and stack the part on a cart outside the booth. When all of the parts are sprayed, they are moved to a central drying area. For larger parts, such as a cabinet body, the part is received on a cart, positioned in a booth, sprayed, and then moved to the central drying area. For some stains, the part is immediately wiped off with a shop cloth after spraying and before being moved to the drying area. After drying the part is again sprayed with a sealer and moved back into the central drying area.			
Chemical concentration:	Varnish (% by weight): 0.28% formaldehyde			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses high quality data that are from frequently used sources (e.g., NIOSH HHEs,)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	Low	Concentration data is characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources (site visit and interview)
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	All information is site-specific and provided directly by the site for the practices and materials that they used.
Overall Quality Determination		Medium		

Study Citation:	NFDA, (2020). Comments of the National Funeral Directors Association (NFDA) requesting that EPA remove funeral service, including embalming and mortuary science, as a condition of use from EPA’s proposed scope for its formaldehyde risk assessment (submitted by Lesley Witter).			
HERO ID:	10370214			
Conditions of Use:	Commercial Use - Embalming			
EXTRACTION				
Parameter	Data			
Production, import, or use volume: Throughput:	”Funeral service accounts for only approximately one percent of total formaldehyde usage each year in the United States.” (page 3 of 4) An embalming with a formaldehyde-based product typically involves between one gallon and sixteen ounces of embalming solution with only a portion of that volume formaldehyde-based embalming product (page 3 of 4)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	From the National Funeral Directors Association, they do not site sources, but it can be assumed they are knowledgably about their practices	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	From USA	
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	High	2020	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.	
Overall Quality Determination		Medium		

Study Citation:	NFDA, (2021). Comment submitted by National Funeral Directors Association (NFDA) containing the formaldehyde exposure study.			
HERO ID:	10386042			
Conditions of Use:	Embalming fluid			
EXTRACTION				
Parameter	Data			
Number of sites:	The National Funeral Directors Association (NFDA) represents over 20,000 individual members and 11,000 funeral homes pg. 1/4			
Chemical concentration:	”Data on concentration of formaldehyde in solutions used during embalming were collected during the study. For arterial embalming, the concentrations of formaldehyde in the injection solutions ranged from 0% to 9.75%, with a mean of 5.3% for initial arterial injections; and 0% to 7.33%, with a mean of 5.3% for secondary arterial injections, where they occurred. For cavity treatment, the concentrations of formaldehyde in the injection solution ranged from 5 to 50%, with a mean of 29%. Furthermore, both arterial and cavity solutions are diluted further with bodily fluids following injection.” pg. 13/38			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Data is from a survey of NFDA members
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		Medium		

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Incorporation into article- Wood Product Manufacturing- Particleboard and fibreboard		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	Information from the Australian Wood Panel Association (AWPA) indicates that 932 000 m3 MDF and 965 000 m3 particleboard were manufactured using formaldehyde resins in year 2001-2002. Information from Australian Customs indicates that approximately 233 000 m 3 wood panel products were imported in Australia in financial year 2001-2002.		
Life cycle description:	These wood panel products have both industrial and do-it-yourself (DIY) applications for decorative, structural and industrial purposes, such as shelving. Decorative applications include furniture, shelving, panelling/partitioning, mouldings and doors. Examples of structural applications are domestic and commercial flooring, access flooring, concrete formwork and exterior signs.		
Process description:	The formaldehyde resins are charged into storage tanks and injected and mixed with refined wood fibre through an enclosed system. The particleboard and MDF are rolled and pressed ina semi-enclosed area during the hot press stage (the temperature is 160oC to 200oC) where resins set. The types of formaldehyderesins used in this industry include urea, phenol, melamine formaldehyde resins and some combination of these resins, such as melamine urea and melamine urea phenol formaldehyde resins. Figure 7.5 (p. 69) provides a flowchart.		
Chemical concentration:	the concentrations of free formaldehyde in theresins used in this industry range from < 0.2% to 0.5%		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	Medium	Ranges are provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination		High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Incorporation into article- Wood Product Manufacturing- Plywood			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	According to the information from the Plywood Association of Australia (PAA), 189 533 m3 of plywood and LVLwere produced in the year 2001-2002 with total consumption of 3340 tonnes phenol formaldehyde and 500 to 850 tonnes of urea formaldehyde resins. PAA represents manufacturers who produce approximately 98% of plywood and LVL in Australia. PAA advised that Australian-made plywood occupies 55% of the Australian market. Information from Australian Customs indicates thatapproximately 74 000 m3 plywood products were imported in Australia in financial year 2001-2002.			
Life cycle description:	The types of plywood products used in Australia include structural plywood, concrete formwork plywood, marine plywood, exterior and interior plywood, and overlaid and composite plywood. Products are used within Residential buildings including mobile homes, such as caravans and manufactured homes. Residential building applications include LVL framing, flooring, bracing, plywood webbed beams, roofing, cladding, interior wall and ceiling linings, plywood in domestic wet areas; Building components for commercial and industrial structures including relocatable buildings (classrooms, offices etc.). Structural LVL and plywood components for commercial and industrial structures includeflooring, stressed skin panels, beams, arches, gussets, portal frames, and bracing walls; Material handling, such as pallets, shelving, containers, bins and transport equipment; Construction on site applications, such as structural ramps, overheadprotection barriers, runways etc.; and DIY in a wide range of projects, such as flooring, wall and ceiling lining,boat building.			
Process description:	Phenol formaldehyde resin, which is the predominate resin (approximately 88%) used in this industry, is used for bonding structural, exterior and marine plywood and structural LVL. Urea and melamine urea formaldehyde resins are usually used for interior and some formply products. Formaldehyde resins are delivered in tankers and transferred into a holding tank from where they are pumped into enclosed mixing vessels and mixed with extenders (wheat flour), fillers (shell flour) and water. The mixed resin is then pumped into glue spreaders and applied to the veneer using rubber rollers or pressurised curtain coaters, which is an open process. The spread packs of veneerare then cold pressed and finally hot pressed at about 140 C, where the formaldehyde resins are set.			
Chemical concentration:	Formaldehyde resins containing < 0.2% to up to 5% free formaldehyde are used in the manufacture of plywood and associated structural veneer based products, such as laminated veneer lumber (LVL).			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Ranges are provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination			High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Incorporation into article- Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Paper treating is an automatic, continuous processinvolving two resin stages. In the first resin stage, urea resin is pumped from storage tanks to an automatic closed batching station where additives, water and a catalyst are added to help with paper saturation and promote curing in later drying and laminating processes. This mixture is pumped into the first stage bath wherethe paper for impregnation is automatically fed by rollers through the bath at a speed of approximately 40 meters per minute and is impregnated as it passes through the bath. The bath is open at the top. The paper then passes into a closed oven with temperatures ranging from 120°C to 170°C for drying. In the second resin stage, melamine resin is pumped into an automatic closed batching station and mixed with a release agent and a catalyst. This mixture is then pumped into a second stage resin application station where the paper (after the first resin stage) is fed through the rollers and is coated with the resin mixtures automatically. The coated paper then goes into the second drier. Finally, the paper is automatically cut to length and stacked in plastic wrapped packs for shipment.			
Chemical concentration:	Urea and melamine resins containing up to 1.5% free formaldehyde are used in paper treating and coating.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Ranges are provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination			High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Incorporation into article- Textile Finishing			
EXTRACTION				
Parameter	Data			
Life cycle description:	The formaldehyde resin products used in the textile industry include printing inks, dyes and textile finishing products.			
Process description:	Textile printers use formaldehyde resins as a cross-linking agent in acrylic binder systems for pigment printing of polyester/cellulose or synthetic materials. The formaldehyde resin is diluted with water and mixed with print paste for approximately 10 minutes in a vat by either manual stirring or mechanical mixing. Typically 1% to 3% of the resin product is used in the print paste depending on the depth of shade of the print required. The print paste is then transferred onto the fabric using a print screen (flat bed printer). The print is generally cured at 150 oC for up to 3 minutes to cross link the acrylic resin binder.At large textile dyeing enterprises, formaldehyde resin is pumped from drums into a large storage/dispensing vessel and then transferred to the dyeing equipment where the product is diluted at a rate of 1-2 g/L. The temperature inside the dyeing machine is about 100 oC. The product is rinsed off after dyeing and the water goes to trade waste. The operation is a daily activity and manual processes occur at some smaller sites.Formaldehyde resins are used as cross-linking agents for cotton fabric and other cellulotics to produce a finish that resists hydrolysis and is inert, durable and unaffected by heat or bleach. Formaldehyde resin is poured into an open tank and diluted with water to ratios of 1:10 to 1:20. Textile finishing processes includepadding, drying, and curing. The padding is normally done by immersing the fabric in the resin aqueous solution, followed by squeezing it between two rollers, and finally drying and curing. The durations of the padding vary depending on the type of fabrics			
Chemical concentration:	The concentrations of free formaldehyde inthese products are generally < 2%.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	Medium	Ranges are provided with uncertain statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.	
Overall Quality Determination		High		

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Industrial use of adhesive- sand binder		
EXTRACTION			
Parameter	Data		
Life cycle description:	At foundry sites, a variety of iron castings are produced for the automotive industry		
Process description:	At sand coating sites, the resin is pumped into a mixer at a rate of 1% to 1.2% resin by weight of sand. At some sites, the resin is decanted from drums manually into a measuring cup and then poured into a mixing vessel. Mixing normally takes about 5 minutes and the coated sands are then decanted into bags ready for core making at foundries. This is a batch operation and the frequency of the operation varies from site to site.Foundry using sand as the moulding material consists of six basic processes: pattern making, core making, moulding, metal melting and pouring, and casting cleaning (fettling). Core making is the process of creating solid shapes from sand using a variety of binding system. These solid shapes, called ‘cores’, determine the internal cavities of the casting. Hot, warm and cold box core making techniques are used in the foundry. About 90% of the cores are produced by hot and warm box technologies, using urea formaldehyde resin, phenol, and furfuryl alcohol systems.Typically, the sand coated with formaldehyde resins is blown into a hot mould (with temperatures around 110 C) where formaldehyde resin melts and functions as a bonding agent to make cores. At larger enterprises, sand coating and core making occurs in an enclosed system. Drums containing formaldehyde resins are connected to an automatic dosage system, which supplies a set dosage of the resin into core making machines		
Chemical concentration:	The hot box resin system contains typically 5% to 6% free formaldehyde in the resin, whilst the warm box typically contains 2% to 3% free formaldehyde.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	Medium	Ranges are provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination		High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Incorporation into article- Fiber glass		
EXTRACTION			
Parameter	Data		
Life cycle description:	manufacture of fireproof hubcaps used in the mining industry.		
Process description:	Formaldehyde resin is diluted with up to 40% water before it is mixed with other ingredients by manual stirring. The mixture is applied to a mould using mop rollers or bristle rollers. The mould is then put in an oven at temperatures up to 60 oC for about 12 hours, where the resin is cured.Glass fibre materials- The resin and other ingredients are diluted with water and mixed in an open tank. The mixture is sprayed onto the glass fibres, which then pass through an oven (temperature 220C to 300C) where the resin is cured.		
Chemical concentration:	Formaldehyde resins containing up to 13% free formaldehyde are used as fire resistant laminates in the fibreglass industry		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	Medium	Ranges are provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination		High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Incorporation into article-Construction			
EXTRACTION				
Parameter	Data			
Process description:	These parts are made of a few layers of either fibreglass or carbon fibre clothes coated with formaldehyde resins. The resin is mixed manually with a hardener in a ratio of 20:3. A worker applies the blend onto each fibreglass or carbon fibre cloth sheet using a brush, before piling several sheets together to make a mat. The mat is then moulded into the shape of a car part. Depending on the application of the part, it is either left at room temperature or gradually heated up to 250 C in an oven for 1 to 2 days when the resin is cured.			
Chemical concentration:	Formaldehyde resins containing about 3% free formaldehyde are used for the manufacture of composite parts			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Ranges are provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination			High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Incorporation into article-Plastics (Foam)			
EXTRACTION				
Parameter	Data			
Process description:	Formaldehyde resins are pumped into a mixing bowl and blended with other ingredients for about 5 minutes in an open system. The blend is then tipped into a mould and baked under 45 C in an oven for about 90 minutes to make solid foams. The foam is then cut and processed into various shapes and sizes to sell to wholesale companies.			
Chemical concentration:	Formaldehyde resins containing up to 5% free formaldehyde are used to make foam insulation for industries			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	Medium	Ranges are provided with uncertain statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.	
Overall Quality Determination		High		

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Processing-Other		
EXTRACTION			
Parameter	Data		
Process description:	The resin is pumped from a refrigerated storage tank into an enclosed mixing tank and mixed with other ingredients. The resin accounts for approximately 11% of the total mixture. The mixed product is then automatically deposited into trays, which are then wrapped and boxed approximately one minute after initial deposit into tray. Firelighter manufacture is a daily operation.The product is stirred manually prior to use and during application. It is applied at a rate of not less than 200 mL/m2 using airless spray equipment. For porous surfaces, such as blockwork, an application rate of up to 400 mL/m2 may be necessary to ensure total saturation.		
Chemical concentration:	Formaldehyde resins containing up to 1% free formaldehyde are used in firelighter manufacture. For anti-graffiti sealer, The product is a low gloss resin containing up to 1% free formaldehyde.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	Medium	Ranges are provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination		High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Commercial Use- Lab Use		
EXTRACTION			
Parameter	Data		
Process description:	Dilution, These aqueous solutions are stored in enclosed large tanks (up to 1000 L) and are automatically decanted into smaller containers before end use. The aqueous solutions are manually dispensed into specimen jars and used for fixing human tissues and organs after autopsy. [Detailed process descriptions, pg. 73-74]		
Chemical concentration:	The most commonly used solutions are neutral buffered formalin solutions containing 4% formaldehyde. The solutions are either purchased from suppliers already in aliquot containers/specimen jars or made on site by diluting concentrated formalin solutions containing 20% to 32% formaldehyde.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	Medium	Ranges are provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination		High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Formaldehyde is manufactured in Australia as aqueous solutions known as ‘formalin’, at approximately 55,000 tonnes per annum (calculated as 100% formaldehyde). Formalin and products/mixtures containing formaldehyde are also imported at approximately 90 tonnes (100% formaldehyde) per year. In addition, approximately 700 tonnes per year of paraformaldehyde (a significant source of formaldehyde) is imported. The global production of formaldehyde in 1999 was estimated 5 to 6 million tonnes (Asia: 1 to 1.5 million tonnes, North America: 1 to 1.5 million tonnes, Western Europe: 2 to 2.5 million tonnes). A global production figure of 12 million tonnes in 1992 was reported. Formaldehyde is listed on the Organisation for Economic Cooperation and Development’s (OECD) List of High Production Volume (HPV) chemicals, i.e. production volume of 1000 tonnes or more in at least one OECD country (OECD, 2004).			
Life cycle description:	The main industrial use of formaldehyde and paraformaldehyde is for the manufacture of formaldehyde-based resins, which are widely used in a variety of industries, predominantly the wood industry. Formaldehyde is also used directly or in formulations in a number of industries including medicine-related industries (such as forensic/hospital mortuaries and pathology laboratories), embalming in funeral homes, film processing, textile treatments, leather tanning, and a wide range of personal care and consumer products. The concentrations of formaldehyde in these products range from 40%, such as in embalming and film processing solutions, to < 0.2%, such as in the majority of cosmetics and consumer products.			
Process description:	Various manufacturing methods were used in the past, but only two are widely used today: the silver catalyst and metal oxide catalyst processes (IARC, 1995). Formaldehyde is manufactured in Australia by catalytic oxidation of methanol. Two methods are used; one uses a silver catalyst and the other a metal oxide catalyst. As formaldehyde is produced in gas form, it is absorbed into water during manufacture.			
Throughput:	The main industrial use of formaldehyde and paraformaldehyde is for the manufacture of formaldehyde-based resins			
Number of sites:	Four companies manufacture formaldehyde at five sites around Australia.			
Chemical concentration:	The aqueous solutions are called formalin and the concentrations of formaldehyde in formalin range from 37% to 54%.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Ranges are provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Import			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	The quantity of imported formaldehyde is approximately 76 to 109 tonnes per annum.The total reported importation of paraformaldehyde is shown in Figure 7.3 and is approximately 700 tonnes per year. It was reported that most imported paraformaldehyde is used in resin manufacture.			
Life cycle description:	The information provided to NICNAS indicates that more than 250formaldehyde-containing products, such as formaldehyde resins, film processing products, surface coating products, and preservatives, are imported. The concentrations of formaldehyde in the imported products vary widely, however, the majority of them are less than 1%. Imported products are either further incorporated into end products or used directly by end users. Some end use products containing formaldehyde are imported and sold directly to the general public. Examples include cosmetics products and other consumer products, such as fabric softener, surface liquid cleaners and dishwashing liquids.			
Process description:	Formalin is imported in packaging of various sizes including 220 kg drums, 20 L drums, 22 kg carboys, 2.5 L bottles, 500 mL bottles and 10 mL ampoules. Imported formalin is transported in pallets in full container loads or on trucks mainly by road. The majority of imported formalin is used in resin manufacture and as laboratory reagents [in Australia].			
Chemical concentration:	Paraformaldehyde is imported as prills or powder in 25 kg bags. The concentrations of formaldehyde in these prills/powder range from 81% to 99%.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Ranges are provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.
HERO ID:	192040
Conditions of Use:	Processing as a reactant

EXTRACTION	
Parameter	Data
Life cycle description:	The resin powder does not contain any free formaldehyde and is used as a binder in the manufacture of abrasive products, such as grinding wheels, brake components (for example, brake linings), and refractory products. These products are typically compressionmoulded and then heat cured
Process description:	The manufacture of resins is a batch process and conducted in enclosed systems. The manufacturing process varies from site to site. Typically, formalin is transferred through a fixed piping system and charged into resin reactors. Manual charging of formalin from drums occurs at some smaller resin manufacturingsites. In the situation that paraformaldehyde is used, it is charged manually from sealed bags into the reactor. Each batch typically takes about 8 to 12 hours, but can vary from 5 to 30 hours depending on the technical grade of the resin. Decanting of the resins is via a closed pipe system to storage tanks on site fromwhich it is pumped to drums, bulk containers or bulk tankers for road transport. Some workplaces decant the resins manually into 8 to 200 L drums.Solid phenol formaldehyde resin powder is also manufactured in Australia. The molten phenol formaldehyde resin is dropped from the reactor onto a cooling floor where it becomes a brittle solid, which is then manually broken into lumps. The lumps are subsequently blended with curing agents and ground to a powderwhich is then packed in 15 kg or 700-800 kg bags for sale.
Chemical concentration:	The majority of the formaldehyde resins contain < 0.2% free formaldehyde, but some contain > 0.2% depending on the applications of the resins. For example, some fibreglassresins contain up to 13% free formaldehyde. Solid phenol formaldehyde resin powder does not contain any free formaldehyde.

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	Medium	Ranges are provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination

High

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Formulation into mixtures			
EXTRACTION				
Parameter	Data			
Process description:	In general, formulation is a batch process, in which measured amounts of formaldehyde or product containing formaldehyde and other components are added to mixing vessels and blended to form end products. The product is then transferred to containers and dispatched to customers. In general, manual processes occur in small batch productions, such as formulation of anti-graffiti wall sealer. Typically, formalin or product containing formaldehyde is decanted into a vessel for weighing before being poured into an open tub and stirred. Decanting is done with a small jar and funnel. Equipment is cleaned manually between different products with either water or cleaning solvents. For larger-scale production, such as detergents and disinfectants formulations, formalin or product containing formaldehyde is either directly poured into a mixing tank using a drum lifter or is transferred via a transfer pump. Other ingredients are then added, followed by mechanical stirring. For some formulations, formalin or product containing formaldehyde is premixed with other ingredients before adding into the main mixing vessel. The mixing operation is usually conducted under closed or partially closed conditions and the final product is pumped into drums for transport to customers. Decanting is usually an automated process. Table 7.4 provides durations and frequencies.			
Chemical concentration:	Table 7.4 (p.65) contains chemical concentrations of formulated products.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Ranges are provided with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Repackaging			
EXTRACTION				
Parameter	Data			
Process description:	Most repackaging of formalin or product containing formaldehyde is from 200 L drums to smaller containers, such as 5 L and 20 L containers. They are decanted into smaller containers either through a pump (enclosed process) or fed via gravity. Repackaging is usually not a continuous operation and the duration and frequency of the operation vary from site to site. Formalin is also repacked from large storage tanks. The material is pumped into the storage tanks and transferred into various size containers using a pump and an enclosed tubing system. Manual and open repackaging processes were reported during repackaging paraformaldehyde powder (see Table 7.5). It is assumed that enclosed processes may also occur in Australia.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	Medium	Ranges are provided with uncertain statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Commercial Use- Photoprocessing			
EXTRACTION				
Parameter	Data			
Process description:	The products are in 9L or 19 L plastic drums and carried from the storage area to the film processing area. Workers open the cap and insert a tube into the drum. The product is pumped into the bottom of an enclosed wash tank (final bath) in an enclosed machine. Water is injected at the same time to dilute the solution. The formaldehyde concentration in the working solution is < 1%. The aerial film goes through the final bath before passing a dryer (at 140C) and being developed. The wash goes to drain after use. The empty drums are sent to landfill or rinsed with water for re-use. Most commercial film processing sites use enclosed machines (processors) that have a final bath tank specifically for formaldehyde aqueous solutions. The concentrations of formaldehyde in the solutions range from 0.1% to 15%. The solution is poured into the tank and diluted with water in the required ratios ranging from 1:100 to 1:1000. Typically, the processors are operated for an average of 4 or 5 hours a day, 5 days a week. The final bath is replenished about 1 to 2 times a week. The waste generated during film processing either goes to drain or is collected in a container for disposal.			
Chemical concentration:	Formaldehyde products containing high concentrations of formaldehyde (20% to 35%) are used in final baths of some specialised film processing, such as aerial film processing.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination			High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Commercial Use- Lab Use			
EXTRACTION				
Parameter	Data			
Process description:	Large use (forensic/hospital mortuaries/anatomy labs): the concentrated formalin solution is manually poured into an enclosed mixing system, diluted with water in ratios of 1:5 to 1:8 and mixed with other ingredients. These aqueous solutions are stored in enclosed large tanks (up to 1000 L) and are automatically decanted into smaller containers before end use. The aqueous solutions are manually dispensed into specimen jars and used for fixing human tissues and organs after autopsy. Small use (pathology laboratories): concentrated formalin solutions are diluted manually with water using measurement equipment and funnels.The neutral buffered formalin solutions already aliquoted into specimen jars are used in hospitals and doctors’ rooms for preserving human tissues from biopsy. The specimen jars are sealed and sent to pathology labs. In pathology labs including histopathology labs, human tissues are taken out of the specimen jars and accessioned (‘cut-up’) to certain sizes or shapes which are then placed on a tray that goes through a processing machine (‘processor’). Accession is undertaken manually on benches equipped with ‘down draught’ extraction systems. The processor has a number of containers holding different chemical liquids including neutral buffered formalin solution, which needs to be topped up regularly (up to once a day in large laboratories). During the topping up, the container is taken out of the processor and the solution is poured in using a funnel. After the processing, the specimens are waxed and cut to prepare slices for microscopic observations [More description provided in source]			
Chemical concentration:	The most commonly used solutions are neutral buffered formalin solutions containing 4% formaldehyde. The solutions are either purchased from suppliers already in aliquot containers/specimen jars or made on site by diluting concentrated formalin solutions containing 20% to 32% formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.	
Overall Quality Determination		High		

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Commercial Use- leather and fur tanning			
EXTRACTION				
Parameter	Data			
Process description:	Workers dilute the formalin solution at a ratio of 1:10. The working solution is then added manually to an enclosed processing drum. This operation takes about 5 minutes. Furs are added into the drum and mechanically rotated for 18 to 24 hours. The solution is drained before furs are removed manually to an open tub. The tanned furs then go through drying, staking and other numerous processes. The NICNAS survey data indicates ... one leather processing company uses it 6 times a year.Products containing 10% to 15% formaldehyde are used daily in general leather tanning. The processes are similar with the fur tanning, except the addition of the product from intermediate bulk container to the processing drum is via an enclosed system.			
Chemical concentration:	Fur tanning uses formalin containing 37% formaldehyde, which is diluted at a ratio of 1:10. For leather tanning uses 10% to 15% formaldehyde daily in general leather tanning			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.	
Overall Quality Determination		High		

Study Citation: NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.	
HERO ID: 192040	
Conditions of Use: Commercial Use- Water Treatment Products (Santizing)	
EXTRACTION	
Parameter	Data
Process description:	Formalin containing 37% to 40% formaldehyde is used as an additive to sanitise water treatment plants. The formalin is manually measured and poured into a water holding tank to make a 1% formaldehyde solution. The diluted solution is then pumped through the water pipe system for cleaning. This operation is undertaken occasionally, for example, one company conducts the treatment about twice a year.Products containing up to 10% formaldehyde are also used to sanitise bins and digest portable toilet contents. For the bin disinfectants, product is usually diluted at ratios of 1:6 to 1:10 and added manually to sanitary bins. Toilet sanitizers are poured into portable toilets at a rate of 20 to 50 mL product per 5 L of holding tank capacity per week. For recirculating toilets, 200 mL product is needed for initial charge. The waste goes to sewage systems.
Chemical concentration:	37% to 40% diluted to 1% or 1.6%
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Methodology
High	report uses high quality data
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Medium	The data are from an OECD country other than the U.S
Metric 3:	Applicability
High	The report is for an occupational scenario within the scope of the risk evaluation.
Metric 4:	Temporal Representativeness
Medium	The report is generally more than 10 years but no more than 20 years old.
Metric 5:	Sample Size
N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination	
High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Commercial Use- Lubricant		
EXTRACTION			
Parameter	Data		
Process description:	Some industrial lubricants contain > 0.2% formaldehyde as a preservative. For example, conveyor lubricant (0.3% formaldehyde) is used to provide lubrication and equipment protection for conveyor belts made of steel and plastic. Before use, the product is manually poured into a big container diluted with water to 0.1%. The diluted product is continuously dispersed onto the conveyor belt through an enclosed automatic system.		
Chemical concentration:	>0.2%		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination		High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Commercial Use- Lab Use (Research Labs)			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	The average importation quantity for the calendar years 2000 to 2002 was 1100 L formalin products and 150 kg paraformaldehyde prills per year. Information on the quantities of analytical grade formalin formulated in Australia is not available.			
Process description:	Analytical grade formalin and paraformaldehyde powder/prill are commonly used in research laboratories as reagents. The concentrations of formaldehyde in formalin products range from 0.2% to 40%. The paraformaldehyde powder/prill contains 95% to 97% formaldehyde. Most of the analytical grade products are supplied to laboratories as imported/formulated. Some importers repackage the products before selling to either distributors or end users including commercial enterprises, such as contract and company in-house analytical laboratories, universities and government laboratories. Quantities imported are relatively small.			
Chemical concentration:	0.2-40%, mentions 90-95% formaldehyde [but likely formaldehyde equivalent]			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination			High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Commercial Use- Fumigation			
EXTRACTION				
Parameter	Data			
Process description:	Paraformaldehyde, in granular form, is used for fumigation of sterile areas, such as pharmaceutical plants. Workers transfer the paraformaldehyde granules into gas generators, which contain silicone oil. The paraformaldehyde granules are placed on the top of silicone oil. The oil is heated and the formaldehyde gas generated is released into the air at a dispensing rate of 10 g/m3. The activation of the fumigation generators is remote controlled and the gas generation continues for 3 hours. No access is allowed to the area for 30 hours after the fumigation and the air conditioning is initiated 8 hours after the fumigation and remains on for at least 28 hours. Air monitoring is conducted and must be less than 0.2 ppm before access is allowed. The residue in the generators is tipped into a waste drum and sent to an approved waste destruction company. The operation is run 1 to 2 times a year			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	High	The report is for an occupational scenario not within the scope of the risk evaluation (FIFRA).
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination			High	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.		
HERO ID:	192040		
Conditions of Use:	Commercial Use- Embalming		
EXTRACTION			
Parameter	Data		
Process description:	A typical embalming procedure involves cleansing and disinfections of body surfaces and orifices, arterial embalming, cavity embalming, and supplemental embalming. [More details provided on pg. 74-75		
Chemical concentration:	Formalin products containing < 10% of formaldehyde are usually used for cleansing and disinfections of body surfaces and orifices, destroying maggots and vermin, and spray to preserve, disinfect and deodorise external body surfaces		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination		Medium	

Study Citation:	NICNAS, (2006). Priority existing chemical assessment report no. 28 formaldehyde.			
HERO ID:	192040			
Conditions of Use:	Commercial Use-Embalming			
EXTRACTION				
Parameter	Data			
Process description:	It is used as an arterial, internal cavities, and hypodermic injection fluid and on surface packs. Information from the Australian Funeral Director Association (AFDA) indicates that approximately 30% to 40% of deceased bodies are embalmed in Australia for various purposes, such as allowing long distance transportation of bodies, particularly by airplanes, allowing more time for the planning and arrangement of the funeral, and allowing the body to be viewed under optimal conditions. The degree of body embalming varies.A typical embalming procedure involves cleansing and disinfections of body surfaces and orifices, arterial embalming, cavity embalming, and supplemental embalming. Formalin products containing < 10% of formaldehyde are usually used for cleansing and disinfections of body surfaces and orifices, destroying maggots and vermin, and spray to preserve, disinfect and deodorise external body surfaces. [More process description available in source]			
Chemical concentration:	The concentrations of formaldehyde in the products range from < 10% to 40%			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides limited discussion of the variability and uncertainty in the data.
Overall Quality Determination			Medium	

Study Citation:	Niculescu, M., Ghituleasa, C., Mocioiu, A.M., Nicula, G., Surdu, L., Tanasescu, G. (2013). Evaluations of formaldehyde emissions in clothing textiles. Industria Textila 64(2):111-114.			
HERO ID:	3001257			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter		Data		
Life cycle description:		Formaldehyde is added to textiles for resistance to wrinkling, stability, good dimensional stability, compatibility with finishing agents, color resistance, maintenance of fabric whiteness, and environment protection for application of resins and other finishing operations.		
Chemical concentration:		Printed cotton, underside, 39.8 mg/kg; printed shirt, phosphorescent 58.5 mg/kg; shirt with an “non-iron” treatment which had 106 mg/kg formaldehyde. Fig 4 provides formaldehyde emissions in children clothes with the median around 20 mg/kg with the max at about 59 mg/kg. Men’s clothing had a max of 75 mg/kg.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Medium	Source is likely not peer reviewed but appears to be high quality data due to testing being based on European and international standard.
Domain 2: Representativeness		Metric 2: Geographic Scope	Low	Data is for Romania, a non-OECD country.
		Metric 3: Applicability	Low	The report is for a non-occupational scenario (consumer scenario) which may be useful for commercial use scenario.
		Metric 4: Temporal Representativeness	High	Data is less than 10 years old (2013).
		Metric 5: Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Medium	Values measured are shown graphically but are hard to interpret, methodology, sample type, and a few data points are provided in text.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Medium	Addresses variability by looking at different types of textiles from different countries. Does not address uncertainty
Overall Quality Determination			Low	

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA-82-349-1332. Woolrich Woolen Mills, Inc., Woolrich, Pennsylvania. NIOSH:82-349.			
HERO ID:	1316761			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Process description:	The manufacturing processes at the Woolrich plants are typical of the garment industry in general, and are basically comprised of cutting, separating, jointing and sewing, inspection, and pressing.			
Throughput:	Ten thousand square yard lots of cotton material is received and cut at the Woolrich main plant before being sent to the Avis and Howard plants. Each lot of material produces approximately 4000 shirts once received at the pant. Roughly five weeks are required for a particular lot to proceed through the manufacturing processes. Approximately 15,000 shirts are produced per week, and at a given time, 60-70,000 shirts may be in the plant undergoing one of the numerous processing operations. Thus, numerous lots of material may be present at any given time, witheach shirt being handled by 30 to 40 employees. Woolrich uses three different finishing companies to apply the wrinkle-resistantformaldehyde resin to their cotton material.			
Chemical concentration:	Suede 421 ppmCloth sample 136 ppmLint sample 138 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH HHE
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 , more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by comparing formaldehyde content among different type of fab-rics but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-80-144-1109. Film Processing Industry, Hollywood, California. NIOSH:1-34.			
HERO ID:	1316845			
Conditions of Use:	Use of photographic supplies			
EXTRACTION				
Parameter	Data			
Process description:	The exposed film is brought to the laboratory and is removed from a light-tight container in a darkened area. It is automatically sent through a series of tanks that contain the liquid solutions of the various components used in the developing process. The process is divided into the dark side and the light side. The exposed film can only be handled in white light after it has reached the light side of the developing process. There are several variations of the developing process which require different steps and chemicals, but the basic techniques are similar. The end product is the formation of the color images on the film. Developing process (dark side):Backing remover (tanks)Backing washApplication of developerDeveloper stopStop washDeveloping process (light side)Developing ProcessBleach acceleratorBleachSound trackSecond fix washStabilizerEach of the solutions used in the above process are contained in sequential tanks which make up a developing "line." Most major laboratories run at least six to eight developing lines concurrently.			
Throughput:	The film is processed and run on spools throughout the line at speeds which can vary from 275 feet per minute up to 600 feet per minute (on lines using the bleach accelerator process)			
Number of sites:	2			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario(photographic film development) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1980 more than 20 years old
	Metric 5:	Sample Size	N/A	Qualitative information provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report indicates that the information included was from NIOSH site visits
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-82-200-1233. Todd Uniform Company, Maury City, Tennessee. NIOSH Cincinnati:1-24.			
HERO ID:	1316870			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Process description:	Todd Uniform Company markets and services washable industrial service apparel. The plant in Maury City is one of four company operated plants. It exclusively manufactures work shirts. All fabrics are received precut and precured. There is no storage capacity; fabrics are received daily. Shirts are assembled by seamstresses in a series of sewing operations organized on a piece work basis. Once completed, the shirts are inspected and packaged for shipment.			
Chemical concentration:	Latent Formaldehyde Content in Fresh and Stored Fabric Samples: 146-339 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH HHE
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	1982 - more than 20 years old
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized. Sample size is sufficiently representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by using different fabrics for concentration measurements but uncertainty is not addressed.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1993). Health hazard evaluation report no. heta-92-092-2333, General Castings Power Street facility, Cincinnati, Ohio.
HERO ID:	1317161
Conditions of Use:	Foundries

EXTRACTION	
Parameter	Data
Life cycle description: Process description:	Chemical substances in metal products : gray and ductile iron foundry A core is used to define the internal hollows desired in the casting. Cores were made both by hand and by machine. A hot shell core is produced by dumping a resin-coated sand into a heated pattern, holding the coremaking materials in place long enough to produce curing on the surface, removing excess sand from the core, and then removing the hollow-cured shell from the pattern. Employees made oil-based cores, containing linseed oil and petroleum distillates, which were baked in a gas-fired ovens to make a solid core. No-bake cores were made of a phenolic-formaldehyde binder (PEPSET I®, PEPSET II®, and PEPSET III®, Ashland Chemical Company, Columbus, Ohio) mixed with silica sand in an automatic mixer. A polymeric methylene phenylene diisocyanate (MDI) was used as the binder catalyst. A mold provides the cavity into which the metal is poured to produce a casting. Seven squeeze jolt molding machines, which use green sand containing coal dust, were used in conjunction with the deck pouring conveyor. These machines use an air-rammer to compact the sand to make a solid mold. Excess sand was removed using compressed air. The finished molds are placed on a conveyor using chain hoists or manual lifting. One large Osburn molding machine was separate from the rest and had its own pouring conveyor. A mold parting compound was used in the molding area. To produce molten iron, the plant used three electric induction furnaces with a total capacity of 3.5 tons. Each furnace had a tight fitting lid to help control fumes. The metal pouring operation was performed inside the facility using molds on conveyor systems. Molten metal was poured into a large transport ladle and transferred into small ladles with flip lids for pouring on the conveyor deck. Chain hoists were used to maneuver the ladles. The molds were allowed to cool in the location where they were poured. The molds advance to the end of the platform where they fall on the floor. The two pourers also hand-separate castings from the sand. A Bobcat front-end loader was used to load the sand reclamation system and shakeout some of the castings. The reclamation system feeds the sand muellers in the molding areas. The cleaning department had three grinders and one cut-off saw operator. The worker in charge of shipping also did repair welding. The facility used an abrasive blasting machine and a steel shot blast machine to clean castings.
Number of sites:	1

Domain		Metric	EVALUATION	
			Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness		Metric 2: Geographic Scope	High	US
		Metric 3: Applicability	High	The data are for foundry operations which is an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	Low	The data were published in 1991, before the most recent PEL (1992) and more than 20 years old.
		Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty				
Continued on next page ...				

Formaldehyde

General Engineering Assessment

HERO ID: 1317161 Table: 1 of 1

...continued from previous page

Study Citation:		NIOSH, (1993). Health hazard evaluation report no. heta-92-092-2333, General Castings Power Street facility, Cincinnati, Ohio.			
HERO ID:		1317161			
Conditions of Use:		Foundries			
Domain		Metric		EVALUATION	
				Rating	Comments
Metric 7:		Metadata Completeness		N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination				High	

Study Citation:	NIOSH, (1992). Health Hazard Evaluation Report No. HETA-90-174-2231: Modern Materials Incorporated, Rochester, Indiana.			
HERO ID:	1317177			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Process description:	Powder coating is a dry, or solvent-free, painting process used to place a polymer coating on metal surfaces. At this facility, most of the objects to be coated are relatively small and include outdoor furniture, automobile trim, lawn and garden equipment, and other products that are likely to be exposed to harsh environments. The first step in the process is cleaning and surface preparation. The parts are placed in a steel frame wire basket approximately four feet long, three feet wide, and three feet deep. The basket is lifted by an overhead crane and sequentially dipped and soaked in a series of heated tanks containing water-based cleansers, degreasers, and surface treatment chemicals. A variety of cleaners and treatment chemicals may be used in the dip tanks. These include hydrochloric acid, chromic acid, phosphoric acid, hydrofluoric acid, zinc phosphate, potassium hydroxide, sodium hydroxide, ethylene glycol monobutyl ether (Butyl Cellosolve®), and a variety of phosphates and detergents. After surface treatment and a final rinse stage, the basket of parts is moved into a small, gas-fired drying oven. When all the water has been evaporated, the basket is removed from the oven, allowed to cool, and then pushed across the floor into the coating area. The parts to be coated are hung from racks on a continuously moving overhead conveyor and are carried through one or more ventilated spray booths. The coating is supplied as a finely divided dry powder which, according to literature reports, ranges in diameter from 5 to 100 micrometers (:m). There is currently some interest in the development of powder coatings with smaller particle sizes which would allow thinner coatings to be applied, but which might also present a greater inhalation hazard. At Modern Materials the powder coating is applied using two electrostatic spray guns, located on opposite sides of the booth. The guns produce an aerosol of electrically charged coating particles. In some cases the spray guns can be attached to a stand or reciprocating arm and no operator is required. However, if the items being coated are complex shapes, the guns must be aimed and moved by an operator. The powder is sprayed from the gun by compressed air, and particles are attracted to the metal objects by the electrical field that is developed between the charged gun and the electrically grounded conveyor. After the objects to be coated are covered with a thin film of dry powder, they are carried into a gas or electrically-heated oven where the powder melts and flows to produce an even coating. With some coating formulations the elevated temperature in the oven also cures the paint by initiating a polymerization reaction. Depending on the type of coating being used, the oven temperature ranges from about 200 to 250o C. Residence time in the oven is generally no more than a few minutes.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (surface coating) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1990 - More than 20 years old
	Metric 5:	Sample Size	N/A	This report provided qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	This report provided qualitative information
Continued on next page ...				

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Study Citation:	NIOSH, (1992). Health Hazard Evaluation Report No. HETA-90-174-2231: Modern Materials Incorporated, Rochester, Indiana.		
HERO ID:	1317177		
Conditions of Use:	Use of Paints/Coatings		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	NIOSH, (1973). Health hazard evaluation: Bakan Plastics.		
HERO ID:	1317291		
Conditions of Use:	Plastic Manufacturing		
EXTRACTION			
Parameter	Data		
Process description:	Plastic parts for plastic sprayers and dispensers are molded utilizing machines which heat the resin material and inject it into molds under hydraulic pressure. (2/4)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality techniques that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium	

Study Citation:	NIOSH, (1992). Health Hazard Evaluation Report No. HETA-91-169-2196: Texprint Products, Macon, Georgia.
HERO ID:	1317776
Conditions of Use:	Use of fabric, textile and leather products

EXTRACTION

Parameter	Data
Process description:	Raw greige (unbleached, undyed) cloth is shipped to the facility for processing. Cloth is "plated" from rolls onto buggies, inspected, and transported to the Preparation and Finishing Department, where it is prepared for printing. The preparation process includes washing the cloth to remove starch and smoothing and stabilizing the cloth in a heat-setting tenter. Raw cotton material is further processed in a mercerization step, which is a conditioning process that results in a flatter, softer product that is more receptive to dyes. The Mercerizer machine treats the cloth with a caustic soda (sodium hydroxide) solution. The Stock-Paste carrier is used to adjust the viscosity and application characteristics of the dye. The stock paste consists of Reserve Salt Flake® (m-nitrobenzene sulfonic acid sodium salt, sulfuric acid disodium salt, and water), kelgin (a polysaccharide from seaweed), urea, sodium bicarbonate, Revatol-S® (a substituted benzene derivative), Trydet 2675® (stearic acid and a polyglycol ester), water, and up to 40% mineral spirits. Ammonium hydroxide is added, infrequently, to the pigment stock-paste. Stock paste is fed to the Dye Mixing Department ("color kitchen") through pipes. This Department is separated into two distinct areas: a computerized auto-mixing area and a manual mixing area. Eighteen "mother" colors are used to produce the desired dyecolors. The manual mixing area is used to make fine adjustments in dye color or prepare low volume colors. Dye is scooped out of vats by hand, weighed, and mixed into other vats. No powder dyes are used. In the Strike-Off Department (Sample Department), dyes are mixed by hand, and trial patterns and colors are produced on an experimental basis. Dye is added to the roller with a hand-held pump. Then the cloth, which sticks to a belt (referred to as a "blanket") having an adhesive, is drawn under the roller. The ink comes through small holes engraved in the roller, imprinting a pattern on the cloth. Several rollers may be needed to impart different colors or patterns to the cloth. In the Rotary Printing Department, dye is printed on cloth in a similar manner to that in the Strike-Off Department; except the operation is automated, and the scale of the operation is greater. Dye from the auto-mixer is transferred to the Rotary printers and is blown inside the cylinder for high volume printing. There are four rotary printers. Adhesive compounds are applied to the belts (referred to as "blankets"), which carry the cloth under the dye cylinders. Additional adhesives are added to the belts when needed. Occasionally, old adhesive must be removed from the belts; this is reportedly done with acetone and/or xylene. In the Finishing Department, three Hirano® machines are used for heat-tenting and application of soil-resist substances (Scotchgard®, Zonyl®). In addition, "resists," which are actually resins, are applied to the cloth for shrinkage control. One of the "resists," known as Permafresh LO®, mixed with water, an emulsifier, and a catalyst additive before it is applied to the fabric.
Number of sites:	1
Chemical concentration:	Permafresh LO®, contains formaldehyde at a concentration of <0.5%. This particular type of resin is designated as a low formaldehyde emission product, according to the manufacturer.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The report is for an occupational scenario (fabric printing) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1991 - more than 20 years old
	Metric 5: Sample Size	N/A	qualitative process description provided, formaldehyde concentration of resist provided from MSD sheet.
Domain 3: Accessibility/ Clarity			

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Study Citation:	NIOSH, (1992). Health Hazard Evaluation Report No. HETA-91-169-2196: Texprint Products, Macon, Georgia.			
HERO ID:	1317776			
Conditions of Use:	Use of fabric, textile and leather products			
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	NIOSH, (1973). Health hazard evaluation: union pacific railroad.			
HERO ID:	1317912			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Process description:	Engines are brought in the service building for servicing. The servicing consists of fueling, greasing and filling the sand boxes. The engines are often left running as was the case on the day of the visit. Six train engines and four switch engines were in the building. All the end doors and side windows were open and ten ceiling exhaust fans were on.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for fuels and related products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - process description.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1980). Health hazard evaluation report: HHE-77-74-720. Ottenheimer and Sons, Inc., Dawson, Springs, Kentucky. NIOSH:77-74.			
HERO ID:	1318533			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Process description:	The manufacturing process is divided into three areas: (1) Cutting -Here, rolls of cloth are spread by machine on large tables, and tracing paper is placed on top of the cloth layers and marked. The cloth is then cut by an automatic cutter with a blade that moves in an up and down motion. (2) Sewing Room This area comprises most of the floor space in the main plant and is subdivided into six sections for the various phases of assembly of the uniforms; and (3) the Shipping Department.The types of fabrics used are primarily polyesters, with lesser quantities of polyester/cotton blends and nylon blends. Three durable press fabrics including "MEDA," "Valid Poplin," and "Resolute," were reported by the workers to be of primary concern. The durable press characteristics of these fabrics are imparted by a glyoxal-based resin, 1,3-dimethylol-4,5-dihydroxy-2-imidazolidinone (DMDHEU). (page 2 of 8)			
Throughput:	12,000 uniforms per day (page 2 of 8)			
Chemical concentration:	Resolute - White: 938 ppm (3/21/78) 86 ppm (4/5/78)Valid Poplin - Blue 912 ppm (3/21/78) 88 ppm (4/5/78)Resolute - Cherry Red 700 ppm (3/21/78) 70 ppm (4/5/78)Valid Poplin - White 580 ppm (3/21/78) 84 ppm (4/5/78)(page 8 of 8 for Table II, which has these results. Page 4 of 8 for discussion)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (Garment fabrication) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1977 - More than 20 years old.
	Metric 5:	Sample Size	High	Results of the formaldehyde content of individual fabrics were presented which could be used to develop summary statistics. Uncertainty was not discussed but it is assumed that as this is a NIOSH study, uncertainty was addressed in the sampling method.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results of the formaldehyde content of individual fabrics were presented which could be used to assess variability between fabrics. Uncertainty was not discussed but it is assumed that as this is a NIOSH study, uncertainty was addressed in the sampling method.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-82-264-1232. Olympic Medal Laboratories, Bremerton, Washington. NIOSH:1-10.			
HERO ID:	1319165			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Process description:	Biological specimens are sent from surgery to the histology lab and are Preserved in formaldehyde solution. Once a day, for approximately 1 hour; the pathologist conducts a gross examination of the tissue. Portions of the tissue are removed for slide mounting. The specimens are placed back in formaldehyde for storage. The removed tissue is mounted in a paraffin block, sliced l with a microtome, and mounted on a slide. The mounted slide then goes through a series of solutions; where the stains are applied and the slides fixed. The coverslips are applied and the slides are complete. About once a week the specimens that are no longer needed are disposed of. The contents of the container (the specimen and formaldehyde solution) are put through a strainer and rinsed with water. The formaldehyde is washed down the sink and the specimen is placed in an uncovered container. (Page 4 of 10)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (pathology lab) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 - more than 20 years old
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative information provided
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-80-190-1135, American Cyanamid Company, Kalamazoo, Michigan. NIOSH:1-23.			
HERO ID:	1319179			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Process description:	The plant chemical processing (entirely by batch operation) isconducted in three separate buildings. Organic Flocculants: Polyamine and polyacrylamide products are manufactured in a modern, well-designed installation which was built in 1975. Chemical feed stocks, of various degrees of hazard, are epichlorohydrin, dimethylamine, ethylene diamine, hydrochloric acid, acrylamide monomer, isopropyl alcohol, ammonium persulfate, and formaldehyde. Major chemicals are handled in bulk from outside storage tanks, while minor ingredients are handled by drum. Various chemicals are added to large mixing kettles according to formulation via pipe transfer systems. When the batch is made it is transferred via pipe system to railroad tank cars, trucks, or 55 gallon drums. Alum is batch processed from company mined bauxite, sulfuric acid, and water in a wooden tank installation. Various amounts of bauxite and sulfuric acid, and water are added to large wooden kettles; the liquid is agitated with stirring rods; then the product is transferred to railroad or truck tank cars by pipe.Specialty Chemicals: In the remaining operable building, melamine formaldehyde resin products are being produced. The hazardous chemicals employed include formaldehyde, melamine powder, acrylamide monomer, hydrochloric acid, and sodium hydroxide solution. The manufacturing process chemicals are added to the process kettles using pipe transfers from storage tanks. (Page 4 of 23)			
Throughput:	Current (as of this paper) production 3.0 million pounds per month for specialty chemicals. (Page 3 of 23)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario(chemical manufacturing) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1980-81: more than 20 years old.
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative information provided
Overall Quality Determination			High	

Study Citation:	NIOSH, (1992). Health Hazard Evaluation Report No. HETA-88-240-2210: The Mueller Company, Decatur, Illinois.			
HERO ID:	1320542			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Process description:	Mueller Company is a grey iron and brass foundry that produces valves for water and gas distribution service. At the time of these surveys, the Mueller Company operated a mulling operation, core room, and pouring deck operation within the brass foundry. The company prepared cores by a traditional foundry casting process using a formaldehyde-based resin system. The required ingredients (sand, clay, and binders) were mulled and transferred to the appropriate packing location. The sand core was then made by placing the mulled mixture into a core box (bench molding) or core molding machine. The sand core then passed through a curing oven. After curing, the cores were cleaned, inspected, and transferred to the pour deck of the foundry. The raw metal charge consisted of ingots, which were composed of approximately 76% copper, 12-13% zinc, and 6-7% lead. The ingots were charged into electric induction furnaces and melted. At the correct temperature, the melted charge was tapped and transferred to pouring stations. On the pouring lines, the molten metal was poured into molds and cores under local exhaust ventilation. After pouring, the molds were allowed to cool for a pre-determined amount of time. The molds were transferred to the shake-out area where the castings were separated from the mold and sand. After shake-out, cast parts were transferred to the rough grind area, where casting surfaces were ground to remove gross imperfections. As necessary, parts received final finishing, were assembled, and packed for shipment.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (foundry) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1988 - more than 20 years old
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	qualitative information provided
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1980). Health hazard evaluation report: HHE-79-86-675. Tufts Medical School, Boston, Massachusetts. NIOSH:79-86.				
HERO ID:	1320877				
Conditions of Use:	Laboratory Use				
EXTRACTION					
Parameter	Data				
Number of sites:	1				
Chemical concentration:	Bulk samples of embalming and formalin solutions were performed.Bulk sample No. 1 could not be analyzed for formaldehyde by ion chromatography due to the interfering substances present in the sample. Portions of the sample were then reacted with chromotropic acid as in P&CAM 125 . This colorimetric method could not be used since a different shade of color was formed (alcohol, phenol, and other aromatic hydrocarbons interfere with this method). Then, a titration method was attempted without any success. The pH of the solution was too low for titrating formaldehyde with standardized sulfuric acid.Bulk sample No. 2 was analyzed for formaldehyde content by titrating with standard 0. 1005 N sulfuric acid. From duplicating analyses, the formaldehyde concentration was determined to be 24. 1 mg per ml. This is equivalent to 2.4 percent formalin solution.				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US study	
	Metric 3:	Applicability	High	The assessment is for an occupational scenario (academic Lab) within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	1979 - More than 20 years old	
	Metric 5:	Sample Size	N/A	Facility data	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Only one value was provided - no discussion of variability or uncertainty was included, but as this is a NIOSH study, it is assumed that uncertainty was addressed in the method used.	
Overall Quality Determination			High		

Study Citation:	NIOSH, (1983). Health evaluation and technical assistance report: HETA-81-422-1387. California Society For Histotechnology, Los Angeles, California.
HERO ID:	HETA-81-422-1387:1-49. 1321033
Conditions of Use:	Laboratory Use

EXTRACTION	
Parameter	Data
Process description:	1. Gross Dissection a. the organ or biopsy is taken from a formalin solution (10%), Zenker Fixative or Bouin. b. The organ or biopsy is measured, described and sectioned. c. The sections are immersed for 4 hours in a formalin solution2. Tissue Processing a. the automated tissue processor is used. It usually has 12 positions which contain ethyl alcohol, chloroform, and paraffin. the technician hooks small metal perforated cassettes containing tissue above solutions. i) Eight of the containers hold graded alcohol (80-100%) Alcohol is used to remove water from the tissue since it is not miscible with paraffin. ii) The tissue cassette is immersed in Chloroform or Xylene to remove ethyl alcohol iii) The tissue cassette is immersed in paraffin, which firms up the tissue for cutting. b. The tissue cassette is removed from processor and is vacuumed while in molten paraffin. This process removes air from the tissue so that each cell is infiltrated with paraffin.3 Slide Preparation and Staining a. Paraffin embedded tissue blocks are serial sectioned on a microtome. b. The sections are placed in warm water or a water-gelatin solution after which the tissue sections are placed on slides to which they may now adhere. c. The slides are placed in a slide holder and heated in a oven at 60C paraffin is melted off for the most part. d. the slide holder is dipped in xylene or toluene to remove the paraffin e. the slide holder is then dipped into graded ethyl alcohol and rinsed with water. f. a typical staining procedure is as follows: i) Slides are briefly immersed in hematoxylin, a regressive stain used to intentionally overstain the tissue. ii) slides are rinsed with water and then excess hematoxylin removed with 1% hydrogen chloride in 75% ethyl alcohol. iii) slides are rinsed with water, blued with lithium carbonate for good nuclear detail and then rinsed with water again. iv) Slides are now immersed briefly in eosin, a counterstain and are then rinsed with water followed by a rinsing with 95% ethyl alcohol. v) Slides are rinsed with water and then immersed in xylene or a toluene/terpineol solution vi) slide holder is removed from xylene so that they may be coverslipped with a xylene or toluene-based mounting resin.
Number of sites:	8 facilities selected for monitoring out of 13
Comments:	Study noted that phenol, xylene, toluene, and alcohol negatively interference with P&CAM 125

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (Histology) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided

Overall Quality Determination

High

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-80-81-1173. Keokuk Steel Castings, Incorporated, Keokuk, Iowa. NIOSH:1-31.			
HERO ID:	1321050			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Process description:	Keokuk Steel Casting, a subsidiary of Kast Metals, Inc. produces medium-sized ferrous products used primarily for the subsequent manufacture of excavation equipment. "No-bake" type cores and molds are used in the production process. Cores are produced by means of an automated "Isocure" system, in which the core sets, or hardens, instantaneously. Ashland Chemical's Isocure I-308 (phenol-formaldehyde resin with solvents) and Isocure II-612 (diphenylmethane diisocyanate with solvents) are mixed with sand immediately prior to entering the metallic core mold. As a curing system, Ashland Chemical's Catalyst 702 (dimethylethylamine) is then blown into the mixture, the mold separates, and the core is manually removed and stacked onto skids. Molds are produced in two areas, one for small molds and one for larger molds. Pepset 2590, consisting primarily of diphenylmethane diisocyanate (MDI) and hydrocarbons, or Pepset 1590, a phenol-formaldehyde and hydrocarbon mixture, are mixed with sand and fed into molds, manually tamped down, then allowed to air set. The remainder of the process prior to metal pouring deals with combining cores and molds, which takes place in an assembly line fashion downstream of the core/mold production area. The metal pouring area is partially enclosed and ventilated via dilution ventilation. Approximately once per hour a "heat" is poured. Subsequent to metal pouring, the casts are allowed to set and harden. Once the casts are sufficiently cool, they are transported to the shakeout area where the casts are separated from the molds (Georgia Iron Works or "GIW" process). The broken molds are crushed, treated, and the sand is returned to the mold production process for reuse.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (foundry) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 more than 20 years old
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1980). Health hazard evaluation determination report: HHE-79-72-680, Energyloc, Inc., Portland, Oregon. NIOSH:79-72.			
HERO ID:	1322624			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Life cycle description:	Formaldehyde is in the insulation as a phenol-formaldehyde binder			
Process description:	Energyloc is a weatherization contractor which sells and installs insulation for homes. Each crew of two or three loaded the materials needed for that day in their truck and proceeded to the job site. Every house or job is different. Access to the crawl space maybe from the outside or through the inside of the house. The installers enter the crawl space and, if needed, lay down a plastic vapor barrier. The fibrous glass rolls and/or batting are then passed into the crawl spaces where they are installed. Installation of the fibrous glass is accomplished by the worker lying on his back, inserting the fibrous glass between the floor joists and stapling the material to the joist. The fibrous glass insulation is also usually wrapped around the heating ducts and either taped or tied in place. The materials to which the installers are exposed to are fibrous glass fibers, formaldehyde (present in the insulation as a phenol-formaldehyde binder), cellulose dirt and dust.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA-83-276-1499. Charlie’s Taxidermy And Gifts, Fleetwood, Pennsylvania. NIOSH:83-276.			
HERO ID:	1357922			
Conditions of Use:	Taxidermy			
EXTRACTION				
Parameter	Data			
Life cycle description:	Formaldehyde is used as one of the solvents during taxidermy.			
Process description:	The article provides process description for taxidermy. Descriptions of general sorts of procedures and materials used in taxidermy are indicated and includes processes used for fish, birds, deer, hand tanning, freeze drying, skulls, and miscellaneous. The processes mention the use of solvents, though formaldehyde is not mentioned.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources, assessment methods, results	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-283-1224. Southern Minnesota Beet Sugar Cooperative, Renville, Minnesota. 40:1-32.
HERO ID:	1516473
Conditions of Use:	Non-TSCA

EXTRACTION	
Parameter	Data
Production, import, or use volume:	The SMSC factory processes nearly 1 million tons of sugar beets annually. The processed products and annual production rate are: granulated refined sugar (about 99.9% sucrose), 100,000 tons; beet molasses, 50,000 tons; and beet pulp pellets (by-products), 50,000 tons.
Life cycle description:	Formaldehyde used as a bactericide
Process description:	Sugar beets are delivered to the factory in trucks and are either piled on the ground or dumped directly from the trucks into wet hoppers. The beets float into the factory via a water flume and go through various debris removing processes. After cleaning, the beets are cut into long noodle-like pieces called "cassettes". The cassettes are introduced into the diffuser at one end while water enters the diffuser at the opposite end. The diffuser, about 20 1 in diameter and 200 1 in length, is located in the northwest section of the main building. Approximately 300 tons of beets and a similar volume of water are processed through the diffuser each hour. Inside the diffuser, sugar is extracted from the cassettes via osmosis. The cassettes, then free of most of their sugar, are dried and made into beet pulp pellets. The sugar solution leaves the diffuser in the form of "raw juice". Once removed from the diffuser, the raw juice cycles through various stages of purification, precipitation, pH adjustments (using carbon dioxide gas from the lime kiln), and filtration to remove impurities and other non-sugars. Excess water is removed in the evaporator and the juice becomes thicker. The remaining water is driven off by boiling and then crystallized to a high concentration of sugar called "white massecuite". This massecuite is then centrifuged to remove and separate the sugar crystals from the liquor containing sugar syrups and impurities. The finished sugar is then sifted, packaged, and/or stored prior to shipment. There are other sideline processes not described herein which are used to recover even more of the sugar from the beet. Liquid formaldehyde is stored in a 5,000-gallon tank located on the first floor of the factory underneath the diffuser. It is used inside the diffuser as a bactericide. The quantities of formaldehyde used daily vary with the lactic acid and nitrite levels found in the diffuser and usually range from 0-180 gallons. Formaldehyde is contained in an enclosed system. The controls for the holding tank are located away from the tank in the northeast part of the plant adjacent to the diffuser on the second floor of the slicer deck.

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	The assessment or report uses high quality data from frequently used source (NIOSH HHE).
Domain 2: Representativeness		Metric 2: Geographic Scope	High	The data are from the United States
		Metric 3: Applicability	Uninformative	The report is for an occupational scenario, however, the condition of use is outside of the scope of the risk evaluation due to non-TSCA uses. Formaldehyde is being used as a bactericide, which may be cover under FIFRA and/or under FDA due to use during food manufacturing.
		Metric 4: Temporal Representativeness	Low	The report is more than 20 years old
		Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources (IH site visit)
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	N/A	Not applicable as site-specific information

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Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-283-1224. Southern Minnesota Beet Sugar Cooperative, Renville, Minnesota. 40:1-32.
HERO ID:	1516473
Conditions of Use:	Non-TSCA

		EVALUATION	
Domain	Metric	Rating	Comments
Overall Quality Determination		Uninformative	

Study Citation:	NIOSH, (1982). Health hazard evaluation, report: HETA-81-033-1208. Placer County Distributors, Tahoe City, California. NIOSH:81-033.			
HERO ID:	1599520			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Life cycle description:	produces garments with designs, numbers, or lettering			
Process description:	Process of silk screening garments has been described here The silk screening operation begins by applying single or multiple colored inks (either water soluble or non-water soluble) to the garment. If the garment requires only one color this in turn means only one screening application. Each additional color requires an additional screening per color. After the garment is screened it is then placed on a conveyor belt which slowly moves it into an ultraviolet heating chamber (temperature equals about 200 degrees Fahrenheit). The garment moves through the heating chamber allowing the inks to catalyze and the garment continues on the conveyor until it is received at the end. It is then placed on a table where the silk screen material completes its drying.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources (IH visit)
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	n/a
Overall Quality Determination			High	

Study Citation:	NIOSH, (2007). NIOSH pocket guide to chemical hazards.		
HERO ID:	192177		
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product		
EXTRACTION			
Parameter	Data		
Chemical concentration:	Formalin is an aqueous solution that is 37% formaldehyde by weight; inhibited solutions usually contain 6-12% methyl alcohol.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Source is NIOSH, frequently used source, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States
	Metric 3: Applicability	High	The report is for an occupational scenario(formalin production) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report is more than 10 years old but not more than 20 years old.
	Metric 5: Sample Size	Low	characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium	

Study Citation:	NIOSH, (1976). Criteria for a recommended standard: Occupational exposure to formaldehyde.			
HERO ID:	192344			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Supply capacity (1972) 7,530 million pounds*Demand (1972) 5,000 million pounds*Demand (1976 - estimated) 6,300 million pounds* *expressed as 37% solution			
Process description:	Pg.: 35/177: Commercial production of formaldehyde is accomplished by a variety of techniques, including controlled oxidation of low molecular weight aliphatic petroleum hydrocarbons and oxidation of methanol in the presence of a metal catalyst. Two basic techniques for the production of formaldehyde by oxidation of methanol are operation of the process in either a fuel-rich mode or a 1 fuel-lean mode. Other variations in the oxidation processes are related to differences in catalyst and the extent to which off-gases are recirculated.			
Chemical concentration:	Pg. 36/177: Commercial preparations of formaldehyde are available in grades of methanol free, methanol stabilized (NF), or reagent. In addition to methanol or other alcohols, commercial preparations may contain formic acid. Aqueous solutions consist of 0-15% alcohol (methyl, propyl, n-butyl, or isobutyl) in water containing 30-50% dissolved formaldehyde by weight, which is introduced as a gas consisting of formaldehyde monomers.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (formaldehyde monomer manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1976 - more than 20 years old
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	NIOSH Study
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination		High		

Formaldehyde

General Engineering Assessment

HERO ID: 1976942 Table: 1 of 1

Study Citation:	NIOSH, (1986). Current intelligence bulletin: Reprints - Bulletins 31 thru 47.			
HERO ID:	1976942			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	US production 6.4 billion pounds of aqueous formaldehyde (1978). Projected consumption (1983) 7.5 billion pounds			
Process description:	Formaldehyde production: reacting methanol vapors with air over a catalyst.			
Chemical concentration:	Formalin contains from 37% to 50% formaldehyde			
Comments:	noted that a pack of cigarettes contains 40 ppm of formaldehyde by volume or 0.38 mg per pack.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (domestic Manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 - prior to the PEL (1992) and more than 20 years old
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA-83-301-1478. Lion Uniform Company, Beattyville, Kentucky. 83-301-1478:1-26.		
HERO ID:	201729		
Conditions of Use:	Textile Finishing		
EXTRACTION			
Parameter	Data		
Life cycle description:	processing		
Process description:	The bulk material is received from the textile mill on bolts containing approximately 1000 yards of nomex fabric. It is stored wrapped in its shipping cover, which is either paper or plastic, depending on the supplier. Almost half of the building is devoted to storage and cutting. The fabric is cut to order, and the various pieces are stored in bins awaiting assembly by the sewers. The sewing operation is located in the other half of the building, with a small section devoted to the manufacture of other non-nomex uniforms (e.g., service station uniforms). The sewing operators are responsible for making one part of the jacket. The completed piece is then passed on to the assembly people who sew the pieces together, add linings, pockets, collars, sleeves, and buckles until a jacket has been ' completed. The completed jacket is then passed on to another area for quality control checking. Formaldehyde source is indicated from use of melamine formaldehyde resin, a polymer which provides wear and crease resistance, water repellency, increased fabric resistance, and aids in dye fixation.		
Number of sites:	1		
Chemical concentration:	Bulk fabric samples from the site were analyzed by NIOSH and found to have formaldehyde levels between 100 to 600 ppm. Samples from the supplier were found to contained 260-450 ppm via Burlington Industries Standard method and 3.2-10.0 ppm from BEA process. Repeat tests using the BEA process 3 weeks later did not detect formaldhyde, the Burlington method used 2 1/2 month later resulted in similar results as the first test. Dupont conducted their own test with a different method and obtained 0.05-0.13ppm		
Comments:	The report also reports latent formaldehyde amounts found in other NIOSH studies. Those are not included in extracted data as those data will be extracted with the original NIOSH reports.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The report uses two methods (Burlington Industries standard method of latent formalde- hyde, and an alternative method that does not include heating), these are not from fre- quently used sources, but information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the US (KY, USA)
	Metric 3: Applicability	High	The report is for an occupational scenario (incorporation into article- finishing agents in textile) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1983 which is more than 20 years old
	Metric 5: Sample Size	Medium	Distribution of fabric formaldehyde concentrations were characterized by a range, with uncertain statistics. A comparison with other studies was included to help assess how representative the data are.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	It is clear that the information provided was from the site visit, and clearly documents assessment methods.
Domain 4: Variability and Uncertainty			
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Study Citation:		NIOSH, (1984). Health hazard evaluation report: HETA-83-301-1478. Lion Uniform Company, Beattyville, Kentucky. 83-301-1478:1-26.		
HERO ID:		201729		
Conditions of Use:		Textile Finishing		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 7:		Metadata Completeness	High	The report addresses variability by testing textiles from the site, the supplier, and how it may vary over time. Uncertainty in results were discussed by comparing results to other NIOSH studies and other studies done by Dupont and other entities.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA-82-96-1259. Kaiser Aluminum and Chemical Corporation, Ravenswood, West Virginia.			
HERO ID:	NIOSH:19831983.2068882			
Conditions of Use:	Other Byproduct			
EXTRACTION				
Parameter	Data			
Process description:		The fabrication process begins in the hot roll department where ingots up to 28 inches thick and 160 inches long are run through rolling mills and converted into coiled sheets. Sheets are then converted to a lighter gauge in the cold mill area. Coiled sheets are finally leveled, trimmed, and slit to customer’s specifications in the foil and finishing areas. Descriptions are provided in the article.		
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The data are for an occupational scenario(decomposition product) not specified within the scope of the risk evaluation but may be useful for other occupational scenarios(metal products).
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A- process description
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A- Process description just for site based on site visit and process information directly from sampled site. Variability and uncertainty not applicable.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA-82-377-1376. D and F Corporation, Warren, Michigan. NIOSH:82-377.			
HERO ID:	2452947			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	The D &F Corporation produces wood models, plastic duplications, prototypes, molds, and fixtures for the automobile industry.			
Process description:	The article provides descriptions of the following processes: wood model making, plastic shop operations, and miscellaneous operations. Phenol-formaldehyde resin is used in construction of the wood models. Construction of the model initially requires the use of powered wood working equipment including table saws, routers, planers, radial arm saws, shapers, jointers, sanders, band saws, grinders, etc. These tools are-used to assemble the frame and provide the “rough” outline of the model. However, the majority of the work is accomplished through the use of hand held tools, requiring extensive concentration by the model maker so that the finished model meets the required specifications.			
Chemical concentration:	Concentration of formaldehyde is not provided but report references that a 30% phenol-formaldehyde resin is used.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Site-specific, not applicable
Overall Quality Determination			High	

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA-81-450-1378. Inland Steel Company, East Chicago, Indiana. NIOSH:81-450.
HERO ID:	2972529
Conditions of Use:	Other Byproduct

EXTRACTION	
Parameter	Data
Process description:	This facility is engaged in the iron and steel-making industry. An essential feature in the production of iron is the blast furnace where iron ore is melted (reduced) to produce pig iron. The furnace is charged from the top with iron ore, coke, and limestone; hot air is blown in from the bottom, and the carbon monoxide produced from the coke transforms the iron ore into pig iron containing carbon (the limestone acts as a flux). At a temperature of about 1600° C, the pig iron melts and collects at the bottom of the furnace and the limestone combines with impurities to form slag. The furnace is tapped regularly and the pig iron may then be poured into pigs for later use, e. g. in foundries, or into ladles where it is transferred, still molten, to the steelmaking plant. This continuous casting operation utilizes four tapholes which are located around the perimeter of the base of the blast furnace. The four tapholes and trough systems are rotated so that at least two are operational at any time. Iron and slag flow through the tapholes down the trough system to a skimmer box where the slag is separated from the iron, iron flows down one trough system where it is poured into railcars for transport to other steel-making processes. The slag flows down a separate trough to the outside of the building where it cools and is then hauled away. Relining of troughs A clay plug is placed via remote-controlled equipment into one of the four tapholes to seal the tap hole so that the trough systems can be repaired after several days of cooling. Steel coverings over the trough systems are removed by use of remote-controlled overhead cranes; employees are also required to help guide the coverings. The old refractory lining is stripped away using pneumatic chipping equipment, both handheld, and mobile, exposing the brick lining of the trough. Eighty-pound sacks of Narcarb are emptied into the trough and evenly spread over the bottom and pounded. A steel mold is then placed in the trough, sacks of Narcarb are emptied into the space between the sides of the trough, and the mold is pounded with a hand held pneumatic hammer. The steel molds are removed and the trough lining (Narcarb®) is heated and cured for 2 to 4 days. During the heating and curing process, the repairmen are assigned to work in other areas of the blast furnace, stripping and relining one of the other four troughs. After the curing time, the troughs are ready for use and are usable for a period of approximately 10 to 12 days before the relining process is again necessary.
Number of sites:	1

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	The report uses high quality data that are from frequently used sources (NIOSH HHE).
Domain 2: Representativeness		Metric 2: Geographic Scope	High	US
		Metric 3: Applicability	Low	The report is for an occupational scenario (iron and steel mill) but the source of formaldehyde is unknown and does not appear to be clearly related to the process.
		Metric 4: Temporal Representativeness	Low	1982 - more than 20 years old
		Metric 5: Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	N/A	Site-specific, not applicable

Overall Quality Determination	Medium

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-100-1140. Raybestos Friction Materials Company, Crawfordsville, Indiana. NIOSH Cincinnati:1-25.			
HERO ID:	3649297			
Conditions of Use:	Use of fuels and related products			
EXTRACTION				
Parameter	Data			
Life cycle description:	The brake block division produces pads for brake shoes.			
Process description:	The sintered metal division produces clutch facing units for use inheavy-duty applications. Clutch facings are composed primarily ofcopper with lesser quantities of other materials (iron, lead, zinc, and graphite). Lead content ranges from 2% to approximately 8% by weight. The powdered raw materials are combined in the mix area. The mixes are transferred to the wafer press area and subsequently compressed into wide, thin, disk-shaped wafers. Pairs of such wafers are sandwiched around single similarly shaped steel disks that have been stamped and/or cut and ground in an adjoining area. These wafer-disk units are sent to the sintering area where they undergo a heating process that metallurgically bonds the wafers to the metal disk. Finally, the clutch facings undergo a series of operations that include curing, grinding, drilling, slotting, and grooving.The brake block division produces pads for brake shoes. Asbestos(chrysotile) , barium, lead, zinc, graphite, and phenol - formaldehyde resin (components vary depending upon the specific formulation) are combined in the mixing area. Subsequently, the mix is transported in an open dumpster to the rotary briquetter, where individual briquettes (blocks of pad material) are formed. An individual briquette is approximately 36 inches long, 7 inches wide, and 1 inch thick. The briquettes are transferred to curing presses, where they are compressed and partially cured. Final curing of the briquettes occurs in curing furnaces. Briquettes then undergo a variety of processing operations including cutting, grinding, and countersink-drilling. The final products are individual brake blocks (pads), approximately 4 inches wide, 6 inches long, and 314 inch thick, that are ready for attachment to the metal portion of brake shoe.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses high quality data from frequently used sources (NIOSH HHE)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	more than 20 years old.
	Metric 5:	Sample Size	N/A	qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources (IH site visit)
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	site specific qualitative information
Overall Quality Determination			High	

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 82-127-1370. Hoover Company, Industrial Park, North Canton, Ohio. 82-127-1370:1-31.			
HERO ID:	3970584			
Conditions of Use:	Plastic and Rubber products			
EXTRACTION				
Parameter	Data			
Life cycle description:	The Hoover Company produces vacuum sweepers of various sizes for commercial and home use.			
Process description:	Essentially all of the component parts of the sweepers are manufactured and assembled on-site. This requires several industrial processes, including a foundry operation, injection molding, spray painting, degreasing, plating, extruding, and numerous assembly line operations. The primary operations at the IP include assembly, injection molding, plastic blending and pelletizing, painting, metal fabrication, and plastic extrusion . For injection molding, plastic vacuum sweeper parts are produced in a large open area of the building containing approximately 30 injection molders. Various types of plastics are utilized. In the area machine purges reportedly exposed the machine set-up operators to irritating odors and smoke. Three set-up operators normally work in the injection molding area .			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment uses high quality data that are from frequently used sources (NIOSH HHEs) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that may be outdated.
	Metric 5:	Sample Size	N/A	NA- Lifecycle and process descriptions only
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	NA- Information directly from site visit and interviews.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-388-1129. Santa Cruz Metropolitan Transit District, Santa Cruz, California. NIOSH:1-20.			
HERO ID:	4040607			
Conditions of Use:	Use of fuels- Exhaust			
EXTRACTION				
Parameter	Data			
Process description:	Buses are moved from the parking area to either side of the pump island to be fueled, check and service engine fluids, swept and wash on alternate evenings.			
Throughput:	Engines are shut off during servicing which takes 15-20 minutes 65 buses (54 diesel, 6 gasoline, and 5 propane) are serviced nightly			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses high quality data and/or techniques or sound methods that are from frequently used sources (NIOSH HHEs)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The data are for an occupational scenario (diesel/gas bus servicing) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	site specific information directly from site
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA-81-396-1118. Keebler Company, Cincinnati, Ohio. NIOSH:1-24.			
HERO ID:	4058405			
Conditions of Use:	Baking			
EXTRACTION				
Parameter	Data			
Process description:	Keebler Bakery is composed of two major divisions: baking andpacking. Baking consists of 3 areas; mixing, where the dough isformed; machining, where the dough is shaped into the appropriatesize; and ovening, where the product is baked. Packing consists ofseveral different areas. Those covered during the survey inculde: A-1 and #4 Redi Serve Cracker Lines. The tubs of dough spent several hours in a climate-controlled room at approximately 80°F to allow for yeast fermentation before being transferred to machinery.The dough shaping machines are automatic, requiring one machineoperator for a control panel. The machine operator is also responsible for making hourly checks on the system, i.e. gauging the thickness of the dough.There are 6 ovens in the oven area, and all are fueled by naturalgas. Oven #1 is new (only about 1 year old), and slightly different than the older ovens. Its burners are enclosed for better efficiency, and it uses the circulation of hot air around the crackers to bake them. Older ovens rely on exposing the cracker to radiant heat directly from the burner for baking. The packing section, where crackers are wrapped in various types of containers receives all freshly baked crackers from the ovens.A-1 Redi Serve Cracker Line (receives crackers from oven #1) is composed of 4 machines that automatically feed crackers two at a time into a plastic lining, then cut and heat seals them into individual 2 crackers packages. The cutting and heat sealing is done by a piece of metal called a crimper at about 3000f. Dimethylpolysiloxane oil is automatically dropped ontothe crimper at a rate of 3 drops every 5 minutes to keep theplastic from sticking to the crimper. Number 4 Redi Serve Cracker Line is very similar to A-1 except thatthe machines are much older and the dimethylpolsiloxane is applied manually to the crimper once or twice a day.			
Throughput:	A-1 Redi Serve has been in operation since the beginning of June 1981 and packages, on average, 2200 boxes each containing about 500 two-cracker packages per day.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (baking) within the scope of the risk evalua-tion.
	Metric 4:	Temporal Representativeness	Low	1981 - more than 20 years old
	Metric 5:	Sample Size	N/A	Information provided was derived from NIOSH site visit.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Information provided was derived from NIOSH site visit.
Overall Quality Determination		High		

Study Citation:	NIOSH, (1996). Initial submission: prepublication version of health hazard evaluation of a Unocal Corp urea fertilizer facility, Kenai AK, with cover letter dated 6/13/96.			
HERO ID:	5888126			
Conditions of Use:	Processing into Reactant- Fertilizer			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	The Kenai facility produces approximately 1 million tons of urea and 1 million tons of ammonia per year (11/38)			
Process description:	The Kenai facility produces urea fertilizers through ammonia intermediaries in both prill and granular forms. During the process, a urea formaldehyde concentrate (UF-85) is added to improve the handling characteristics of the urea fertilizer. The UF-85 additive reportedly reacts to form methylenediurea and a combination of urea formaldehyde polymers. (10/38)			
Throughput:	Plant #2 produces from 1250 to 1450 tons of the prill urea per day. Plant #5 typically produces from 1700 to 1800 tons of the granular urea per day. (11/38) Approximately 95% of the domestic urea fertilizer producers condition their urea with a formaldehyde-based additive (ureaforms) and virtually all solid urea producers employ some type of conditioning agent to improve product handling. (12/38)			
Number of sites:	5 plants, 2 of which produce the fertilizer containing formaldehyde. (11/38)			
Chemical concentration:	UF-85 is a liquid mixture containing 60% formaldehyde, 15% water, and 25% urea. (12/38)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Sampling/analytical methodology is an approved NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for use as an intermediate in the manufacture of fertilizers, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is addressed in sampling/analytical methodology. Variability isn't addressed.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1983). In-depth industrial hygiene survey report of the arrow shirt company Atlanta, Georgia no: 125.12 (36). 14:B2-14.			
HERO ID:	5908875			
Conditions of Use:	Commercial Use of Fabric, textile, and leather products not covered elsewhere			
EXTRACTION				
Parameter	Data			
Process description:	The Arrow Shirt Company received pre-cured finished fabric from a textile-finishing plant. The dress-shirt fabric was treated at the textile mill with crease-resistant resins and then cured before receipt by Arrow Shirt. Treated fabrics give off various levels of residual formaldehyde, depending upon the type of fabric, type of resin system, and type of manufacturing treatment the shirt requires. The fabric in use during this survey had been treated with a resin produced by Sun Chemical Company called dimethyl-dihydrodi-ethylene-urea. The Atlanta plant received pre-cut shirt parts in lot sizes of 200 dozen each from an Arrow pattern cutting plant. Each shipment of shirt parts was checked for quantity and quality and then scheduled for production. Distinct steps in the manufacture of dress shirts at the Atlanta plant include the following: (1) Collar and Cuff: A lining is fused (with heat) to the collar and cuff fabric parts. The collar and cuff are then turned right side out and pressed, and the collars are stitched to a collar band. Buttonholes and buttons are added to the cuffs and collars. (2) Yoke and Back: The yoke and back of the shirt are sewn together. (3) Fronts (Joining): The centerplate is sewn onto the shirt fronts, and the buttonholes are then sewn into the centerplate. (4) Assembly Operation: The collars are sewn to the yoke and front after joining. (5) Cuff and Sleeve: The cuffs are sewn onto the sleeves after the sleeves are added to the body of the shirt. (6) Spot Removal: Dry-cleaning agents are used to remove spots from the fabric of shirts. (7) Finishing: The completed shirts are pressed on an apparel press, buttoned, folded, and boxed or bagged for shipping.			
Throughput:	Approximately 1600 dozen shirts were scheduled for completion each day. The residence time of the fabric in the plant was usually no longer than 4 days.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses information directly from the company doing the processing, the associated information does not indicate any flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents the data sources and assessment methods.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Information is site-specific and directly from the site.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1981). Current intelligence bulletin 34: Formaldehyde: evidence of carcinogenicity.			
HERO ID:	63806			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	US produced 6.4 billion pounds of aqueous formaldehyde in 1978. Consumption exceeded 7.5 billion pounds in 1983. half used for resins.			
Life cycle description:	Half of production goes to resin production such as urea- and phenol-formaldehyde resins. These resins are then used as adhesives when making particleboard, fiberboard, and plywood. Urea-formaldehyde concentrates are used in coating, paper, and thermal insulation. It also has uses in textiles, plastics parts, medicines, and embalming. Table on pg. 2 lists all of the uses of formaldehyde			
Process description:	"usually manufactured by reacting methanol vapor and air over a catalyst (chemical initiator)."			
Chemical concentration:	"Formaldehyde is sold mainly as an aqueous solution called formalin, which is 37% to 50% formaldehyde by weight."			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The report was compiled by NIOSH, a frequently used source, and generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario, manufacture, within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1981 which is older than 20 years
	Metric 5:	Sample Size	N/A	Only quantitative data extracted are approximate production volumes from U.S. governmental sources.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its sources such as the source for production data was US International Trade Commission.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Variability and uncertainty not applicable for extracted data.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-298-944. Hospital of the University of Pennsylvania, Philadelphia, PA.			
HERO ID:	8592482			
Conditions of Use:	Processing: Plastic materials and resin manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	During the evaluation of May 8, 1981, the employees were engaged in forming plastic legs. Nylon hose is put on a previously plaster formed leg. A proper size sheet of polypropylene, polyethylene, acrylic or polyester resin is cut. The plastic is then put on a plate previously sprayed with a silicone parting agent. The sheets are then inserted into an oven with thermal rise exhaust, and heated 5-10 minutes at 300-425 F depending on the plastic and the thickness of the sheet. The sheet of plastic is then removed from the oven and manually stretched tightly over the mold. The excess plastic is then cut off.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - process description.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-084-916. Kutztown State College, Kutztown, PA.			
HERO ID:	8607314			
Conditions of Use:	Building and construction materials			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Concentrations of formaldehyde in %; (mg/g)Pink fibrous glass: 0.0097%; 0.097 mg/gBrown fibrous glass: 0.0013%; 0.013 mg/gBlack fibrous glass: 0.0021%; 0.021 mg/gBrown insulation: 0.0087%; 0.087 mg/gGreen Foam: 0.0004%; 0.004 mg/g			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for building and construction materials, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by presenting data for multiple products, but uncertainty is not addressed.	
Overall Quality Determination		High		

Formaldehyde

General Engineering Assessment

HERO ID: 8607314 Table: 2 of 2

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-084-916. Kutztown State College, Kutztown, PA.			
HERO ID:	8607314			
Conditions of Use:	Furniture and furnishings not covered elsewhere			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Panel Board in president’s office: 0.58 (mg/g)Panel Board in room 302 book case: 0.29 (mg/g)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for furniture and furnishings not covered elsewhere, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by presenting data for multiple products, but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HETA 81-211-984. USPHS Hospital, San Francisco, CA.			
HERO ID:	8609616			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Process description:	Patients are connected to the dialysis console for 3 to 5 hours depending on the patient’s diet, the condition of the artificial kidney being used and other medical factors. Once the patient is disconnected from the artificial kidney, the technician and occasionally the nurse take the artificial kidney to the wash area. The kidney is purged with water and tested to determine whether or not the kidney can be reused. If it is reusable, it is purged (15-20 seconds) and stored with a 6% formalin solution until the patient returns for their next treatment. Prior to reusing a kidney, the formalin solution is drained and two liters of heparinize saline solution are purged through the dialysate compartment for 30 minutes. A drain line is connected from the kidney to the sink drain and water is run to dilute the formalin solution.			
Chemical concentration:	6% in formalin solution.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Report is more than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	No scope to address variability and uncertainty.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HHE 80-103-827. Joel & Aronoff, Ridgefield, NJ.		
HERO ID:	8610377		
Conditions of Use:	Production of Printed Decals		
EXTRACTION			
Parameter	Data		
Process description:	A major product of this plant is printed decals which are mass-produced on large sheets by thescreen printing process as depicted in Figure I.1 Generally the operation consists of: (1)placing the sheet of material to be printed under the frame, (2) lowering the screen frame ontothe sheet, (3) placing ink on the screen and spreading it with a squeegee, and (4) lifting theframe and removing the printed sheet. The other main areas of the plant include thechopping, laminating, cutting, sewing, trimming and packaging of decals Each printer washed his own screens three or four times per day with each washing lasting 5 to 7 minutes. Screens were washed with a spray hose in a small closed room (approximately450 cubic feet)(5/18)		
Throughput:	There were normally three or four semiautomated printing presses in operation during the day (5/18)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses IH site visit and interviews to report process description.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	U.S. data
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Report clearly documents its data sources and assumptions.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Information specific to site studied.
Overall Quality Determination		High	

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HHE 80-192-828. Rock Hill Printing and Finishing Company, Rock Hill, NC.			
HERO ID:	8610851			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Process description:	The plant process begins with the unloading of loom-state fabric (gray goods) obtained from several countries. These include the United States, China, Japan, India, and Taiwan . Rolls of fabric are sewn together into a continuous length and mercerized in the greige department. Mercerizing is a continuous process in which fabric is treated under tension with hot caustic soda to makeit stronger and more receptive to dyes. Following this, residual starch is removed by enzyme digestion. The fabric is then steamed, acid dipped, neutralized, washed, and bleached with sodium hypochlorite and hydrogen peroxide in the white department. It is then dried in frames at 300 - 4000 c. In the screen print department polyester fabric is disperse-dyed a solid color and then screen-or roller-printed. The dyestuffs may contain one or more dyes, a dye carrier, and antimigration and antifoaming agents. These are weighed and mixed by an operator on an elevated mixing platform and emptied into a vat. After dyeing and printing, the fabric is pre-dried under infrared lamps and then passed into a hot house tenter frame which holds the fabric at a desired width to prevent shrinking. Selected fabrics and patterns may be subjected to an "ageing" process, which involves treatment with acetic and formic acid. After ageing, the fabric is cleaned in a soaping process, which improves the absorbency of the fibers prior to chemical finishing. In the chemical finishing process the cloth is treated with urea-formaldehyde resins, softeners and wetting agents. These give permanent press, durability, dimensional stability, spot resistance and water repellant qualities to the cloth. Following this the surface of the cloth may be finished (e.g. knapped) before being shipped to clothing manufacturers. (The fabrics used arepretreated with flame retardant when purchased.)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for textile finishing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - process description.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1981). Health hazard evaluation report: HHE 80-181-909. Ralston Purina Company, Cincinnati, OH.			
HERO ID:	8621028			
Conditions of Use:	Use of cleaning products			
EXTRACTION				
Parameter	Data			
Process description:	Friday and 2 hours on Sunday. On Friday, two operators pump concentrated EP liquid from a 55 gallon drum into a closed mixing tank where 35 gallons of EP liquid is mixed with 165 gallons of water. An overhead piping system then allows for each of the 10 extruders to be sequentially filled with approximately 20 gallons of diluted EP liquid. As each extruder is filled, an operator positions a 4-wheeled, plastic cart at the exit orifice to catch excess EP liquid. The extruder is then plugged and the process continues at the next extruder in line until all units are filled. The plastic cart which now contains a mixture of meal and EP liquid is moved to a small washroom where it is emptied into a floor drain by turning it on its side. On Sunday evening, two extruder operators spend approximately 2 hours draining the extruders in preparation for the Monday production run. This process begins by preheating the extruders with 2470F steam. Then, each extruder is unplugged and the contents are drained into a plastic cart as it is moved down the line. After all units are empty, the extruders and the floor of the extruder room are hosed down with hot water to remove residual EP Liquid and meal.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	Data are for an occupational scenario but lacks information on source of formaldehyde. Formaldehyde is reported as not being an ingredient of the cleaning product. The data may be similar/useful for use in cleaning products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - process description.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1980). Health hazard evaluation report: HHE 79-006-782. Coastal Industries, Inc., Selma, AL.			
HERO ID:	8627585			
Conditions of Use:	Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The fabric is pre-cut; treated with a glyoxal-based resin system, 1,3-dimethylol-4,5, dihydroxy-2-imidazolidinone (DMDHEU); and dried, but not cured, prior to shipment to the sewing plant. The sewing plant personnel sew the fabric into trousers, which are then shipped back to the initial plant to be postcured. The postcuring procedure permits the trousers to retain their crease as well as their ability to recover from wrinkling due to washing. (page 4 of 15)			
Chemical concentration:	Bulk samples of cloth contained an average of 96.3 micrograms of latent formaldehyde per gram of cloth sample (SD ±_14, range 86.5 -106. 1) (page 5 of 15)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for finishing agents in textiles, apparel, and leather manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability addressed by a range of concentrations of formaldehyde in cloth but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	NIOSH, (1980). Health hazard evaluation report: HHE 80-2-727. Continental Plastic Containers, Springdale, OH.			
HERO ID:	8627948			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Parisons are pushed, end-to-end, from a feed hopper through a tube to a gravity feeder where they are dropped onto vertically projecting pins which are part of a continuously moving carrier chain. The carrier chain conveys the parisons through the electrically fired conditioning oven as their temperature is raised to orientation temperature. At the oven exit the parisons are removed vertically from the carrier chain by picker fingers, transported horizontally to the molding station and with a downward vertical motion placed into the molding station. Prior to insertion of each set of parisons the molds are sprayed automatically with a dimethyl siloxane polymer used to ensure proper mold release. In the molding station a mandrel (inside metal collar) rises into the interior of the parison as a pair of thread forming dies compress the lower end of the parison against the mandrel. This action forms the completed bottle neck and anchors the parison . The picker finger rise rapidly, stretching the parison, and the mold halves close on the stretched parisons. Air is blown through the mandrel into the parison conforming the plastic to the shape of the molds. The plastic is cooled in the molds, the molds and dies open, and the bottle is ejected from the machine by a pulse of air. The bottles are conveyed from the module by a chute to a conveyor belt and over to a packing area where they are flame treated and boxed. (3/14)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for intermediates in plastic and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 82-342-1223. William Blount High School, Maryville, TN.			
HERO ID:	8630777			
Conditions of Use:	Chemical substances in construction products			
EXTRACTION				
Parameter	Data			
Process description:	Urea formaldehyde foam insulation was installed in the exterior walls as they were built and the walls were capped with a concrete filled U-block at the top. The exterior wall surfaces were sealed with a black mastic prior to putting up the external brick facing. The roof, a galvanized steel deck with two inch fiberboard insulation and a built up top surface, was installed in 1979. During the summer months of 1979 the building was completed which included painting all of the interior wall surfaces with an epoxy resin paint.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (building materials- urea foam insulation used within a school) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1982 - more than 20 years old
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative information provided
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 79-157-1212. Crane Company, Rogers, AR.			
HERO ID:	8632187			
Conditions of Use:	Medical products not covered elsewhere			
EXTRACTION				
Parameter	Data			
Process description:	Molds and cores are produced in a central area, using a resin-treated sand. The casting itself is performed in the main furnace area and the annex. A barrier wall isolates the melt furnaces and automatic floor furnaces from the remainder of the foundry. After metal pouring, the castings harden, cool, and are separated from the molds in the shakeout area. Broken molds are crushed and the sand returned to the coremaking area for re-use.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for metal products not covered elsewhere, applicable to all occupational exposure scenarios.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HHE 80-167-1078. Stephenson and Lawyer, Inc., Grand Rapids, MI.			
HERO ID:	8632189			
Conditions of Use:	Foam cutting (not a COU) but no emissions detected			
EXTRACTION				
Parameter	Data			
Process description:	Departments housed at the facility include Sawing, Press, Hot-Wire, Buffing, Lamination, Packaging, Storage and Maintenance. In these departments sheets and/or rolls of polyurethane, and polyethylene materials are cut, sized, corrugated, and bonded to form gaskets, filters, cushions, and surgical products. Of major concern at the plant were the hot-wire cutting areas. In these areas hot wires, heated many times greater than the melting temperature of the foam materials, were adapted to cut, bore, flange, and engrave foam parts.			
Number of sites:	1			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSHE HHE
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (foam hot wire cutting within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1980 - more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	information provided from NIOSH site visit
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	NIOSH, (1982). Health hazard evaluation report: HETA 81-411-1182. Corhart Refractory, Louisville, KY.			
HERO ID:	8632259			
Conditions of Use:	Adhesive in construction material manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Dry sand at 90 degrees F and binders, (phenol formaldehyde resin, methylene bisphenol diisocyanate catalyst, and a aromatic hydrocarbon solvent) are automatically fed into the mixers, and dropped into wooden forms for hardening. These forms are transferred to a rollover machine which removes the molds. Each rollover machine is operated by one employee. Workers, called "mold toppers" manually fit each mold with a top or core and apply foundry paste to seal the mold. All newly formed molds are then loaded into metal containers called "cans" which are packed with loose sand for support and to slow refractory cooling after the pour. Cans are automatically moved by crane into the furnace area where molten silica is poured into the sand mold. The furnace operator is inside a climate control booth during the pour. Immediately after the pour, cans are moved by crane to the extra "hot hole" department of the furnace area where the pour funnels are manually removed. The cans are then transferred by crane to the "annealing building" where they are cooled for 4 days to 2 weeks. After cooling, cans are taken to a shake out area where hardened refractory is removed from the can and sent through the finishing department to be prepared for shipment. (5/27)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for use as a sealant in construction material manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	Process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 82-205-1314. North Central Dialysis Centers, Chicago, IL.			
HERO ID:	8632564			
Conditions of Use:	Use of Cleaning Products (Dialysis)			
EXTRACTION				
Parameter	Data			
Process description:	Facility #1: At the time of the initial environmental survey, a machine (Lixivitron, United Medical Products) was utilized for automatic cleaning and disinfecting of the units. Use of the machine was discontinued prior to the follow-up environmental survey. A manual procedure was then utilized in which cleaning and disinfecting were carried out over a large shallow sink by a re-use technician. Following cleaning and volumetric testing, a vacuum aspirator connected to the sink faucet was used to draw a 3% formaldehyde solution into the kidney unit. The unit was then capped and placed on a cart for storage. A maintenance technician also spent time in the area. This employee was responsible for routine repairs of the dialysis units. Following each repair, a 3% formaldehyde solution was passed through the machine’s network of tubing.Facility #2: Cleaning and disinfecting of the artificial kidneys at this facility were also carried out manually over a large shallow sink. At the time of the initial environmental survey, the fluid from the aspirator was channeled directly into the drain using a long section of tubing. During the follow-up environmental survey, the tube had been removed and the fluid from the aspirator flowed into the sink before reaching the drain.Facility #3: The cleaning and disinfecting process was conducted in a manner similar to the other facilities except that a shorter and deeper sink was utilized for cleaning .			
Chemical concentration:	Artificial kidney units are cleaned and disinfected with a 3% formaldehyde solution.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - process description.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 82-223-1340. Rubbermaid, Incorporated, Wooster, OH.			
HERO ID:	8632596			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	”The Wire Line operation involves the coating, curing, finishing, and packaging of vinyl resin-coated wire products. In the extrusion area, polyethylene is formed into sheets at a die fed by twinextruders through a coextrusion block. The sheet is then passed over cooling rolls and through a thickness gauge to a vented corona discharge station, which prepares the sheet for printing. In the Plastics II area, polyethylene items are produced by injection molding. (5/36)”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for incorporation during plastic material and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A- process information	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A- process information from site interview	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 82-239-1355. Allen Bradley Company, Milwaukee, WI.			
HERO ID:	8637925			
Conditions of Use:	Chemical substances in furnishing, treatment/care products-Cleaning and furniture care products			
EXTRACTION				
Parameter	Data			
Process description:	The employees in Department 205 assemble two basic types of coils; paper core/varnish covered and plastic core/epoxy covered...The nylon core coils are also wound in the winding area and soldered in the assembly area. These coils are then transported to the molding area. The 4 inch wide wire wrapped coils are placed in a press along with preheated epoxy powder in pill form. These epoxy pills are produced in the molding area by compression of powder. Under heat and pressure the epoxy pill is molded around the coil, with local ventilation in place. These presses are regularly cleaned with a formaldehyde based cleaner.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The source is a NIOSH interview with the employees, a sound method from a frequently used source.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		High		

Study Citation:	NIOSH, (1983). Health hazard evaluation report: HETA 82-391-1303. Mitchell Plastics, Inc., Cheswick, PA.			
HERO ID:	8639198			
Conditions of Use:	Reactant-Adhesives and sealant chemicals in: Plastic and resin manufacturing; Wood product manufacturing; All other basic organic chemical manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Acetal resin, in pellet form, is mixed with reground scrap and manually added into a heated hopper (80-85 C) above a reciprocating screw injection molding machine. The heated pellets are screw fed into a heated chamber (190 to 200 C) yielding a viscous liquid. In this form the resin is injected into a water-cooled mold (30-35 C) where it conforms to the interior cavity of the mold. After a specified time, the mold opens and the molded part is removed, trimmed, and hulk packaged for subsequent shipment to the customer.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH method.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment,and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA 83-191-1423. National Zoological Park Conservation Center, Front Royal, VA.			
HERO ID:	8646306			
Conditions of Use:	Wood and engineered wood products			
EXTRACTION				
Parameter	Data			
Life cycle description:	Truss rafters were inadvertently treated with an exterior, rather than interior, chemical process to make them fire-retardant. Zoo personnel were not aware of this until construction had proceeded to the point that formaldehyde off-gassing from the rafters was no longer dispersed to the outside. Once the roof was -completed, the problem was obvious. (4/10)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for commercial use of wood products, an in-scope occupational scenario,	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:		NIOSH, (1984). Health hazard evaluation report: HETA 82-348-1442. The Dotson Company, Mankato, MN.	
HERO ID:		8646356	
Conditions of Use:		Foundries- Binder/Industrial Adhesive	
EXTRACTION			
Parameter	Data		
Process description:	Shellcore: There are two shell core work stations in the foundry. One operator operates one pneumatic shell core machine in the northeast corner of the plant. Shell cores are formed when the sand, precoated with a thermosetting resin binder (Faskure), is placed in a gas-fired core box at 550-600°F for 6-10 minutes. After the polymerized shell cores are manually removed from the machine they are placed on a nearby worktable to cool and off-gas for 2-3 minutes. Two, twenty-four inch pedestal fans, positioned about one foot above the work table, aid in dispersing any emissions from the cores into surrounding work areas. On an as needed basis, a Bink’s hand-held compressed air atomizing gun is used to disperse a solvent based parting compound on the core box to help prevent the sand from sticking to the mold pattern. Somewhat smaller shell cores are made at another shell core operation positioned in the northwest corner of the plant where one employee operates one or two shell core machines. The working conditions, production materials, and equipment used are essentially the same in both shell core manufacturing operations. Phenolic Urethane: A phenolic urethane, no-bake Isocure system is used at two work stations in the northcentral part of the foundry: U-180 machine and bench Isocure, each with one operator. The process involves three parts: part I, a liquid phenolic resin; part II, a liquid isocyanate (methylene bisphenyl isocyanate, MDI); and part III, the catalyst, an amine gas (dimethylethylamine). Parts I and II are manually added to and mixed in equal amounts along with sand in a 500 (lb) capacity muller. Sand is gravity fed to the muller from one of two storage silos. Mixed sand from the muller is transported to hoppers above the core machines and is either pneumatically forced or gravity fed into the corebox. Once in the corebox mold, the sand mixture is gassed with varying amounts of the amine catalyst for about 1-10 seconds depending upon the size of the core. The U-18C and bench Isocure® operations are quite similar with the bench Isocure processes being a little less automated. Both machines, U-180 and bench Isocure are equipped with local exhaust systems to aid in purging excess amine gas from the cores. Once every 20 to 25 cores made, a solvent-based mold release agent is dispersed into both core machine mold boxes via a hand-held can with a mouth piece so that the employee must blow into the can in order to aerosolize the release agent. The same mold release agent and method of application are used in the bench coremaking operations. Bench Coremaking: Two to three employees work at the bench coremaking processes stationed in the northwest corner of the foundry. Initially, the components of the bench sand, including varying amounts of an alkyd core oil, cereal-binder (ground corn), kerosene, iron oxide, phenolic coated sand, and water are mixed in a 400 (lb) capacity sand muller for about 20 minutes. The sand mixture is transferred via wheel barrel to one or both of the bench coremaking worktables and the one blow bench machine operation. The bench coremaker uses several hand tools such as mallets, hammers, trowels, and metal “strike-off” bars to hand pack the sand into the core pattern. Blow bench procedures are the same except that the sand mixture is pneumatically forced into the core pattern cavity. Finished cores are placed on transite boards and cured in gas-fired ovens at 420°F for nearly 4 hours on second shift. Cured cores from each coremaking department are sent to the foundry mold floor. (pdf pg. 4-6)		
Comments:	Report only monitored for formaldehyde for the shell core processes, phenolic urethane process, but not the bench coremaking (pdf pg. 6)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for use in a foundry (as part of the binder/resin).
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	N/A - process description.
Domain 3: Accessibility/ Clarity			
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General Engineering Assessment

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Study Citation:		NIOSH, (1984). Health hazard evaluation report: HETA 82-348-1442. The Dotson Company, Mankato, MN.		
HERO ID:		8646356		
Conditions of Use:		Foundries- Binder/Industrial Adhesive		
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	N/A - process description.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA-84-065-1519. Southern Oregon State College, Ashland, OR.			
HERO ID:	8647135			
Conditions of Use:	Paper products			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Eight sheets of carbonless paper contained formaldehyde in concentrations from 100 to 800 ppm. (8/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for commercial use of paper products, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1984). Health hazard evaluation report: HETA 83-066-1531. Globe Industry, Lowell, IN.			
HERO ID:	8647540			
Conditions of Use:	Surface active agents in plastic material and resin manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	In the padding process, textile scraps are combined with a phenolic resin at 300-500 degrees F to form a green phenolic pad or are combined with latex to form a gray resinated pad. Phenolic pads are molded to fit the cars’ shape in a hot press. In the asphalt process, a rolling machine forms a thin layer of asphalt which is then sandwiched between two sheets of polyethylene plastic. In the rubber process, a sheet of rubber is combined with a phenolic pad and heated to 500-550 degrees F in a curing oven. The product is sprayed with cold water before being cold molded into its final shape. (4/18)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for surface agents in plastic and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	Process description	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (2019). Evaluation of ergonomics, chemical exposures, and ventilation at four nail salons.		
HERO ID:	8683475		
Conditions of Use:	Personal Care Products		
EXTRACTION			
Parameter	Data		
Process description:	The nail salon technicians at these salons provided a variety of services:Acrylic nails: application, fill, and removal. Standard acrylic nails were created when acrylic monomer liquid was mixed with acrylic polymer powders and applied to the natural nail (with or without a nail extension). The acrylic was shaped using a small brush when still curing and shaped further using a handheld powered rotary filing tool to make the final nail shape after the acrylic had hardened. Then the nail was cleaned and painted using standard or gel polish. The dip acrylic nail manicure involved alternating layers of cyanoacrylate nail glue and finely milled methacrylate polymer powder on the natural nail with an extension. The nail was either dipped into or sprinkled with the powder. These layers were repeated several times to create a strong acrylic nail. The copolymer typically was pigmented and the nail did not need further colored polish.Manicures and pedicures: during manicures and pedicures, technicians used hand tools to trim and shape the natural nail. Products used during this service included nail polish remover, disinfectants, rubbing alcohol, lotions and moisturizers, callus remover or softener, colored nail polishes, and clear coats. Gel and shellac manicures and pedicures involved polish cured using ultraviolet light into a hard, shiny coating. This coating was generally removed by soaking in acetone.Technicians at three of the salons (B, C, and D) also provided waxing hair removal services.		
Number of sites:	4 Salons were studied.		
Chemical concentration:	Formaldehyde was found in concentrations of 0.128%(mean) in used nail polish and 0.0474%(mean) in unused nail polish.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Uninformative	Data are for nail salons with nail polishes containing formaldehyde, which is outside of the scope (Non- TSCA).
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5: Sample Size	Medium	Chemical concentration data is characterized by some statistics (mean, range), but not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	This metric is not applicable to the data being extracted
Overall Quality Determination		Uninformative	

Study Citation:	NIOSH, (2003). Niosh health hazard evaluation report- Bemis.			
HERO ID:	8684536			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The manufacturing process involves the extrusion of film, flexographic printing, and bag making. The facility operates 24 hours per day using a variety of shift schedules that generally differ between departments. Polyethylene and other ingredients are extruded together (forced under high pressure through a hot, metal die) continuously, and the resulting plastic film proceeds through an array of rollers to a cutter and onto large rollers or spools. This process produces a variety of chemicals such as alcohols, acetates, aliphatic hydrocarbons, and ozone, during the melting of the polyethylene pellets. The extrusion department operates 24 hours a day, for 7 days a week. Mat boards are hardened in mold-making machines using a heated process. Once hardened, the molds can be used to make rubber printing plates, which are then affixed to the rollers of printing presses and used to print labels onto plastic films used in packaging. A variety of solvents are used in the printing process, including, alcohols, solvent blends, and solvent-based inks. There are 18 flexographic presses, operating 24 hours a day, seven days a week. The printing department employs approximately 230 people, who are organized into four crews. Plastic films are heat-sealed on 62 automated bag machines to make plastic bags for packaging. The thermal sealing and cutting of the bags releases smoke that contain formaldehyde and acrolein, various other organic vapors and particulates. The bag machines are equipped with local exhaust ventilation. The bag department employs 170 people, who work 5 days per week on three 8-hourshifts.			
Throughput:	The bag department consisted of approximately 60bag machines that could manufacture bags at a rateof 300-500 bags a minute			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for plastic and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Assessment is generally based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	N/A	N/A - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - process description.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1976). Health hazard evaluation: Hersey Products Company, Inc.			
HERO ID:	8688008			
Conditions of Use:	Adhesive			
EXTRACTION				
Parameter	Data			
Process description:	Process description starts on PDF Pg. 4 and includes descriptions for core making, molding, melting and pouring, shakeout and sand reclamation, and fettling.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for solvents used as industrial processing aids, an in-scope occupational sce- nario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - process description.	
Overall Quality Determination		High		

Study Citation:		NIOSH, (1976). Health hazard evaluation determination: Masonite Corporation.		
HERO ID:		8688419		
Conditions of Use:		Adhesives and sealant chemicals in wood product manufacturing		
EXTRACTION				
Parameter		Data		
Process description:		Different adhesives are used in the bonding of the boards depending on the characteristics required of the finished product. The synthetic adhesives used by the suppliers to the facility are urea-formaldehyde and principally phenol-formaldehyde resin systems. The fabrication process involves a multiplicity of different types of woodworking machinery common to the industry. The process begins in the saw-sanding department where the boards are cut to serviceable sizes. This involves a multi-blade rip saw used for cutting the boards into strips of different widths which are cut into a multiplicity of segments of various lengths by cross-cut saws. Belt, drum and pneumatic sanders are employed where needed for caliper control or surface smoothness. The boards proceed to the fabrication department where they are formed in the woodworking area and/or cut in the punch press area. The boards are formed by shapers, routers, planars, and other miscellaneous woodworking machinery. The punch presses are used to obtain precision cut hardboard parts. (2-3/27)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	Data are from the U.S.
		Metric 3: Applicability	High	Data are for adhesives and sealants in wood product manufacturing, an in-scope occupational scenario.
		Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
		Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation: NIOSH, (1976). Health hazard evaluation: Rock Hill Printing and Finishing Company.	
HERO ID: 8688438	
Conditions of Use: Finishing agents in textiles, apparel, and leather manufacturing	
EXTRACTION	
Parameter	Data
Process description:	The cloth is received in the White Department from the bleach plant in a wet condition although portions of the cloth may have dried out. The cloth is first run over a roller and through a wet box to obtain fairly uniform moisture throughout the cloth. The wet cloth is then run over a series of steam heated dryer cans which predry the cloth to a moisture content of 15-18%. The cloth then travels through a series of three hot frames which are heated by natural gas to a temperature of 300-400°F. which completes the drying. For polyester and polyester blends it is necessary to heat set the fabric to fix the width of the cloth which is very critical for the printing operation which is to follow. At the offtake end the dried/heat set fabric is then wound onto a core to form a roll weighing several thousand pounds (approximately 3-4 feet in diameter). (3/32)
EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Methodology
High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
High	Data are from the U.S.
Metric 3:	Applicability
High	Data are for finishing agents in textile manufacturing, an in-scope occupational scenario.
Metric 4:	Temporal Representativeness
Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
Metric 5:	Sample Size
N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination	High

Study Citation:	NIOSH, (1976). Health hazard evaluation determination: Rycraft, Inc..			
HERO ID:	8688540			
Conditions of Use:	Likely source is combustion as formaldehyde is not a chemical included in the glaze.			
EXTRACTION				
Parameter	Data			
Process description:	RyCraft manufactures small ceramic cookie stamps. Production of the stamps includes rolling of the clay, cutting the blanks, pressing in the design, installation of a handle, firing the greenware, dipping the bisque in a glaze and firing of the glaze. This evaluation covers only the firing of the greenware and glaze in the kiln room. The unfired stamps are placed in kilns and are heated to 1940° F. After the bisque is cooled, they are removed and the glaze applied. They are then inserted in the kiln and fired to 1915° F. During the firings, the materials that are volatile at temperatures less than 1940° F are emitted from the kiln. Once in the general atmosphere of the kiln room, they are exhausted through a ceiling fan.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (ceramic manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1976 - more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination		High		

Study Citation:	NIOSH, (1976). Health hazard evaluation determination: Welch Plastics and Manufacturing Company.		
HERO ID:	8688557		
Conditions of Use:	Plastic material and resin manufacturing		
EXTRACTION			
Parameter	Data		
Process description:	The operation of concern involves the production of an automobile dashboard part in molding room #2 (dimensions of about 100 by 20 feet with a 15-foot ceiling), at Press #22. Approximately 1 ,500 to 2,000 dashboard units were produced each day (as observed during the periods of this evaluation). A total of four employees per shift, three shifts per day are involved in the immediate area of Press #22. The backside operator places a piece of wood-grained vinyl plastic sheet on a 11 vacu-form11 machine. The vacu-form heats (infra-red lamps) the vinyl plastic sheet and forms (by vacuum under the sheet) the dashboard features. This formed sheet is placed into the face of the mold with the aid of a "static electricity wand. " Zinc stearate is applied to the mold face as a release aid. An acrylonitrile-butadiene-polystyrene copolymer (ABS material) is injection molded to this vinyl sheet to give the dashboard rigidity. The ABS material which is used~ this operation is commonly a mixture of 11 virgin 11 ABS (Monsanto Lustran, and reground scrap ABS materials. These reground materials are commonly the rejected dashboard parts (containing PVC and ABS material), and other non-ABS materials. The front side operator then removes the dashboard piece and trims off unwanted portions. A 11 cut-off11 operator performs further trimming adjacent to Press #22. Another employee relieves the front and back operators during lunch and coffee breaks.		
Throughput:	1,500 to 2,000 dashboard units were produced each day.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty in throughput are not addressed.
Overall Quality Determination	Medium		

Study Citation:	NIOSH, (1974). Health hazard evaluation determination: Osborne Photographic Laboratories, Inc..			
HERO ID:	8688937			
Conditions of Use:	Photographic Supplies			
EXTRACTION				
Parameter	Data			
Process description:	Osborne Photographic Laboratories, Inc. processes and develops color, black and white films, and prints. With the exception of the hand printing operation most of the developing and printing operations are automatic. The chemical mix facility located in a loft and the hand printing process were the operations evaluated. Twenty-five gallon stock photographic solutions (commonly referred to as a "fix " an "stop-fix" solutions) are prepared in the loft on an as needed basis, usually once a week. The stop-fix solution container is partly filled with water; part A, a dry chemical, is added and mixed with an electric driven stirrer-agitator until the chemical is dissolved. One gallon of acetic acid is then added and mixed. The procedure for preparing "fix" solution is identical to "stop-fix" solution except that Part A is a different dry chemical and 1 quart of formaldehyde is substituted for the gallon of acetic acid. During the addition of acetic acid or formaldehyde the worker holds the gallon or quart container as it is poured into the partly filled stock solution containers. The dilution proportions of the work solutions are 20:1 and 30:1 for the "fix" and "stop-fix" solutions respectively. Three employees are assigned the responsibility of preparing batch stock solutions in addition to other duties. The time consumed in preparing a batch of solution varies from 10-15 minutes. While preparing the stock solution the worker usually remains in the loft until the stock solution is properly prepared. It is not necessary that he remain atop the containers while the solution is being mixed. Space is available where the employee can position himself away from the container if necessary. It is only during addition of chemicals that the worker is atop the container to which the chemicals are added. A total of 5 stock solution containers are located in the loft. Two employees are engaged in black and white hand printing process in the dark room. Stop and stop-fix solutions used in the hand printing process are dilute stock solutions. Rubber gloves are available to the employees working in the black and white handprint.			
Chemical concentration:	The water/formaldehyde dilution ratios for the "fix" and "stop-fix" solutions are 20:1 and 30:1 respectively.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for photographic supplies, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	Low	Chemical concentrations are given in ratios.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1973). Health hazard evaluation: Gates Rubber Company.			
HERO ID:	8689109			
Conditions of Use:	Rubber product manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The braided hose department employing approximately 70 peopleoccupies three floors of a brick building with wooden floors. Identical solutions are used on each floor, with frequent changes in the formulations. The process consists of applying a braided polyester thread reinforcement to various types of unvulcanized rubber hose. Braiding machines weave the thread around the hose and most of the work force are engaged in operating these machines. The threads are passed through dip tanks containing the previously-mentioned chemicals prior to winding on spools and utilization by the braider. The composition of these dips is varied depending upon the characteristics desired in the finished hose.Approximately 2,200 different types of hose are produced and usually in relatively small lots. This makes the task of identifying the exact composition of an individual dip very difficult, since hose lots are identified by serial number; and these are seldom remembered by employees.Exposure to the employees would result from vaporization of chemicals coming from the fibers that have been pre-treated. The chemical containers, where the fibers pass through and are coated with the numerous formulations, are closed and are located on the floor. Any exposure coming from the tanks or from the treated fibers would have been collected on the breathing zone samples of the workers involved, since these workers have to replenish thesupply of-solutions in the chemical containers.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for rubber product manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - process description.	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1973). Health hazard evaluation: Western Foundry Company.			
HERO ID:	8689187			
Conditions of Use:	Solvents used as industrial processing aids			
EXTRACTION				
Parameter	Data			
Process description:		The substances involved in the process are a mixture of paraformaldehyde and furfuryl alcohol, a mixture of phosphoric and sulfuric acids and sand. These materials are allmechanically mixed together as needed and the final mixture is fed into the pattern and the core made. It takes about 10 to 15 minutes to make a large core and about 45 minutes for it to cure.The materials are used at room temperature except in the cold weather when the sand is heated. Since the sand is not uniformly heated, some portions become too warm and when mixed with the other substances, more vapors are released. (page 2 of 4)		
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	From U.S.	
	Metric 3: Applicability	High	Data are for solvents used as industrial processing aids, which is an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Over 20 years old	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	NIOSH, (1973). Health hazard evaluation: Robin Products Company.			
HERO ID:	8689205			
Conditions of Use:	Plastic and resin manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	In the plastic production area of the plant a plastic resin is received as pellets in bags or drums, the appropriate resin is injected into a mold with the waste being ground up for reuse, the molded parts are audited, and the finished parts are packaged for shipment to the customer. (8/23)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:		NIOSH, (1972). Health hazard evaluation: May Foundry.			
HERO ID:		8689271			
Conditions of Use:		Plastic and resin manufacturing			
EXTRACTION					
Parameter		Data			
Life cycle description:		Base formaldehyde resin is manufactured and then subsequently used in the production of no-bake resin cores and molds.			
Process description:		One half pounds of catalyst were mixed in an automaticscrew mixer just prior to being poured into wood moldingforms. The base resin contained furan resins, furfuryl alcohol,and some urea formaldehyde. The catalyst contained toluenesulfonic acid, isopropy1 alcohol, and water. The sand hardenedin less than five minutes. The finished core was sprayed with amixture of graphite and isopropyl alcohol and ignited to burn offthe alcohol .			
EVALUATION					
Domain		Metric		Rating	Comments
Domain 1: Reliability		Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness		Metric 2:	Geographic Scope	High	Data are from the U.S.
		Metric 3:	Applicability	High	Data are for plastic and resin manufacturing, an in-scope occupational scenario.
		Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
		Metric 5:	Sample Size	N/A	N/A - process description.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	N/A	N/A - process description.
Overall Quality Determination				High	

Study Citation:	NIOSH, (1989). HETA-1989-0030-2198: Delco Remy, Olathe, Kansas.			
HERO ID:	8724592			
Conditions of Use:	Fuels and related products			
EXTRACTION				
Parameter	Data			
Process description:	In the Paste Department of the lead acid batteries (primarily for automobiles) manufacturing, a series of manufacturing lines place lead paste on the battery plates. The plate molding and pasting process is virtually automatic except at the end of the process line where employees inspect, remove, and stack the plates on pallets to be transported to other areas of the plant. Most of the complaints in the department were reported to come from the employees performing the inspection jobs. (3/16)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for commercial use of fuels and related products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation: NIOSH, (1990). HETA-1990-0047-2237: Jags Beauty Salon, Norman, Oklahoma.
HERO ID: 8724597
Conditions of Use: Personal care products

EXTRACTION

Parameter	Data
Process description:	Jags Beauty Salon is a hair styling and hair cutting salon located in a detached single story brick building. The present business owner leases the building. The building layout includes a waiting area at the front of the building, three hair styling rooms, a restroom, and a dispensary. Two of the three hair styling rooms were being utilized at the time of the NIOSH survey. All hair styling products are stored in the dispensary and most hair care products are mixed in the dispensary. At the time of the NIOSH survey the salon employed one full-time and one part-time cosmetologist, and was open for business from 9:00 a.m. to 9:00 p.m.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Uninformative	Data are for hair care products, an out of scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5: Sample Size	N/A	N/A - process description.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - process description.

Overall Quality Determination **Uninformative**

Study Citation:	NIOSH, (1990). In-depth survey report: Evaluation of a ventilation system to control formaldehyde exposures during embalming at Cincinnati College of Mortuary Science, Cincinnati, Ohio.			
HERO ID:	8727994			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Process description:	The embalming table is of porcelain on steel construction, with the top of the table having a slight slope. The body is placed on the table so that the head is higher than the feet. A drain is located at the foot of the table A short length of rubber hose leads from the drain to a urinal located below the table Blood and embalming fluid flow down the table, through the drain, and into the urinal. The table can be rotated and the height and slope also can be adjusted.Located near the foot of the table is a hot and cold water supply, an aspirator, and a pump for injecting the embalming solution.			
Number of sites:	20,000			
Chemical concentration:	A disinfectant mixture used for embalming contains 2% formaldehyde along with phenol, ethanol, and glycerol.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - process description, chemical concentration.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - process description, chemical concentration.
Overall Quality Determination			High	

Study Citation:	NIOSH, (1984). In-depth survey report: Control technology for formaldehyde emissions at Dixie Furniture Plant, Lexington, North Carolina.			
HERO ID:	8728028			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Produces veneers and furniture			
Process description:	Veneered panel consist of a core with a face and a back veneer glued to each side (additional pairs of plies may be added). Hot-press process- heat metal plates which apply the pressure and heat the glue. RF-procees- uses radio-frequency radiation to generate heat, the hydraulic press only applies pressure. Cold-press processes apply pressure while the boards are maintained between 60 deg and 100 deg F, this require much longer cure times. (5/22)			
Throughput:	14,000 ft2 per day for hot-press production, average daily glue-line square footage was approximately 48,000 ft2; 10% of this was produced on the RF press, less than 20% of panels are produced via cold-press (5/22)			
Number of sites:	Studied 1 site			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesive and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (averages) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	NIOSH, (1983). Preliminary survey report: Control technology for formaldehyde emissions at Drexel Heritage Plant 60, Morganton, North Carolina.			
HERO ID:	8728030			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The veneers are received as thin strips bundled together. The strips are pressed, trimmed, and joined into sheets, which are cut to the proper size. The panels are prepared for pressing by passing them through a glue-spreader and stacking layers on top of each other repeatedly. The panels are placed on a conveyor belt, and heat and pressure are applied for 2-3 minutes. After the pressed panels have been inspected, they are stacked and moved to the loading dock. (6/10)			
Throughput:	The normal production level averages between 20,000 and 30,000 square feet of panels per day. (4/10)			
Chemical concentration:	Glue contains almost 90% urea formaldehyde resin. (7/10)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesive and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Information is site-specific process description directly from site interview.
Overall Quality Determination			Medium	

Study Citation:	NIOSH, (1982). Preliminary survey report: Control technology for formaldehyde emissions at Hoosier Panel, New Albany, Indiana.		
HERO ID:	8728035		
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing		
EXTRACTION			
Parameter	Data		
Life cycle description:	Formaldehyde is used in urea-formaldehyde adhesives for veneered panels and then emitted during the hot-pressing procedures.		
Process description:	The simplest veneered panel consists of three plies, a face and a back veneer glued to each side of a core. Additional plies may be added to make a panel which is stronger and more stable dimensionally. An established way to achieve a high rate of production is to reduce the glue-curing time by heating the glue while pressure is being applied to the panels. One way to do this is to heat the metal plates which apply the pressure, generally referred to as a "hot-press" process. Another way is to generate heat in the glue-line with radio-frequency (R/F) radiation in much the same way that food is cooked in a microwave oven. "Cold-press" processes, those for which pressure is applied while the boards—and glue—are maintained between 60 and 100°F, require much longer periods of time for the glue to cure. For most applications, the glue which currently provides the best performance for the least cost is a urea-formaldehyde (U/F) resin adhesive. The core may be a sheet of veneer, particleboard ("chip-core") or fiberboard, or a piece of edge-glued solid-wood "lumber-core". Almost all particleboard and fiberboard are made with formaldehyde resin binders, and a formaldehyde resin glue may be used to assemble lumber-core. To improve the appearance of a panel, the core may be "banded" with solid wood edges prior to veneering. Here again, the adhesive may contain formaldehyde. A variety of hardwoods and softwoods, including oak, walnut, poplar, and pine, are used for veneer stock. Some plastic laminates are being used in certain products; usually these panels are cold-pressed. The veneers are received in flitch form, thin strips bundled together as they were cut from the log. The veneer flitches are pressed, trimmed, and joined into sheets, which are then cut to the proper size for the panel being produced. The large panels of particleboard and fiberboard are cut into pieces of the appropriate nominal size. Hoosier Panel makes its own lumber-core, using its facilities for kiln-drying green lumber, surfacing the rough lumber, cutting the boards into thin strips, and edge-gluing these together into a continuous length which is then cut into pieces of the necessary size for core stock. The cores are then banded, if necessary, and trimmed to the desired size. Hot-press veneering is accomplished on one of three steam-heated platen presses, operated at around 250°F. There are two ten-opening presses, one five-opening press, and two glue spreaders located in the glue room. The decision of how many presses and spreaders to run is primarily determined by workload. Four workers are required to operate a press: two loaders and two unloaders. The procedures are intensively manual. As is typical for this type of press, processing the boards through the press is facilitated by sandwiching the boards to be pressed between metal caul plates.		
Throughput:	The normal production level averages between 20,000 and 30,000 square feet of panels per day.		
Chemical concentration:	Perkins L-100 is a high solids (63-65 percent) urea resin with no more than 3 percent free formaldehyde.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for adhesives and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Continued on next page ...			

Formaldehyde

General Engineering Assessment

HERO ID: 8728035 Table: 1 of 1

...continued from previous page

Study Citation:	NIOSH, (1982). Preliminary survey report: Control technology for formaldehyde emissions at Hoosier Panel, New Albany, Indiana.		
HERO ID:	8728035		
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing		
Domain	Metric	EVALUATION Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium	

Study Citation:	NIOSH, (1974). Survey of Burlington Industries, Inc., Burlington House Finishing Plant, Form Fabrics Plant, Durham Domestics Plant, Brookneal Finishing Plant.			
HERO ID:	8728041			
Conditions of Use:	Finishing agents in textiles, apparel, and leather manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	During the finishing process, resins containing formaldehyde are combined with catalysts and cured in ovens at high temperatures to form the permanent press treatment of fabrics. Several varieties of resins and catalysts are used in the textiles industry. Their application depends to a large extent on the effects desired in the finished product. (11/26, in depth description from 10-13)The textiles industry uses formaldehyde resins and ionic chloride containing catalysts in permanent press treatment of fabrics. Sampling was deemed necessary at Burlington Industries finishing plants because they were using resins of high free formaldehyde content (carbamates) together with magnesium chloride catalysts. The combination was thought to enhance the formation of BCME as opposed to plants which use low free formaldehyde resins and zinc nitrate catalysts (or some other catalyst of low chlorides content). (5/26)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for finishing agents in textile manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Niu, M., Wu, Z., Lin, X., Liu, Z., Xie, Y., Bhuiyan, I.U., Wang, X. (2018). Manufacturing and properties of ultra-low density fiberboards with an unsaturated polyester resin by a dry process. Holz als Roh- und Werkstoff 76(3):853-859.				
HERO ID:	5957490				
Conditions of Use:	Manufacturing fiberboards				
EXTRACTION					
Parameter	Data				
Process description:	For the manufacturing of ultra-low density fiberboards (ULDFs), fibers of 12% moisture content based on dry weight were weighted and put into a blender whose top had a small hole. To treat the surface of the fibers, unsaturated polyester resin (UPR), toluene di-isocyanate (TDI) and methyl ethyl ketone peroxide (MEKP) were sprayed in sequence into the blender by using a spray gun. UPR and TDI consumption was 10–14 and 0.5–1.5% of oven-dried fiber weight, respectively. The amount of crosslinking initiator MEKP was 3% of that of UPR in weight. After spraying, powdered paraffin, equal to 0.8% of oven-dry fibers weight, was added to enhance waterproofness of the fibers. For each sample of ULDFs, treated fibers were weighted to correspond to a target density and transferred into mats. The mats then underwent a prepress stage, followed by hot-pressing to form the boards of 370 × 370 × 10 mm3. During hot-pressing, the temperature of the press plates was set to 200 deg C, and the applied load adjusted to result in a pressure on the mat of 500 Pa. The boards obtained were stacked together for 48 h to let them fully cure and be conditioned to equilibrium moisture content in the test-lab. Afterwards, the boards were trimmed into uniform size, as a final preparation before testing mechanical and physical properties.				
EVALUATION					
Domain	Metric	Rating		Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country	
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation	
	Metric 4:	Temporal Representativeness	High	report is no more than 10 years old	
	Metric 5:	Sample Size	N/A	Description of processes data	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	report documents its data	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Description of processes data	
Overall Quality Determination			High		

Study Citation:	NRC, (1981). Formaldehyde and other aldehydes. :1-340.			
HERO ID:	192157			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Process description:	80% produced by catalytic oxidation of ethylene in aqueous solution. Two quite different processes are used. In one, a mixture of methanol and oxygen is passed over a silver catalyst. In the other process, a mixture of methanol and air is passed over a catalyst consisting of molybdenum and iron oxides.			
Throughput:	'9 billion lbs/yr of the 37-50% aqueous solution or 3.3 billion lbs on an anhydrous basis is prepared (in 1978); 65% of the formaldehyde produces is used in the same plant in which it is produced (pg 33 of 384). 50% - production of urea-formaldehyde and phenol-formaldehyde resins. 20-25% - other resins or high polymers (e.g., polyacetals, melamine resins, alkyd resins) also used to produce hexamethylenetetramine, pyridine			
Number of sites:	16 companies.			
Comments:	Plant capacities vary widely from about 14 to 600 million lb/yr. Three companies (Celanese, Borden and DuPont) have over 50% of our national capacity. Most formaldehyde is stored and transported as aquous solutions containing 37-50% formaldehyde and 1-15% methanol (page 33 of 384). Costs fir transportation tend to be high because water and methanol also are needed to be transported. Several large plants are near lumber plants in the South and the far West.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for domestic manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Published in 1981. The completed exposure or risk assessment is more than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	NRDC, (2020). Comments of the Natural Resources Defense Council on EPA’s draft scope of the risk evaluation for formaldehyde.			
HERO ID:	10370217			
Conditions of Use:	All conditions of use			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Union County, Arkansas [PDF Pg. 40]Maximum storage capacity of formaldehyde of any facility in the county: 10,000,000 - 49,999,999 lbsShelby County, Tennessee [PDF Pg. 42]Maximum storage capacity of formaldehyde of any facility in the county: 10,000,000 - 49,999,999 lbsHarris County, Texas [PDF Pg. 44]Maximum storage capacity of formaldehyde of any facility in the county: 100,000,000 - 499,999,999 lbs			
Number of sites:	Union County, Arkansas [PDF Pg. 40]2 facilities reporting to TRI between 2000-2018Shelby County, Tennessee [PDF Pg. 42]5 facilities reporting to TRI between 2000-2018Harris County, Texas [PDF Pg. 44]39 facilities reporting to TRI between 2000-2018			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for all in-scope occupational scenarios.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by discussion of sites at in multiple states but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	NZ DEPT OF HEALTH, (1981). Review of occupational health problems associated with formaldehyde exposure (26).			
HERO ID:	5908861			
Conditions of Use:	Particleboard manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Wood chips were coated with formaldehyde-containing resin, piled onto a flat metal sheet, moved under a roller to compress the chips, pressed and heated to form boards. The boards were cooled, trimmed, and stacked.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	N/A	Information is qualitative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.	
Overall Quality Determination		Medium		

Study Citation:		NZ DEPT OF HEALTH, (1981). Review of occupational health problems associated with formaldehyde exposure (26).		
HERO ID:		5908861		
Conditions of Use:		Furniture manufacturing - veneer bonding		
EXTRACTION				
Parameter		Data		
Process description:		Sheets of particleboard were coated on both sides with urea formaldehyde, phenol formaldehyde, or melamine formaldehyde glue in a gluing machine. The boards are laid on a sheet of veneer, another sheet of veneer placed on top, and then loaded into a heated press. The presses have a capacity of 6 boards and operated on a 6-12 minute cycle.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Information is qualitative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			Medium	

Study Citation:		NZ DEPT OF HEALTH, (1981). Review of occupational health problems associated with formaldehyde exposure (26).		
HERO ID:		5908861		
Conditions of Use:		Pathology laboratory		
EXTRACTION				
Parameter		Data		
Process description:		Specimens preserved in formalin were examined by a pathologist. Some specimens were mounted for microscopic examination or preserved for permanent display in perspex boxes.		
Chemical concentration:		37-50% formaldehyde in formalin		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			Medium	

Study Citation:	NZ DEPT OF HEALTH, (1981). Review of occupational health problems associated with formaldehyde exposure (26).			
HERO ID:	5908861			
Conditions of Use:	Joinery - particleboard cutting			
EXTRACTION				
Parameter	Data			
Process description:	Particleboard is cut on a circular saw for some hours at a time. Formaldehyde in the resin bonding on the particleboard is released in dust particles.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	N/A	Information is qualitative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.	
Overall Quality Determination		Medium		

Formaldehyde

General Engineering Assessment

HERO ID: 5908861 Table: 5 of 6

Study Citation: NZ DEPT OF HEALTH, (1981). Review of occupational health problems associated with formaldehyde exposure (26).	
HERO ID: 5908861	
Conditions of Use: Formulation chemist	
EXTRACTION	
Parameter	Data
Process description:	A commercial product in liquid form consisting of 10% formaldehyde is mixed in a large tank. 37% formaldehyde is added to produce the final solution which was then packed into containers by semi-automated machinery.
Chemical concentration:	10%, 37%
EVALUATION	
Domain	Metric
Domain 1: Reliability	Rating
Metric 1:	Methodology
	Medium
	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
	Medium
	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
Metric 3:	Applicability
	High
Metric 4:	Temporal Representativeness
	Low
	The report is for an occupational scenario within the scope of the risk evaluation. The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
Metric 5:	Sample Size
	Low
	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	Medium
	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	High
	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination	
Medium	

Study Citation:		NZ DEPT OF HEALTH, (1981). Review of occupational health problems associated with formaldehyde exposure (26).		
HERO ID:		5908861		
Conditions of Use:		Mortuaries		
EXTRACTION				
Parameter		Data		
Process description:		A formaldehyde solution is injected into the blood vessels of cadavers to preserve them temporarily. The viscera may be treated with a similar solution for the same reason.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Information is qualitative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			Medium	

Study Citation:	OECD, (2015). Emission scenario document on use of adhesives.			
HERO ID:	3833136			
Conditions of Use:	Use of Adhesives			
EXTRACTION				
Parameter	Data			
Process description:	Adhesives are formulated by mixing together volatile and non-volatile chemical components, such as binders, plasticizers, and solvents in sealed, unsealed, or heated processes. The specific formulation process, which is outside the scope of this ESD, depends on the type of adhesive being produced. This ESD assumes that the formulation step occurs at a separate site from the application step. Additional information on the formulation of adhesives, including methodologies to estimate environmental releases and occupational exposures, can be found in the Emission Scenario Document on Adhesive Formulation (OECD, 2009).The main components of adhesive products typically include elastomers or adhesive polymers, tackifiers, fillers, and solvents; however, other components may include plasticizers, stabilizers, viscosity control agents, preservatives, surfactants, and antioxidants.The reference includes a comprehensive discussion of adhesive applications, but some of this discussion may not be relevant as the only adhesive of interest is Phenol-Formaldehyde resins, which may require specific application methods as it is a reactive using polycondensation.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	OECD report based on EPA study and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The report is from the United States
	Metric 3:	Applicability	Medium	The report is for an occupational scenario (use of adhesives) within the scope of the risk evaluation, but information is general for the use scenario and not necessarily specific to formaldehyde.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old (2015).
	Metric 5:	Sample Size	N/A	No sample data were extracted.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	This report aggregates all of the information such that it is not possible to differentiate what processes and application techniques apply to Formaldehyde.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	OECD, (2002). SIDS Initial Assessment Report: Formaldehyde (CAS no: 50-00-0).		
HERO ID:	5348397		
Conditions of Use:	Production and processing		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	The global production of formaldehyde in 1999 is estimated to be 5 – 6 million (metric) tons (Asia: 1–1.5 million tons, North America: 1-1.5 million tons, Western Europe: 2-2.5 million tons).Page 9 of 395		
Life cycle description:	Formaldehyde is mainly used as an intermediate in the chemical industry for the production of condensed resins for the wood, paper and textile processing industries (approx. 40% urea-formaldehyde resins, 10% phenol-formaldehyde resins, 10% polyacetal resins and 5% melamin-formaldehyde resins). Formaldehyde is also used in the synthesis of methylene dianiline (MDA), diphenylmethane diisocyanate (MDI), hexamethylenetetraamine (HTMA), trimethylol propane and neopentylglycol (in total approx. 25%), pentaerythritol (5%) andacetylenic agents (5%) (BASF-SRI Consulting, Jan. 2000).		
Chemical concentration:	The sales product in aqueous solution contains in general 35 – 55 % formaldehyde. The 49 - 49.3 % sales solution of BASF product of formaldehyde contains the following impurities: Methanol: 0.5 – 2 % w/w, Formic acid: about 0.3 % w/w, Iron: < 0.0001 - % w/w (page 7)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Some data is from the US but the the study was Sponsored by Germany.
	Metric 3: Applicability	High	The report is for occupational scenarios within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.
	Metric 5: Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium	

Study Citation:	OECD, (2009). Emission scenario documents on pulp, paper and board industry.			
HERO ID:	6558581			
Conditions of Use:	production/preparation of paper			
EXTRACTION				
Parameter	Data			
Process description:	While there is considerable variation in the paper products made and the processes used, most paper making processes can be grouped into the following categories: Stock preparation, Paper machine, Sizing (optional), Coating (optional), Dyeing of paper (optional)			
Chemical concentration:	Table 3.2 shows chemical types used and amounts e.g., In the wet end operation a resin, like melamine-formaldehyde, is used at a concentration o 0.1 to 20 kg/tonne.			
Comments:	Table A1.7 Wet strength additives Chemical Usage...Melamine formaldehyde resin: 8 - 22 kg per tonne of product. Table A1.9 Coating chemicals...Melamine-formaldehyde resin: 0.45 kg per tonne of product.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Sampling/analytical methodology is not an approved OSHA/NIOSH method but is an acceptable methodology.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Europe (and the UK), all OECD countries.	
	Metric 3: Applicability	High	Data are for paper production/preparation, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Monitoring data were collected after the most recent PEL and greater than 10 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Sample type provided but no other metadata.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	OECD, (2018). Economic valuation in formaldehyde regulation.				
HERO ID:	7681892				
Conditions of Use:	All conditions of use				
EXTRACTION					
Parameter	Data				
Chemical concentration:	Concentrations of formaldehyde can range from 40% in embalming and film processing activities, to less than 0.2% in most cosmetics and consumer products.				
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country	
	Metric 3:	Applicability	High	Data are for all conditions of use.	
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability addressed by a range of formaldehyde concentrations in products.	
Overall Quality Determination			High		

Study Citation:	Offermann, F.J. (2017). Formaldehyde emissions from laminate flooring. ASHRAE Journal 59(3):102-105.			
HERO ID:	5943040			
Conditions of Use:	Use of Floor coverings			
EXTRACTION				
Parameter	Data			
Process description:	”The MDF core of Lumber Liquidators’ laminate flooring is manufactured with urea-formaldehyde (UF) resins. These resins release formaldehyde from the core as free formaldehyde that exists in the MDF following manufacture, as well as formaldehyde created from hydrolysis of the UF resin by water vapor. The free formaldehyde results in initially higher emission rates following installation, while hydrolysis caused by indoor relative humidity is responsible for the long-term emission rates. The top (wear) layer of laminate flooring typically consists of a melamine resin...” (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	N/A	Process description	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Process description	
Overall Quality Determination		High		

Study Citation:	Oh, Y. S., Lee, J. K. (2004). Evaluation of Korean softwood plywood bonded with urea-formaldehyde resin adhesive. Forest Products Journal 54(2):77-80.			
HERO ID:	5945093			
Conditions of Use:	Processing: Wood Product Resin Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	”In 2000, the worldwide production/consumption of wood-based panels (such as particleboard, medium density fiberboard, oriented strandboard, and veneer board products) was 171 million m3, with plywood accounting for about 32 percent (FAQ 2002). In 2001, in North America, the quantity of construction and industrial plywood produced by 92 plywood mills was 15.4 million m3 (17.4 billion ft. 2 , 3/8 in. basis), accounting for 44 percent of the total wood composites produced in North America (Panel World 2002). During approximately the same time period, more than 1 million m3 of hardwood and decorative plywood were bonded in North America, mainly with urea-formaldehyde (UF) adhesives and principally for interior applications (Sellers 1999)” (1/4)			
Process description:	””””A UF resin was synthesized in a 4-L glass reactor to determine the best conditions to control the exothermic reaction. . . Rotary-cut Korean softwood veneers were supplied by a commercial plywood manufacturing industry in Korea. The veneer was 2.1 mm in thickness, 4 to 6 percent moisture content (MC). The veneers were checked for wood density and pH... The adhesive spread was applied with a roller coater at a rate of 171 g/m2, single glueline basis. The total assembly time, which includes the time from first adhesive application until hot-pressing, was 30 minutes. A total of nine panels were hot-pressed at 120””C for 4 minutes. The prepress and hotpress pressures were 1034 kPa (150 psi) and 1379 kPa (200 psi), respectively.”” (2/4)”			
Chemical concentration:	The UF resin used in this study was made with 16.19 moles of urea, 18.62 moles of formaldehyde, and 52.9 moles of water. It contained 0.52% free formaldehyde. (2/4)			
Comments:	Mainly process description. The production volume information relates to wood-based panels, some of which is not specific to Formaldehyde. The concentration information is just specifying the concentration of formaldehyde used to produce the resin.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Korea, an OECD country.
	Metric 3:	Applicability	High	Data are for adhesives and sealant chemicals in wood product manufacturing, am in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5:	Sample Size	N/A	Mainly process description information.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Mainly process description information. The concentration information is just specifying the concentration of formaldehyde used to produce the resin.
Overall Quality Determination			High	

Study Citation:	Oh, Y.S., Kim, J.M. (2015). Properties of oriented strandboard bonded with phenol-urea-formaldehyde resin. Journal of Tropical Forest Science 27(2):222-226.			
HERO ID:	2902884			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	In 2008, European oriented strandboard production was forecasted to grow at an annual rate of 10% between 2008 and 2012, reaching 5.8 billion m3 in 2012.			
Throughput:	resin flow rate is 120 mL/min			
Number of sites:	In 2005, there were over 60 oriented strandboard plants in operation in North America.			
Chemical concentration:	37% formaldehyde is used in phenol-formaldehyde and phenol-urea-formaldehyde resins. Free formaldehyde levels were 0.19% in PF resin and 0.01% in PUF resin.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is from Korea, an OECD country.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	No sample data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	No sample data
Overall Quality Determination			High	

Study Citation:	Ohmichi, K., Komiyama, M., Matsuno, Y., Takanashi, Y., Miyamoto, H., Kadota, T., Maekawa, M., Toyama, Y., Tatsugi, Y., Kohno, T., Ohmichi, M., Mori, C. (2006). Formaldehyde exposure in a gross anatomy laboratory–personal exposure level is higher than indoor concentration. Environmental Science and Pollution Research 13(2):120-124.			
HERO ID:	1514215			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Chemical concentration:	FA solution contains 31.1% formaldehyde			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Japan, an OECD country.	
	Metric 3: Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2006)	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Okawa, M. T., Apol, A. G. (1978). Health Hazard Evaluation Determination Report 77-56-467, Johns-Manville Products Corporation, Pittsburg, California.			
HERO ID:	8442004			
Conditions of Use:	Asphalt, paving, roofing, and coating materials manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Paper matte is fed from large rolls through a series of accumulation loops before entering the asphalt saturator. The large rolls are continuous since they are attached together via an operation called splicing. In the saturator, hot petroleum liquid asphalt which has been heated to approximately 400°F is applied to the matte as it passes through another series of loops. When it leaves the saturator, the matte has been completely saturated with asphalt. The saturated matte then passes through a baffle of liquid asphalt which has been thickened. This bath and baffle system is known as the coater. When fibrous glass matte is run on the production line, the saturator is not used, and the matte goes directly through the coater. As either type of matte leaves the coater, granules of the desired color are dropped on the top side of the matte and pressed into the still hot asphalt with a roller ("pressroll area") . Additionally, a mixture of sand and talc is placed on the backside of the matte to pre vent sticking and three thin strips of polyester film are applied. The material then passes through a water spray and another series of cooling and accumulation loops ("cooling section"). An intermittent strip of liquid asphalt is applied to the shingle at the sealamatic resin strips applicator as it leaves the cooling loops and proceeds to the final steps (cutting, stacking, wrapping, and storage). (3/19)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for incorporation into asphalt and roofing materials, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Okawa, M. T., Apol, A. G. (1978). Health Hazard Evaluation Determination Report 77-57-460, Johns-Manville Products Corporation, Vernon, California.			
HERO ID:	8442101			
Conditions of Use:	Asphalt, paving, roofing, and coating materials manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Paper matte is fed from large rolls through a series of accumulation loops before entering the asphalt saturator. The large rolls are continuous since they are attached together via an operation called "splicing." In the saturator, hot petroleum liquid asphalt which ahs been heated to approximately 400F is applied to the matte as it passes through another series of loops. When it leaves the saturator, the matte has been completely saturated with asphalt. The saturated matte then passes through a baffle of liquid asphalt which has been thickened. This bath and baffle system is known as the coater. When fibrous glass matte is run on the production line, the saturator is not used, and the matte goes directly through the coater. As either type of matte leaves the coater, granules of the desired color are dropped on the top side of the matte and pressed into the still hot asphalt with a roller. Additionally, a mixture of sand and talc is placed on the backside of the matte to prevent sticking and three thin strips of polyester film are applied. The material then passes through a water spray and another series of cooling and accumulation loops. An intermittent strip of liquid asphalt is applied to the shingle at the sealamatic resin strips applicator as it leaves the cooling loops and proceeds to the final steps (cutting, stacking, wrapping, and storage). (3/18)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for the manufacture of asphalt roofing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Olin Corp (1983). Industrial hygiene survey with attachments.			
HERO ID:	5467300			
Conditions of Use:	Unknown- Paint shop and storage area			
EXTRACTION				
Parameter	Data			
Chemical concentration:	0.025 wt% in fleece rolls (pg 12)			
Comments:	Parts of the document are redacted.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified (Methodology for measuring concentration not specified).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for occupational scenario that cannot be clearly ascertained (some information redacted)
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	This metric is not applicable to the data being extracted
Overall Quality Determination			Low	

Study Citation:	Oliva-Teles, M.T., Paiga, P., Delerue-Matos, C.M., Alvim-Ferraz, M.C. (2009). Evaluation of Formaldehyde in Foundry Waste Sands Using Liquid Chromatography. Analytical Letters 42(3):492-504.			
HERO ID:	4084759			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Process description:	Formaldehyde is one of the major components present in phenolic alkaline and furanic resins, which are the most widely used binders of the silica sand to produce the molds and cores. Sand molding is one of the most versatile metal-forming processes, providing tremendous freedom of design in terms of size, shape, and product quality. Molds and cores used in foundries for the manufacture of metal objects are formed by agglomeration of large quantities of sands with binders. The mold and core are destroyed after the production of a single metallic piece.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	data are from an OECD country other than the U.S.	
	Metric 3: Applicability	High	report is for an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 years but no more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Perkins, J.L., Kimbrough, J.D. (1985). Formaldehyde exposure in a gross anatomy laboratory. Journal of Occupational Medicine 27(11):813-814.			
HERO ID:	1986762			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Process description:	Twenty-five cadavers, prepared by injecting from 1 to 2 gal of embalming fluid containing 3.7% formaldehyde on a volume basis, were used for the course. They were placed on stainless steel tables in the laboratory, where they remained for the duration of the course. When not in use, the cadavers were wrapped in embalming fluid-soaked cloth and enclosed in plastic. Wash bottles of embalming solution also were available for use to avoid desiccation and mold growth.			
Chemical concentration:	Embalming fluid contains 3.7% formaldehyde on a volume basis			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1985)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics. (concentration)
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Pervier, J.W., Barley, R.C., Field, D.E., Friedman, B.M., Morris, R.B. (1974). Survey reports on atmospheric emissions from the Petrochemical Industry.			
HERO ID:	5441658			
Conditions of Use:	Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	In 1974, formaldehyde production reached 7.5 billion lbs/year (168/341)			
Number of sites:	54 sites in 1974. (178/341)			
Chemical concentration:	The standard solution of formaldehyde is 37% by weight. (168/341)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for the production of formaldehyde, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Data are greater than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Most critical metadata provided.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	Peters, R. W., Daniels, E. J., Wolsky, A. M. (1992). Research agenda for waste minimization. Water Science and Technology 25(3):93-100.
HERO ID:	1621894
Conditions of Use:	Disposal

EXTRACTION	
Parameter	Data
Production, import, or use volume:	Annual production data from Chemical and Engineering News 1989 but is for PV of 1988. PV of formaldehyde: 3.37 x 10 ⁶ tons.
Process description:	List of several processes provided in Table 3 for various waste minimization alternatives in the chemical industry and in the article several are described. Lower-temperature processing - Lower-pressure (and therefore lower temperature) operation of distillations and other conventional separations can reduce losses from polymerization and degradation of monomers, biological products, and other heat -sensitive materials, with less inhibitors. Lower- temperature coolants on process overheads can help reduce losses of volatiles to vent systems discharging to flares. Replacing cooling water with chilled water can reduce byproducts related to reactions on surfaces in jacket- or coil-cooled reactors. Cool storage can provide the capacity to condense and recycle upset releases of volatiles that might otherwise be sent to flares. Such releases often overwhelm vent refrigeration systems without cool storage that are typically sized for normal vent flows. In-plant conversion of waste streams to clean fuels or feeds - Many organic chemical processes produce tars that are separated and sent to hazardous waste disposal or to in-plant incinerators. Some of these streams contain significant inorganic contents. Pressurized gasification can achieve complete conversion at a higher temperature than incineration with oxygen, and the syngas is cleaned in a pres ^r - surized process to obtain a clean fuel or chemical feedstock gas. No permits are required for their convertors per se, but only for their ultimate combustor, if the gas is used for fuel. Extensive pilot testing of waste gasification and leachability testing of the inorganic slag residues would be required before gasification of any particular type of residue could be commercialized. Avoidance of extraneous water streams introduced to chemical processes - In many chemical and refinery processes, steam jet evacuators or ejectors are used to create process vacuum conditions. Direct steam stripping also is used to make separations of organics in many processes. These operations result in contaminated waste streams that are typically treated in bioponds or concentrated and then incinerated. It may be better to reduce losses by eliminating this water, which is used solely to perform a physical function (such as to create a vacuum, improve separation coefficients in distillation, etc.). A mechanical vacuum system offers an alternative to steam jets, which do not create volumes of contaminated water as a by-product. Heat pumps can be used to recycle the contaminated condensates from the overheads of steam strippers. Selective separation by membranes - Membranes offer an attractive alternative to distillation as a means of separating products at much lower energy costs and superior means of product recovery. Current polymeric membranes suffer from attack by solvents and are limited by temperature to a narrow operating range. The membranes are subject to clogging and cannot be readily cledned. Ceramic and metallic membranes offer an attractive alternative because they avoid these problems. There are virtually no developed applications for the severe temperature and corrosive conditions encountered in the petrochemical industry. Novel selective energy sources - Most processes proceed by application of substantial amounts of heat, a nonselective energy source. The use of ultrasound techniques enables the reactions to proceed at lower temperatures. Laser systems enable reactions to proceed at lower temperatures because selection of the proper frequency enables activation of the specific chemical bond of interest. Magnetic fields and the use of microwaves have found applicability in biochem· ical systems. Selective reactions with less energy consumption are possible by using alternative energy sources that enhance both the selectivity and conversion at ambient temperatures. Figure 1 provides principal flows and transformations of material in the petrochemical industry - Natural gas -> methanol -> formaldehyde -> adhesives, polyurethanes.
Throughput:	

EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Unclear if source is peer reviewed but is a technical report that appears to contain high quality data.
	Metric 2:	Geographic Scope	High	Data is for US.
Domain 2: Representativeness	Metric 3:	Applicability	High	Data is applicable to production volume of formaldehyde and various methods to reduce waste.
	Metric 4:	Temporal Representativeness	Low	Data is over 20 years old (1988)

Continued on next page ...

Formaldehyde

General Engineering Assessment

HERO ID: 1621894 Table: 1 of 1

...continued from previous page

Study Citation:	Peters, R. W., Daniels, E. J., Wolsky, A. M. (1992). Research agenda for waste minimization. Water Science and Technology 25(3):93-100.			
HERO ID:	1621894			
Conditions of Use:	Disposal			
EVALUATION				
Domain		Metric	Rating	Comments
	Metric 5:	Sample Size	N/A	Data does not consist of statistics.
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	Medium	Provides data sources and results and sources are generally described.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			Medium	

Study Citation:	Petersen, H. (1987). Formaldehyde and new concepts for its application in textile finishing. Colourage 34(12):23-32.			
HERO ID:	5946609			
Conditions of Use:	commercial use (textile finishing)			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Depending on the chemical constitution, the concentration, the molar ratio in the methylation er alkoxy methylation, and the temperature, the commercial crosslinking solutions contain between 0.1 and 1.5 % of free formaldehyde.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Petersen, H., Pai, P.S. (1981). Reagents for low-formaldehyde finishing of textiles. Textile Research Journal 51(4):282-302.		
HERO ID:	5955197		
Conditions of Use:	Textile finishing		
EXTRACTION			
Parameter	Data		
Process description:	Low-formaldehyde finishing agents can be prepared by etherifying the methylol groups with alcohols. Fabrics finished with N-alkoxymethyl compounds give off less formaldehyde than those finished with the corresponding unetherified methylol compounds. Finishing padbath, padding, drying and curing.		
Throughput:	Methylol compounds are supplied as 40-SO%-that is, 2.5-4 molar solutions. The application concentrations of the padbaths range from 0.4 to 1.2 moles per liter.		
Chemical concentration:	Figure 6, Table 5, Figure 7, and Figure 8 shows the amount of free formaldehyde on finished fabrics		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination		Medium	

Study Citation:	Pham, H. Q., Marks, M. J. (2004). Epoxy resins.		
HERO ID:	7348912		
Conditions of Use:	Plastic and resin manufacturing		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	In 1994, 433,000 MT of epoxy resin was produced. (5/125)		
Process description:	Melamine– formaldehyde, urea– formaldehyde, and phenol– formaldehyde resins react with hydroxyl groups of high MW epoxy resins to afford cross-linked networks. The condensation reaction occurs primarily between the methylol or alkylated methylol group of the formaldehyde resin and the secondary hydroxyl group on the epoxy resin backbone. The high bake temperatures used in these applications drive off the condensation by-products (alcohol or water). Acids such as phosphoric acid and sulfonic acids are often used as catalysts. These formaldehyde-based resins are widely used to cure high MW solid epoxy resins at elevated temperatures (up to 200C) for metal can, drum, and coil coatings applications. The resultant coatings have excellent chemical resistance, good mechanical properties, and no effects on taste (adding or taking away taste from packaged foods or drinks). The vast majority of the food and beverage cans produced in the world today are coated internally with epoxy– formaldehyde resin coatings. The phenol– formaldehyde resoles are also used with epoxies in coatings for high temperature service pipes and to protect against hot, corrosive liquids. (62/125) Urea– formaldehyde resins can be cured at lower temperatures and faster speed than phenol and melamine–formaldehyde resins and are widely used in the coil coatings industry where cure schedules are extremely short. However, their use has been declining because of concerns over the release of formaldehyde fumes. (99/125)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for plastic and resin manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (production values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability is addressed by comparing types of formaldehyde resins. Uncertainty isn’t addressed,
Overall Quality Determination		High	

Formaldehyde

General Engineering Assessment

HERO ID: 5954043 Table: 1 of 1

Study Citation:	Pirila, V., Kilpio, O. (1949). On dermatitis caused by formaldehyde and its compounds. Annales medicinae internae Fenniae 38(1):38-51.				
HERO ID:	5954043				
Conditions of Use:	Laboratory Chemical				
EXTRACTION					
Parameter	Data				
Chemical concentration:	Present as formalin (35-40% solution of formaldehyde)				
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	The data are from an OECD country other than the U.S.	
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5:	Sample Size	N/A	Concentration information.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Concentration information.	
Overall Quality Determination			High		

Study Citation:		Pizzi, A., Sorfa, P. (1979). Liquid formaldehyde concentrates as hardeners for tannin-based adhesives. <i>Holzforschung und Holzverwertung</i> 31(5):113-115.			
HERO ID:		5948230			
Conditions of Use:		Processing: Adhesive in resin/wood product manufacturing			
EXTRACTION					
Parameter		Data			
Life cycle description:		""The use of small amounts of amino plastic resins as fortifiers for tannin-based adhesives is not new. The use is new, through, of liquid formaldehyde concentrates as both hardeners and/or fortifiers for such adhesives... Higher concentration of formaldehyde in water can be achieved by partial reaction of the formaldehyde with urea under alkaline reaction conditions, as to form methylol ureas without further condensation to amino-plastic resins. They constitute ideal hardeners for tannin-based adhesives and can very successfully substitute paraformaldehyde, now considerably more expensive. Under certain conditions they can also be used in the function of fortifiers of the tannin/ formaldehyde network.			
Chemical concentration:		""In general liquid formaldehyde concentrates contain approximately 17-23% urea and 50-60% formaldehyde in water solution. The commercial formaldehyde concentrate used throughout this study was BASF Kauresin K244 containing approximately 22- 23% urea and 53-54% formaldehyde ."			
EVALUATION					
Domain		Metric	Rating	Comments	
Domain 1: Reliability		Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness		Metric 2:	Geographic Scope	Low	Data are from South Africa, a non-OECD country.
		Metric 3:	Applicability	High	Data are for adhesives and sealant chemicals in wood product manufacturing, am in-scope occupational scenario.
		Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
		Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			Medium		

Study Citation:	Price, J. H. (1978). Health Hazard Evaluation Determination, Report No. HE 77-41-505, General American Transportation Corporation, Masury, Ohio, July 1978.
HERO ID:	1317279
Conditions of Use:	Installation/Demolition of Building Materials

EXTRACTION	
Parameter	Data
Process description:	Shell plates composed of either carbon steel or stainless steel are received in flat form. The carbon steel shell plates are edge prepped and cut to size with plasma arc or oxyfuel torches, whereas the stainless steel plates are machine prepped with a plane. The shell plates are rolled into cylinders, tacked with stick electrodes, then welded using a submerged arc process. The end pieces for the tanks are cut into circles (using the aforementioned process) and hot pressed to form the tank heads. Depending upon the size of the tank to be fabricated, various cylinders are assembled together to form the tank shell. The tank end heads are then placed onto the shell and welded with a submerged arc. Submerged arc welding is performed on the interior and exterior seams of the shell assembly. Prior to welding on the shell exterior, the tacks used to temporarily bond the cylinders together are removed by air-arc gouging. After completion of the submerged arc process, the seams are visually patched and ground in preparation for X-raying. Any defects detected in the seams are repaired using a stick electrode. After the basic shell of the tank is completed, various fittings, fixtures, and pads are welded to the assembly. This process may involve tack welding with stick electrodes, flux-cored arc welding shielded with carbon dioxide, and stick/wire electrode welding (for stainless steel). Some of these operations entail considerable welding time and may include both interior (i.e., manways) and exterior welding on the tank car. After these welds are inspected and any repairs made (using stick electrodes), the tank car is stress relieved in an annealing furnace. The gears, yoke, and coupler assembly are then applied prior to having the tank car hydrotested and gauged for capacity. Some of the tank cars are insulated with a fiber material (reported to be fibrous glass) or with a urethane foam. When insulating with the fibrous material, rolls of the material are manually wrapped around the outer wall of the tank. An outer metal shell (jacket) is applied over the insulation. This jacket is welded onto the tank using a wire electrode shielded with a gas mixture of 98% argon, 2% oxygen. Cars which require foam insulation are jacketed and welded using the same process prior to insulation. Either polymethylene polyphenylisocyanate (PAPI), methylene bisphenyl isocyanate (MDI), or occasionally toluenediisocyanate (TDI) are injected inside the void area surrounding the tank car. These urethane foams are also used in forming barrier molds inside the tank and for insulating around the bolsters and sills of the tank. The barrier molds are formed by manually pouring the urethane material into the molds, whereas the bolsters and sills are manually sprayed. The isocyanates are stored in a closed system and pumped to a nozzle where the activator and resin are mixed. The final phase involves the application of valves, platforms, walkways, ladders, rails, and pipes for the brakes and air cylinders. The railroad tank car is then prepared for painting and stenciling. After painting, the tank car is given a final inspection, weighed, and shipped. The fabrication of an aluminum tank car is primarily the same as for a carbon steel or stainless steel car. The aluminum shell plates are edge prepped and cut to size with either plasma arc or oxyfuel torches. These plates are rolled and assembled in a similar fashion except that non-ferrous electrodes are used in the assembly (welding) process. The aluminum cars are also prepared for X-ray; however, a chipping process is used in lieu of air-arc gouging. After X-raying, the fittings and fixtures are applied and the tank is tested and gauged for capacity. From this point, the car proceeds through the same basic fabrication phases as the carbon steel or stainless steel tank cars.
Throughput:	Welding materials used (1976) Flux 446,160 lbs. Submerged Arc Wire 272,546 lbs. Stick Electrodes 258,200 lbs. Flux Core Wire 438,780 lbs Aluminum and 0.045 Gas Metal Arc Wire 103,823 lbs.
Number of sites:	1

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High US
	Metric 3:	Applicability	High The report is for an occupational scenario (tank car manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low 1977 - prior to PEL (1992) and more than 20 years old.

Continued on next page ...

General Engineering Assessment

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Study Citation:	Price, J. H. (1978). Health Hazard Evaluation Determination, Report No. HE 77-41-505, General American Transportation Corporation, Masury, Ohio, July 1978.			
HERO ID:	1317279			
Conditions of Use:	Installation/Demolition of Building Materials			
Domain		Metric		EVALUATION
				Rating
				Comments
	Metric 5:	Sample Size	N/A	Information related to process description and throughput
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Information related to process description and throughput
Overall Quality Determination			High	

Study Citation:	Price, J. H. (1979). Health Hazard Evaluation Determination, report HE 78-13-577, Equitable Bag Company, Inc, Florence, Kentucky.			
HERO ID:	63750			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Adjacent to Department 12 is Warehouse 3 where the raw materials and finished product are stored. The combined floor space for the two areas is 185,000 square feet (15,000 ft2 in Department 12 and 170,000 ft2 in Warehouse 3) with ceiling heights of 20 feet. There are 19 production personnel distributed over 2 shifts in Department 12 and 1 employee in the warehouse. The warehouse area is equipped with 4 roof exhaust fans having a total capacity of 72,000 cubic feet per minute (cfm). The ventilation system in Department 12 consists of 1 roof exhaust fan with an estimated capacity of 20,000 cfm. During the environmental evaluation, the exhaust fans at the following locations were operating: (a) 3/10 and 16/78, warehouse fans EE4 an-i HH12; (b) 9/20/78, warehouse fans EE4,EE12, and HH12; (c) 8/16 and 9/20/78, exhaust fan in Department 12 (itis not known if the fan operated on 8/10/78).			
Chemical concentration:	Various types of wet stock paper stored/processed contained 0.49 to 1.63 mg/g paper (6 bulk samples of paper)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The report uses high quality data from frequently used sources (NIOSH) and the source of the method used for formaldehyde content is not clear but does not appear to indicate quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	U.S. data	
	Metric 3: Applicability	High	The report is for an occupational scenario (finishing agent in textiles) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report clearly documents its assessment methods, but there is indication that there are missing pages of the report, so lack of clarity of the full individual results.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Limited discussion on the variability but did not address uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Price, J. H. (1977). Health Hazard Evaluation Determination Report No. HHE-77-31-432, Inland Steel Corporation, East Chicago, Indiana.			
HERO ID:	8442687			
Conditions of Use:	abrasive grinding			
EXTRACTION				
Parameter	Data			
Process description:	Process involved is abrasive grinding of steel billets and bloom. The basic function of the facility is the removal of defects from the steel billets and blooms before they are processed in a rolling mill. Billets are pieces of steel ranging in size from 3 7/8 to 7 1/4 inches square with lengths varying from 14 to 41 feet. Blooms have a larger cross-sectional area than billets, with such dimensions as 8 1/2 x 7 1/2 inches and lengths up to 14 feet. Steel billets and blooms are brought in from the primary mill and prepared for inspection by either a descaling process employing sulfuric acid (Pickling) or a Magna-Glo process. Inspection of the steel is performed to determine if any cracks or splits are present which would propagate upon further processing. The actual cleaning is done by first immersing the steel into a sulfuric acid bath at heated temperatures, then into a rinsing tank containing water. Under normal operating conditions the acid is heated to approximately 170 F. In preparation for pickling the blooms are gathered into groups of six and the billets into groups of seven by an overhead crane; these groups are referred to as lifts. During pickling, two lifts of blooms are immersed in each of the two pickling tanks, giving a total of 24 blooms; or three lifts of billets are placed in each tank, giving a total of 21 billets. The “pickle-hooker” and his assistant work in the general area of the tanks where they chain and unchain the lifts in the tanks. These employees are also involved with the addition of ingredients to the tanks. The acid for the tanks is stored outside the building and pumped in when necessary. A chemist analyzes the tanks several times daily for salts, temperature, and percent by weight of sulfuric acid. When the acid concentration is too low or the salt concentration too high, the tank contents are pumped out into underground holding areas, then removed by truck. After the scale has been removed, an inspector examines the lifts to mark any defects that are present. Depending on the number of defects, the type of steel, and operation time available, the steel is sent either to the chippers or to the grinders for further processing. Surface defects are generally removed by hand in the Chipping Area using pneumatic hammers. Those defects which are deeper into the steel are removed through abrasive grinding. Each grinding machine is equipped with a cab to house the operator and with a 110 pound abrasive wheel which rotates at 900 rpm. This equipment is mounted on tracks in order that the grinding wheel can be moved along the steel to be ground. Each operator services 2-3 tables (total of 8 tables) where the billets and blooms are positioned during processing. The finished billets and blooms are then loaded by crane onto railcars to be moved to a rolling mill.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Priha, E., Riipinen, H., Korhonen, K. (1986). Exposure to formaldehyde and solvents in Finnish furniture factories in 1975-1984. Annals of Occupational Hygiene 30(3):289-294.			
HERO ID:	1320786			
Conditions of Use:	Chemical substances in Furnishing/Lacquers			
EXTRACTION				
Parameter	Data			
Process description:	use of acid -cured lacquers and paints where formaldehyde/formaldehyde-based resins are used as a binding agent			
Number of sites:	50 sites surveyed, represent 60% of industry in Finland			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland-an OECD country
	Metric 3:	Applicability	High	The report is formaldehyde in lacquers used in furniture making for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The data used for this publication was from 1975-1984, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			Medium	

Study Citation:	programs, E.O. (1974). Air pollution control engineering and cost study of the paint and varnish industry.			
HERO ID:	6580284			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Life cycle description:	Resins, along with drying oils, make up the backbone of surface coatings since they are responsible for the formation of a film with physical integrity and adhesion. Formaldehyde is used in the production of urea-formaldehyde resins and melamine-formaldehyde resins, an important component in the paint and varnish industry. Formaldehyde is also a common raw material for the production of phenolic resins and amino resins.			
Process description:	The manufacturing process for pigmented products appears simple from a schematic viewpoint. Basically, it consists of mixing or dispersing pigment and vehicle to give the final product. The paint vehicle is defined as the liquid portion of the paint and consists of volatile solvent or dispersing medium and non-volatile binder such as oils and resins. The non-volatile portion is also called the vehicle solid or film former. The pigment portion of the paint consists of hiding pigments such as titanium dioxide (TiO2), extenders such as talc or barium sulfate, colorants, and any mineral matter used for flattening or other purposes. Also included in the non-volatile portion of the coatings are various additives present in small quantities for a variety of reasons.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		High		

Study Citation:	Pryor, P. (1985). Health hazard evaluation report: HETA-84-427-1613 - Pike Peak Dialysis Center, Colorado Springs, Colorado.			
HERO ID:	8632689			
Conditions of Use:	Laboratory Chemicals			
EXTRACTION				
Parameter	Data			
Process description:	There are 16 dialysis locations including 13 consoles for normal care, one unit for isolation, one unit for back-up, and one location for self care. Patients are connected to an artificial kidney (dialyzer) and dialysis console for four hours per visit. Additional time per patient is based on the patient’s diet, condition of the dialyzers being reused, and the general health of the patient. Once the patient is disconnected from the dialyzer, the nurse or technician connects the system for disinfection. All the consoles are disinfected (bleached} daily and sterilized weekly. Once a dialyzer has been used it, as well as the other dialyzers used during that treatment period, are sent to reuse/sterilization for cleaning in a 4% formalin solution. Here one person will spendapproximately 1 1/2 to 2 hours sterilizing all the dialyzers. This procedure takes place in a room approximately 9 X 18 feet and has two doors which are normally closed during sterilization procedures.The last procedure which was thought to contribute to a potentially high formaldehyde exposure occurs on the weekends when the employees are required to pack and sterilize all the consoles. Normally 3 to 5 employees are in the room during this procedure although only 2 to 3 are required to perform the actual process. This process requires the complete draining of each unit followed by filling and packing with a 10% formalin solution. This solution sets in the individual units for the entire weekend and is drained early Monday morning.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	1984-85 - more than 20 years old.
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative information provided.
Overall Quality Determination			High	

Study Citation:	Pryor, P., Thoburn, T. W., Koons, R. K. (1985). Health hazard evaluation report: HETA-83-313-1534 - Municipal court section, City Of Englewood, Englewood, Colorado.			
HERO ID:	1316838			
Conditions of Use:	Use of photographic supplies			
EXTRACTION				
Parameter		Data		
Process description:		The Municipal Court Section is responsible for processing all the paperwork generated by the activities in the courtroom, as well as recording the transcripts of court proceedings. A 3M 545 Bond Copier is located in a small room attached to the office area. The actual forms, and major copying comes from the main print room, located in a different section of the building. All forms in this office are on carbonless copy paper. Two large closed-door cabinets located on the south wall of the office holds the 24 different forms used by the staff. The upper shelves of the cabinets are open in back with a narrow space between them and the wall. A four-inch diameter hot water manifold is located in this space which feeds six 2-inch pipes, with manometers, which then run down to the floor behind the closed lower cabinet back. The top of the cabinet, however, runs all the way to the back wall. These pipes are part of a hot water heating system used to heat the building during the winter months. The water temperature in each of these uninsulated pipes reaches approximately 180°fahrenheit when the system is used during the cooler months, and thus creating an extremely warm environment within these cabinets.		
Number of sites:		1		
Chemical concentration:		Laboratory results also found formaldehyde in all of the carbonless copy paper tested. These results showed formaldehyde levels from 2.95 to 9.74 micrograms per sample in the bulk paper tested.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment uses sound method, presumed to be NIOSH approach for measurement of formaldehyde
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (public building - court house) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	implemented in 1983 prior to the PEL (1992)
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	information obtained from NIOSH site visit, clearly documents sources and methods.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results. Process description is meant to be specific for the site, and multiple bulk samples were taken to address variability.
Overall Quality Determination			High	

Study Citation:	Quintana, A., Lopez-Doval, L., Rodriguez, R., Souto, J. A., Casares, J. J. (2006). Risk analysis in the chemical industry: an urea-formaldehyde resins case. WIT Transactions on Ecology and the Environment 91:33-41.			
HERO ID:	1144172			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Process diagrams shown on PDF Pg. 4 in Figure 2.			
Throughput:	Phenol formaldehyde resins: 3,000 (tons); Urea formaldehyde resins: 200,000 (tons)			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1: Methodology	High	journal article	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Spain, an OECD country.	
	Metric 3: Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions. (2006)	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Reh, B. D. (1995). Health hazard evaluation report HETA-95-0153-2549, Fort Wayne Foundry Machining Division, Fort Wayne, Indiana. GRA and I(GRA and I):95-0153.			
HERO ID:	1320737			
Conditions of Use:	Use of metal products			
EXTRACTION				
Parameter	Data			
Process description:	The Fort Wayne Foundry Machining Division is not a foundry operation. Approximately 25% of the automotive aluminum castings made in the foundries are machined by this Machining Division. Located in a separate plant which was constructed in 1986, it originally housed only one operation, the 4-3 line. The plant was expanded in 1990 when the 3-1 and quad-4 lines were added, in 1993 when the Cadillac and Saturn lines were added, and in 1994 when the Rochester line was added. At the time of the survey, the Rochester line was not yet operating, but in June 1995, the 4-3, 3-1, and quad-4 lines were scheduled to be shut down and the Rochester line to begin operation. There are two central systems that supply MWF to the machining lines. The 4-3, 3-1, and quad-4 lines are all supplied by system 1, and the other lines are supplied by system 2. Each system consists of a large tank (one that holds 7,000 gallons and one that holds 11,000) under the floor from which MWF is piped to each machine. A series of troughs that run underneath the machines collect the used fluid and carry it back to the central tanks where it is filtered and used again. The MWF is maintained completely by an outside contractor. The contractor tests the MWF in both systems every Monday and then makes the appropriate additions. Based on the pH level and the microbial count, a biocide is added approximately every two to three weeks.			
Number of sites:	1			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (aluminum metal work) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1995 - more than 20 years old
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	Reh, C. M. (1989). Health Hazard Evaluation Report No. HETA-87-370-1973, Native Textiles, Glenn Falls, New York. :87-370.			
HERO ID:	1319215			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Process description:	In the finishing process, an ARTOS frame runs the lace through a melamine/formaldehyde resin, which coats the lace, giving it durability and body.			
Chemical concentration:	Melamine/formaldehyde resin typically contains <1% formaldehyde.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for Manufacture of Textiles, Apparel, and Leather (including fabric/textile finishing), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old.
	Metric 5:	Sample Size	Low	Sample distribution is described qualitatively.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	RHS, (1990). Air monitoring of freshly painted interior rooms with cover letter.			
HERO ID:	1332993			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Chemical concentration:	GM-1650 latex paint formulation: 0.51%			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for paint additive and coating additive used in paint and coating manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1986)
	Metric 5:	Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Rivera, R. (1976). Health Hazard Evaluation Report No. 75-143-333, Unitog Company, Warrensburg, Missouri.			
HERO ID:	1317903			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EXTRACTION				
Parameter	Data			
Process description:	Permanent press clothing is cut and sewn in an adjacent department before it is sent to the pressing department. In the pressing department, the final desired shape of the clothing items is achieved by first pressing it into the shape and then curing it in an oven which is also contained in the same room.Items produced at the plant and pressed in the pressing department include shirts, pants, service suits, 'shop coats, and jackets. These items were fabricated from a fabric that had been pretreated with a formaldehyde resin and purposely left partially uncured (incomplete cross linkage). Some jackets are cured only. After these items have been pressed, they are placed on hangers put on a conveyor (chain) which travels through the curing oven. Shirts are pressed on the opposite side of the room by utilizing a sleeve presser, a collar presser, and a body presser. lastly, the products are folded.			
Number of sites:	1			
Chemical concentration:	FabricGold English Popling Shirting 181-455 (Fabric code 314288596) cone mills: 1 ,190 ppmWhite/red stripe Shirting 5621 (fabric code 313288511) cone mills: 1,699 ppmCharcoal Gabardine Suiting 152-245 (fabric code 318367044) cone mills: 339 ppmRoyal Blue ALT Century twill Suiting 4398 (fabric code 317277041) Regal: 602 ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (fabric pressing and curing) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1975 - more than 20 years old
	Metric 5:	Sample Size	High	Formaldehyde content of individual fabrics were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Formaldehyde content of individual fabrics were provided which could be used to evaluate variability between fabrics. Uncertainty was not discussed but assumed that it was addressed in the NIOSH method used.
Overall Quality Determination			High	

Study Citation:	Rivera, R. O. (1976). Health Hazard Evaluation Determination, Report No. 74-110-306, Morris Bean and Company, Yellow Springs, Ohio.			
HERO ID:	1320884			
Conditions of Use:	Use of Adhesives and Sealants			
EXTRACTION				
Parameter	Data			
Process description:	Cores are made by a process known as the "Cold Box Process". The process involves mixing a two part organic binder with sand. This mixture is then blown into a core mold where a catalyst is injected through the sand mixture. The core is complete and ready to use at that point. In Department 13, mixing is done by using a Muller which is housed in a back work area. All components of the mixture (silica sand, phenol-formaldehyde resin dissolved in a solvent, and MDI dissolved in a solvent) are measured according to the desired batch size. The binders (added to the sand) are taken in open containers from 55 gallon drums located adjacent to the Muller. Drippings from these drums are collected in small open containers. No local exhaust is provided in this area. In Department 68, the mixing is done in a closed system. Binders and sand (stored outside the work area) are automatically measured and piped to the mixer. From this point on, the operation is essentially the same in both work areas. The mixture (moist sand) is delivered to individual hoppers positioned above the core blow machine. The damp mixture is blown into the core box where it is hardened in less than one minute by blowing the catalyst (DMEA) for a pre set amount of time (depending on the size of the core) and then flushing with air for a preset amount of time. A small line is provided to scavenge waste gas. All core blow machines are provided with a local exhaust system and in all cases DHEA is supplied from a gas cylinder (12% DMEA in carbon dioxide). There are fewer machines in Department 13 and they are positioned further apart. Included also in Department 13 is a hood type exhaust at ground level. In Department 68 the 8 core blow machines are positioned much closer together plus there are two full circle machines. In addition to the employees who operate these machines, two trimmers' work stations are located directly behind one of the full circle machines. These employees trim, piece the cores together, and inspect them.			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (foundry) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1976 - More than 20 years old
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative information provided
Overall Quality Determination		High		

Study Citation:	Robinson, C. F., Fowler, D., Brown, D. P., Lemen, R. A. (1987). Plywood mill workers’ mortality patterns 1945 1977 (revised March 1987).
HERO ID:	2453808
Conditions of Use:	Compressed Wood Product Manufacturing

EXTRACTION	
Parameter	Data
Process description:	The process of making plywood is similar to the veneering phase of the furniture industry. The process consists of gluing thin layers of wood, called plies, together with the wood grain of adjacent layers generally at right angles. Through the years, the types of assembly systems have changed in many plants, hot presses are now used exclusively. In the Pacific Northwest, softwood plywood is manufactured principally from Douglas Fir, although small amounts of cedar, pine, spruce, hemlock, larch, true firs, and redwood are also used. The wet logs are sawed into blocks, debarked, and peeled into veneers. The most common method of producing softwood veneers is rotary peeling done by a knife held parallel to the log axis. A continuous sheet of veneer is peeled and then is dried at about 325°-400°F. Some mills edge-glue dry veneers into 4 by 8 foot sheets. During this study period, an odd number of piles typically were glued together to make a plywood panel. Today, much 4 and 6-ply plywood is also produced. Glue was usually mixed in the mill, and the type of glue used was dependent on the final product desired. Glues were soy or soy-blood blends with some straight blood also used in the production of interior plywood panels in the 1940’s and 1950’s. Pentachlorophenol was often added to the protein glues as a mold preventative. Carbon disulfide increased water resistance of cold-pressed glues, and carbon tetrachloride was premixed with carbon disulfide to reduce fire hazards. Phenol formaldehyde resin was the most commonly used glue in the production of exterior panels in the 1940’s-1950’s. Both urea and resorcinol formaldehyde resins were commonly used as patching glues. Ammonium chloride was added to urea glues as a catalyst; it was not used with resorcinols. There was potential worker exposure to the free formaldehyde released by these resins around the patching operations. A hot or cold-press process was used to bond the panel, depending upon glue type and wood species. During the 1940-1950 period, when soy-blood glues were predominant, the cold pressing process was most common with hot pressing used to some extent. Now, hot pressing is almost universal in Pacific Northwest mills. This is due to virtually a complete switch from soybean and blood-albumin glues to phenol-formaldehyde resins which require hot pressing. Hot presses are usually hydraulically driven and steam-heated to a temperature between 240°-330°F. Panels are pressed for 1-1/2 to 14 minutes for softwoods. Time and temperature varies with the panel thickness and glue type, while the pressure varies with wood species. In softwood plywood mills, panels are usually stacked after removal from the press. This permits retained heat to be used for completing the cure of the adhesive. After pressing, the panels are trimmed to exact dimensions. Depending upon the type of product, the panels may also be sanded, patched, and resanded. Prefinishing and treating are usually not done at the plywood plant but in an operation located elsewhere. The exception is concrete form of lining.
Number of sites:	4

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The report is for an occupational scenario (wood products manufacture) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1987 - More than 20 years old.
	Metric 5: Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources.
Domain 4: Variability and Uncertainty			

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Study Citation:		Robinson, C. F., Fowler, D., Brown, D. P., Lemen, R. A. (1987). Plywood mill workers’ mortality patterns 1945 1977 (revised March 1987).			
HERO ID:		2453808			
Conditions of Use:		Compressed Wood Product Manufacturing			
		EVALUATION			
Domain		Metric		Rating	Comments
Metric 7:		Metadata Completeness		N/A	Qualitative information provided
Overall Quality Determination			High		

Study Citation:	Robinson, C. F., Waxweiler, R. J., Fowler, D. P. (1986). Mortality among production workers in pulp and paper mills. Scandinavian Journal of Work, Environment and Health 12(6):552-560.			
HERO ID:	2453832			
Conditions of Use:	Paper manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The industry has two distinct process stages: wood pulping and paper making. Both may be contained within one mill or may take place in separate locations, depending upon supplies of wood and water. Two chemical processes, sulfate (or Kraft) and sulfite, and one mechanical process, groundwood, were dominant in the pulp industry in the United States during the study period. In 1950, ~25% used sulfate process, 23 % used the sulfite process, and 35 % were groundwood mills. The remaining 17 % used various processes, principally soda and semichemical. By 1974, 11 % sulfite and 20 % groundwood processes, 34 % sulfate, and remaining 35 % was principally composed of the newer defibrated process and semichemical mills, with very few soda and chemimechanical processmills. Of the total US pulp production today(1986), over 60 % is produced in sulfate mills, with less than 10 % accounted for by sulfite mills.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for paper manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1986)
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Report addresses variability on different processes, uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	Robinson, J. N., Echt, A. (1995). Health hazard evaluation report No. HETA-93-1084-2500, Reliance Electric, Madison, Indiana. :93-1084.			
HERO ID:	1498812			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Process description:	The manufacturing of electric motors at Reliance is a multi-step process. Shafts are cut to length, centered, and machined in one of two lines. Rotors are manufactured by stacking laminations, which are then cast with aluminum on the four cavity die cast machine (rotorcast). The rotors are then broached, and machined on a lathe to define the outside diameter. The rotors are then heated and the shaft is driven in. Heating takes place in a Selas oven or in an induction heater. Together, the shaft and rotor form the rotating assembly. End shields are either machined or purchased. Motor frames begin as rolls of steel, which are cut to size, folded over, and welded. Punch presses are used to produce fan covers and conduit boxes for some motors. Stators are cleated and insulated. Copper wire is wound into coils and inserted into stator cores. Cleated and insulated windings mated with the coil are then varnished. There are two different varnish dipping operations for the stators: hand dipping and machine-applied varnish using the Young Brothers machine. In either case, varnished stators are then baked in an oven. Single-dipped stators have their interior diameter ground to size on a grinding table. Multiple-dipped stators are manually ground. The grinding tools are known as scratch brushes.The various parts are then assembled either in regular assembly, where each assembler puts together each motor, or the parts are loaded on a tray and sent to Progressive Build, a nine position line where each operator performs one or two operations and passes the motor on to the next station. While some pieces are painted as they are completed, and some rotors receive a primer coat, most painting takes place after assembly.			
Number of sites:	1			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH Study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (motor and generator manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1994 - more than 20 years old.
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative information provided
Overall Quality Determination			High	

Study Citation:	Rodriguez, M., West, C., Brueck, S. E. (2012). Air contaminant, noise, and dermal hazards during aluminum beverage can manufacturing – Texas.			
HERO ID:	8684526			
Conditions of Use:	Use of printing ink, toner and colorant products containing formaldehyde			
EXTRACTION				
Parameter	Data			
Process description:	The beverage can manufacturing process began by unwinding aluminum sheet metal coils. Aluminum sheets were lubricated with DTI M3 lubricating oil, stamped by the cupping press to produce shallow aluminum cups, then extruded by ironers to form can bodies. The tops of the cans were trimmed to a uniform height. Synthetic MWF (DTI Atoguard I-102B) was used for lubrication and to keep cans and machining tools from overheating during extrusion and trimming. After trimming, cans were cleaned with a heated sulfuric acid solution, etched with hydrofluoric acid, and then rinsed. Henkel Deoxylite 115 was added to the rinse water to help the cans flow smoothly throughout the subsequent printing operation. The rinsed cans were dried, and a thin ultraviolet-cured resin was applied to the can’s base for abrasion resistance. The cans then traveled to one of four printers where an ink label and a varnish coating were applied to the exterior. Three rotary printers each had a maximum production capacity of 1,300 cans per minute, and another printer had a maximum production capacity of 1,800 cans per minute. Isopropyl alcohol was used to clean all the printers. Following printing and coating, the cans passed through one of four gas-powered curing ovens. Curing oven emissions were captured and exhausted through an incinerator. After curing, a protective coating was sprayed inside the cans at the lacquer spray machines. The cans then went through one of three ovens heated to 485°F. Afterwards, a wax film was applied to the top of the cans prior to necking. At necker machines, a flange was formed on the top rim of the cans. The flange was used to form the seal with the top of the cans during filling (a step not performed at this plant). The cans received a final check for damage and were then palletized and shipped to the customer.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for use of printing ink, toner and colorant products containing formaldehyde, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2012)
	Metric 5:	Sample Size	N/A	N/A - Process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - Process description.
Overall Quality Determination			High	

Study Citation:	Roffael, E., Dix, B., Schneider, T. (2007). Influence of pulping process on the emission of formaldehyde and volatile organic acids from pulps and medium density fibreboards (MDF). Holz als Roh- und Werkstoff 65(2):145-148.			
HERO ID:	5963848			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Process description:	World-wide medium density fibreboards (MDF) are manufactured using thermo-mechanical pulps (TMP) as a raw material. Recently, results of research work directed attention to the advantages of using pulps obtained by the chemo-thermomechanical pulping process (CTMP) using a mixture of sodium hydroxide and sodium sulphite for production of MDF. When using phenolformaldehyde resins (PF-resins) and binders based on 4, 4-diphenylmethandiisocyanate (PMDI) as bonding agents CTMP pulps lead to MDF of higher mechanical strength (internal bond and bending strength). However, boards made from CTMP showed generally slightly higher thickness swelling and water absorption in comparison with those made using pulps prepared by the TMP-technique. During the CTMP-process chemical degradation of lignocellulosic materials takes place leading to the formation of low molecular weight compounds, including volatile organic compounds which can be released from the pulps and consequently from the boards prepared therefrom (Konn et al. 2006) In this work, therefore, the influence of the pulping method (TMP and CTMP) on the emission of formaldehyde and volatile organic acids from pulps and from boards prepared therefrom was studied in depth.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Source is peer reviewed so likely contains high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data is for Germany, an OECD country.
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Data is over 10 years old (2007).
	Metric 5:	Sample Size	Low	Not characterized by statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Only provides a brief life cycle description and information on chemical/emission concentrations.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Addresses variability by looking at different methods that FA binds to the fibreboards and what would cause lower or higher emissions as a result. Does not address uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Roper, C. P., Jr (1976). Health Hazard Evaluation Determination, Report No. 74-120-260, Goodyear Tire and Rubber Company, Gadsden, Alabama.				
HERO ID:	1009699				
Conditions of Use:	Rubber Product Manufacturing				
EXTRACTION					
Parameter	Data				
Process description:	Raw ingredients are added to the top of the Banbury unit. Each batch of sleeve stock is run through a series of rolling mills and then cut into 3x4 ft. The sleeve stock which has come from the Banbury area are loaded into a warm-up mill where the stock is heated slightly and milled. The stock is cut into lengths after extrusion and layed off as slugs into trays. The slugs are cut to the proper length and weight, shaped and placed into a pre-heating oven at 125 degrees F. The pre-heated slugs are placed into the mold presses, removed from the molded sleeves, and inspected. The sleeves are removed from the the presses and thrown onto metal tables to cool.				
EVALUATION					
Domain	Metric	Rating			Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH HHE.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3:	Applicability	High	The data are for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	1975 - more than 20 years old	
	Metric 5:	Sample Size	N/A	Qualitative information	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Process description.	
Overall Quality Determination			High		

Study Citation:		Roper, P. (1976). Health Hazard Evaluation Determination Report No. 74-86-269, Owens-Corning Fiberglass Corporation, Newark, Ohio.		
HERO ID:		8489748		
Conditions of Use:		adhesive and sealant chemicals in resin manufacturing		
EXTRACTION				
Parameter		Data		
Process description:		Operations to make phenol-formaldehyde resins involve adding components, mixing, and heating chemicals in large drum-shaped mixer/reactors. (7/24)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	Data are from the U.S.
		Metric 3: Applicability	High	Data are for adhesives and sealant chemicals in resin manufacturing, an in-scope occupational scenario.
		Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
		Metric 5: Sample Size	N/A	Process description
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Rossiter, W.J., Mathey, R.G. (1985). Urea-formaldehyde foam insulations: a review of their properties and performance.			
HERO ID:	6020303			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Process description:	As a building insulation, urea-formaldehyde foam is generated on-site using portable equipment. A partially polymerized urea-formaldehyde resin is mechanically foamed and then reacts chemically (cures) in place. Three major ingredients are used in the generation of the foam: urea-formaldehyde resin, a surfactant (generally called a foaming agent) which includes an acid catalyst or hardening agent, and air. In general, three types of resin systems have been used to produce the foams on-site. In one, the urea-formaldehyde resin is transported to the job site as an aqueous solution. In another, the resin is brought to the job site as a powder and mixed with water on-site. In the third, the resin is brought to the job site as a concentrated solution where it is diluted with water prior to application. The equipment for generating the foam generally consists of a compressed air pump and a mixing or foaming gun. In the United States the foaming agent catalyst mixture is in general pumped into the gun where compressed air mixes with it and mechanically expands it into foam consisting of small bubbles. The bubbles are then coated in the nozzle of the gun with the urea-formaldehyde resin which has been pumped through a separate line into the gun. The foam, consisting of resin coated bubbles, is forced out of the gun under pressure at which time it contains about 75 percent water by weight. The water is present because the resin and foaming agent were mixed together for chemical reaction as aqueous solutions.			
Throughput:	no information available			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	data are from the United States
	Metric 3:	Applicability	High	Application of foam insulation in building insulation is an occupational exposure scenario
	Metric 4:	Temporal Representativeness	Low	report is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Rovira, J., Domingo, J.L. (2019). Human health risks due to exposure to inorganic and organic chemicals from textiles: A review. Environmental Research 168:62-69.		
HERO ID:	5041238		
Conditions of Use:	Textile finishing		
EXTRACTION			
Parameter	Data		
Process description:	For a long time, textiles and clothes have been treated with formaldehyde releasing compounds and resins in order to improve the anti-creasing properties. In 1950s and 1960s, the durable press chemical finishing were based on urea-formaldehyde resin and melamine/formaldehyde resin.		
Chemical concentration:	5000–12000 ppm: 0.5–1.2% in chemical finishing agents for clothes (in the 1950s and 1960s); Studies on the concentration of formaldehyde in clothes detected formaldehyde in 3 of 20 items, with levels of 1391 and 3172 ppm; 75.4-206.1 ppm in clothing per another study; <30-163 ppm in clothes in another study		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The report addresses variability in concentration (different studies) and uncertainty in the results.
Overall Quality Determination		High	

Study Citation:	Roy, D.R. (1999). Histology and pathology laboratories. Chemical hazard prevention and medical/health surveillance. American Association of Occupational Health Nurses Journal 47(5):199-205.			
HERO ID:	1986779			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Formalin - 37% to 50% formaldehyde in solution			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	Data is greater than 20 years old.
	Metric 5:	Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	No scope to address variability or uncertainty.
Overall Quality Determination			High	

Study Citation: RTI, (1980). Environmental assessment of iron casting.
HERO ID: 6195396
Conditions of Use: Processing

EXTRACTION

Parameter	Data
Process description:	"Phenol-formaldehyde molds are used in iron shell casting. In this technique a mold, about 3/4 in. thick, is made in two pieces which are clamped together forming a shell. Since the shell alone would not withstand the weight of the molten metal, it is set in a large flask (typically a small railcar) and surrounded with iron shot for added support before the iron is poured into it. (34/172)"
Number of sites:	1,376 foundries (15/172)

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Uninformative	Data are for iron casting, which is not in-scope or similar to an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	Process description information
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Process description information

Overall Quality Determination **Uninformative**

Study Citation:	Ruffing, T.C., Shi, W.W., Brown, N.R., Smith, P.M. (2011). Review of United States and international formaldehyde emission regulations for interior wood composite panels. Wood and Fiber Science 43(1):21-31.			
HERO ID:	5937111			
Conditions of Use:	Use as chemical substance in wood products			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Interior wood composite panels total 14.3 million m3; particleboard most common at approximately 58% of production volume			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for use in wood products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		High		

Study Citation:	Ruhe, R. L., Ehrenberg, R. (1985). Health hazard evaluation report: HETA-84-172-1573 - Philadelphia Limerick Power Plant, Pottstown, Pennsylvania.		
HERO ID:	1322380		
Conditions of Use:	Office Environment		
EXTRACTION			
Parameter	Data		
Chemical concentration:	The analysis of the bulk sample of Thermo-Lag 300-1 for formaldehyde completed by NIOSH detected no formaldehyde in the sample, the limit of detection was 290 ppm. The bulk sample of Thermo-Lag 300-1 submitted to EMV Associates, Inc. had a formaldehyde content of 344 ppm. This clearly showed that formaldehyde is not a primary constituent of the substance analyzed. The low level present in the material is probably a contaminant of one of the primary ingredients used in this product. Nevertheless, NIOSH suspects that even the very low levels of formaldehyde evident in this product may cause adverse health reactions in certain individuals. (Page 9 of 22)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	From US
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1984 - prior to the PEL (1992) and more than 20 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		High	

Study Citation:	Saary, M.J., House, R.A., Holness, D.L. (2001). Dermatitis in a particleboard manufacturing facility. Contact Dermatitis 44(6):325-330.			
HERO ID:	1985025			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Particleboard is a type of manufactured board made from small particles of wood including chips, shreds and flakes. The particles are sorted or “sized“, then dried. The dry matter is mixed with a thermosetting (formaldehyde) resin which is cured by passage through a hot press. The panels are finished by sanding and trimming. Depending on the intended use, the panels can then be coated with wood veneer or laminate.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Canada, an OECD country.	
	Metric 3: Applicability	High	Data are for building/construction materials - wood and wood engineered products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (2001)	
	Metric 5: Sample Size	N/A	Not applicable - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - process description.	
Overall Quality Determination		Medium		

Study Citation:	Saffari, M. (2011). Effects of hardener type and particles size on formaldehyde emission pollution. 8:242-244.			
HERO ID:	5946626			
Conditions of Use:	Use of Resin in Particleboards			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	urea formaldehyde (UF) resins composes more than 90% of resins used in manufacturing of particleboard in the world			
Process description:	For manufacturing particleboards, mat pressed in a hot press at 175 °c temperature and 30 Kg/cm3 pressure. After 5 minutes particleboards produced having 10 mm thickness and 0.7 gr/cm3 density. Particleboard is used in manufacturing of wooden products in houses, schools, offices and etc.			
Chemical concentration:	50% urea formaldehyde in resin			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country (Iran), and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure or emission limits, industry/ processtechnologies) may impact exposures or releases relative to the U.S.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old (report is dated 2011).
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination			Medium	

Study Citation:	Salem, M.Z., Boehm, M., Srba, J. (2013). Evaluation of Mechanical Properties and Formaldehyde Emission of Plywood Manufactured for Construction Applications. Drvna Industrija 64(2):87-93.			
HERO ID:	2872646			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Process description:	Wood logs were steamed for 48 h before the production of veneer. Sheets of veneer were produced with rotary cuts and randomly chosen from the main veneer sheet, and then dried at 110 °C. Subsequently, the veneers were conditioned in a climate chamber to 4-6 % moisture content. Plywood (5-ply) with a nominal thickness of 15 mm was produced from beech veneers using PF resin (46 % solid content). For manufacturing plywood panels, the following parameters were used: hot press time (60 s / 1mm; i.e., 3 min for 3mm thickness), pressure (1.5 MPa) and temperature (118-124 °C). More info provided in Table 2.			
Chemical concentration:	max free formaldehyde 0.1%			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Sampling or analytical methodology is not equivalent to an approved OSHA or NIOSH method and EPA review of information indicates the methodology is acceptable.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data is for Egypt, a non-OECD country.	
	Metric 3: Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	Data is less than 10 years old.	
	Metric 5: Sample Size	Medium	Characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Provides sample type, exposure type, physical form, concentration of formaldehyde in the resin.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Addresses variability by looking at different plywood samples with some various conditions. Does not address uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Salem, M.Z., Boehm, M., Srba, J. (2013). Evaluation of Mechanical Properties and Formaldehyde Emission of Plywood Manufactured for Construction Applications. Drvna Industrija 64(2):87-93.			
HERO ID:	2872646			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Wood logs were steamed for 48 h before the production of veneer. Sheets of veneer were produced with rotary cuts and randomly chosen from the main veneer sheet, and then dried at 110 °C. Subsequently, the veneers were conditioned in a climate chamber to 4-6 % moisture content. Plywood (5-ply) with a nominal thickness of 15 mm was produced from beech veneers using PF resin (46 % solid content). For manufacturing plywood panels, the following parameters were used: hot press time (60 s / 1mm; i.e., 3 min for 3mm thickness), pressure (1.5 MPa) and temperature (118-124 °C). More info provided in Table 2.			
Chemical concentration:	max free formaldehyde 0.1%			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data is for Egypt, a non-OECD country.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Datasources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		Medium		

Study Citation:	Salthammer, T. (2019). Data on formaldehyde sources, formaldehyde concentrations and air exchange rates in European housings. Data in Brief 22:400-435.			
HERO ID:	6039334			
Conditions of Use:	Adhesives and Sealants; Paint and coatings			
EXTRACTION				
Parameter	Data			
Chemical concentration:	[PDF Pg. 409]Painted Wooden Board (with 50 ppb O3) max: 104 (ppb)Painted Wooden Board (with 50 ppb O3) 24h: 40 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data/techniques/methods not from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.	
	Metric 3: Applicability	High	Data are for Adhesives and Sealants; Paint and coatings, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by testing the materials in the presence of different levels of ozone but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	Salthammer, T. (2019). Data on formaldehyde sources, formaldehyde concentrations and air exchange rates in European housings. Data in Brief 22:400-435.			
HERO ID:	6039334			
Conditions of Use:	Cleaning and furniture care products;			
EXTRACTION				
Parameter	Data			
Chemical concentration:	[PDF Pg. 409]Cleaning Agent (with 5 ppb O3): 2.4 (ppb)Cleaning Agent (with 50 ppb O3): 8.8 (ppb)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Germany, an OECD country.	
	Metric 3: Applicability	High	Data are for Cleaning and furniture care products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by testing the materials in the presence of different levels of ozone but uncertainty is not addressed.	
Overall Quality Determination		High		

Study Citation:	Salthammer, T. (2019). Data on formaldehyde sources, formaldehyde concentrations and air exchange rates in European housings. Data in Brief 22:400-435.			
HERO ID:	6039334			
Conditions of Use:	Floor coverings; Foam seating and bedding products; Furniture and furnishings not covered elsewhere;			
EXTRACTION				
Parameter	Data			
Chemical concentration:	[PDF Pg. 409]Carpet (with 28-44 ppb O3): 1.3-8.1 (ppb)Carpet (with no O3): 0.5-4.6 (ppb)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Germany, an OECD country.
	Metric 3:	Applicability	High	Data are for floor coverings; Foam seating and bedding products; Furniture and furnishings not covered elsewhere, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by testing the materials in the presence of different levels of ozone but uncertainty is not addressed.
Overall Quality Determination			High	

Study Citation:	Sancini, A., Rosati, M.V., Sio, S.D., Casale, T., Caciari, T., Samperi, I., Sacco, C., Fortunato, B.R., Pimpinella, B., Andreozzi, G., Tomei, G., Tomei, F. (2014). Exposure to formaldehyde in health care: an evaluation of the white blood count differential. Giornale Italiano di Medicina del Lavoro ed Ergonomia 36(3):153-159.			
HERO ID:	2820911			
Conditions of Use:	Laboratory Use			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Formalin: 37-50% formaldehyde; Lysoform: 10% formaldehyde in soapy solution			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Italy, an OECD country.	
	Metric 3: Applicability	High	Data are for laboratory chemicals, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old. (2014)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment results are provided but underlying methods, assumptions, and data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Savitz, D. A., John, E. M. (1991). Adverse Pregnancy Outcomes among Cosmetologists. Final Report. School of Public Health(R03-OH-02548):169.			
HERO ID:	1976959			
Conditions of Use:	Use of personal care products			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Use of paraformaldehyde tablets or 5% formaldehyde solution was required to sanitize tools and implements.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Low	Salons may be covered by FDA regulations
	Metric 4:	Temporal Representativeness	Low	1991- more than 20 years old
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	data obtained from survey
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination		Medium		

Study Citation:	Schaechtel, D., Moore, D. (1997). Using quantitative risk analysis in decision making: An example from phenol-formaldehyde resin manufacturing.			
HERO ID:	:285-297.			
Conditions of Use:	5938966			
	Processing (mfg of PF resin)			
EXTRACTION				
Parameter	Data			
Process description:	Borden Chemical is a leading supplier of phenol-formaldehyde (PF) resins used in the forest products industry. These resins are made in batch reactors by reacting phenol and formaldehyde together in the presence of an alkaline catalyst. This is a highly exothermic reaction. The heat of reaction is removed by a large condenser, which condenses the water vapor boiled from the reactor contents and returns it as reflux. The reactor typically holds 10,000 or more gallons and contains a motor driven agitator. The process follows these steps: (1) Water and phenol are charged into the reactor. (2) Vacuum is established in the reactor. (3) Catalyst is charged into the reactor. (4) Formaldehyde is slowly charged to the reactor. As the reaction begins, the heat of reaction brings the reactor contents to a boil at a temperature determined by the absolute pressure in the reactor. (5) Reactor temperature is controlled by adjusting the rate of formaldehyde addition or the reactor -vacuum (which changes the boiling temperature). The heat of reaction is removed by the condenser, with reflux returned to the reactor. (6) After all of the formaldehyde has been added, the batch continues to reflux until the desired polymer characteristics are obtained. This condensation reaction is not as exothermic as the initial methylation reaction. (7) The batch is then cooled, which essentially stops the reaction.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	data sources not transparent
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium		

Study Citation:	Scheyer, L.E., Kachman, S.D., Polsani, M. (2001). Use of soy protein hydrolyzate to reduce formaldehyde emissions from pigment print pastes. AATCC Review 1(8):45-48.			
HERO ID:	5939036			
Conditions of Use:	chemical substances in fabric pigment			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Print paste formulations (approximately 450 g) contained 83.15% water, 0.8% scavenger, 7.5% binder, 5.0% pigment, and approximately 2.75% thickener. Formaldehyde-based resins are used as cross-linking agents/ auxiliary resins, 0.8% melamine formaldehyde resin or 0.8% hexamethoxy melamine formaldehyde. Both resins contain 0.5% of formaldehyde			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Reports uses techniques that appear sound and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States (Nebraska).	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The report is generally more than 10 yearsbut no more than 20 years old.	
	Metric 5: Sample Size	N/A	Authors made the formulation.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation:	Scheyer, L.E., Polsani, M. (2000). Use of chemically modified wheat gluten to reduce formaldehyde emissions during curing of pigment print pastes on fabrics. Starch 52(11):420-422.			
HERO ID:	5740641			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Over 25,000 km of fabrics are printed every day with pigment print pastes in the textile industry.			
Process description:	Melamine-formaldehyde auxiliary resins are added to the print pastes to foster crosslinking between binders and fibers.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	N/A	No sample data.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	No sample data.	
Overall Quality Determination		High		

Study Citation:	Schoenberg, J.B., Mitchell, C.A. (1975). Airway disease caused by phenolic (phenol-formaldehyde) resin exposure. Archives of Environmental Health 30(12):574-577.			
HERO ID:	21233			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter		Data		
Life cycle description:		incorporated into an article: Filter manufacturing		
Process description:		The acrylic-wool filter department had five production lines, each with a team of two workers who alternated every other day between the felting and impregnating processes. The felter made the filter car.; tridges from a slurry of fibers (mostly acrylic, but also wool, rayon, and nylon) and placed the filters in a drying oven. The_ impregnator then dipped the filters into a vat of liquid phenol-formaldehyde resin and placed them into a curing oven at 160 C.		
Number of sites:		1		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used source
Domain 2: Representativeness		Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
		Metric 3: Applicability	High	The data are for a filter manufacturing facility which is an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1975, before the most recent PEL (1992) and more than 20 years old.
		Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Schwensen, J. F., Friis, U. F., Menné, T., Flyvholm, M. A., Johansen, J. D. (2017). Contact allergy to preservatives in patients with occupational contact dermatitis and exposure analysis of preservatives in registered chemical products for occupational use. International Archives of Occupational and Environmental Health 90(4):319-333.			
HERO ID:	4454637			
Conditions of Use:	various			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Table 2 (pg 8-10) has formaldehyde concentration data for a variety of products via Danish PROBAS database, which has 38,000 active "substances and materials"			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
	Metric 2:	Geographic Scope	Medium	Data are from Denmark, an OECD country.
Domain 2: Representativeness	Metric 3:	Applicability	High	Data are for a variety of in-scope occupational products.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (minimum/maximum) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty addressed by comparing patch testing results to frequency of chemical occurrence in PROBAS database. Variability addressed by evaluating multiple product types, and multiple products within each product type.
Overall Quality Determination		High		

Study Citation:	Seitz, T., Baron, S. (1990). Health hazard evaluation report No. HETA-87-349-2022, Rockcastle Manufacturing, Mount Vernon, Kentucky. :87-349.			
HERO ID:	626707			
Conditions of Use:	Textile Finishing			
EXTRACTION				
Parameter	Data			
Process description:	The fabric is unrolled on a table in the spreading area, forming many layers of fabric. Pattern pieces are cut from the layers, using scissors or precut dies, and sorted by type. Fabric bundles are then taken to the glue room where the edges are sprayed with an aqueous acrylic emulsion, to prevent ravelling. This operation is performed in a spray booth, in a room adjacent to the sewing area. The fabric bundles are then distributed to the appropriate workstations, where they are sewn and assembled into pants. Conventional sewing machines are used along with a few automated machines for specialized operations such as belt loops. After inspection, the garments are pressed, to form creases, and are then heated in a 325°F oven for a period of approximately 15 to20 minutes, to impart the post-cure. The finished garments are then moved to the packaging area, where they are folded, boxed, and labeled.			
Number of sites:	1			
Chemical concentration:	Table 3 provides formaldehyde concentrations (ug/g of material) for different fabrics that range from 163 to 1430 (also varies whether steam is applied and they are cured).			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for an occupational scenario (textile operation) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1987 more than 20 years old
	Metric 5:	Sample Size	Medium	only single values were provided for fabric formaldehyde concentrations, characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	information provided was from site visit, report clearly documents observations and results.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability was demonstrated in testing different fabric colors, press or unpressed or if it had been cured. Only limited discussion on uncertainty.
Overall Quality Determination			High	

Study Citation:	Seitz, T., Kennedy, E., Gagnon, Y. (1990). Hazard Evaluation and Technical Assistance Branch HETA 90-021-L2055 Superior Manufacturing Cinnccinati, Ohio.			
HERO ID:	8157914			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Waterbed rails made with particleboard containing 85-93% wood and 5-15% urea formaldehyde resin solids. (2/10)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesive and sealant chemicals in wood product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Seow, W.J., Zhang, L., Vermeulen, R., Tang, X., Hu, W., Bassig, B.A., Ji, Z., Shiels, M.S., Kemp, T.J., Shen, M., Qiu, C., Reiss, B., Freeman, L.E., Blair, A., Kim, C., Guo, W., Wen, C., Li, L., Pinto, L.A., Huang, H., Smith, M.T., Hildesheim, A., Rothman, N., Lan, Q. (2015). Circulating immune/inflammation markers in Chinese workers occupationally exposed to formaldehyde. Carcinogenesis 36(8):852-857.
HERO ID:	2993332
Conditions of Use:	Processing as a reactant

EXTRACTION

Parameter	Data
Production, import, or use volume:	Approximately 21 million tons of formaldehyde is produced annually worldwide. 63% of the volume is used in thermosetting resins.
Number of sites:	2 factories in China

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from China, a non-OECD country.
	Metric 3: Applicability	High	Data are for the manufacture of resins, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	High	The report is less than 10 years old(2015).
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted

Overall Quality Determination**Medium**

Study Citation:	Seymour, R.B., Kauffman, G.B. (1992). Formaldehyde: A simple compound with many uses. Journal of Chemical Education 69(6):457-458.		
HERO ID:	5961942		
Conditions of Use:	Processing		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	”More than 6 billion pounds of phenol-formaldehyde resins were produced worldwide in 1988. In the United States in 1989, 1.2 billion pounds of urea-formaldehyde resins were used for bonded wood products, and 14 million pounds of melamine-formaldehyde resins were used for molded dinnerware. In the United States in 1989, 150 millionpounds of acetal resins (formaldehyde resins) were produced;(2/2)”		
Life cycle description:	Formalin is also used for the preservation of biological specimens, the tanning of leather, and the fixation of fur.Formaldehyde is used for the production of many synthetic polymers.		
Process description:	”While the oxidation of methanol continues to be used as the preferred commercial production procedure, formaldehyde may also be produced by the partial oxidation of methane (CH4) in the presence of a magnesia (MgO) catalyst at 750 °C.” (1/2)		
Chemical concentration:	Formalin is an aqueous solution of 37% formaldehyde.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	High	Data are for plastic and resin manufacturing, an in-scope occupational scenario.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	No sample data.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	No scope to address variability and uncertainty.
Overall Quality Determination		High	

Study Citation:	Shishlov, O., Dozhdikov, S., Glukhikh, V., Eltsov, O., Kraus, E., Orf, L., Heilig, M., Stoyanov, O. (2017). Synthesis of bromo-cardanol novolac resins and evaluation of their effectiveness as flame retardants and adhesives for particleboard.		
HERO ID:	5496386		
Conditions of Use:	Industrial/Commercial use		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	no information provided		
Process description:	Bromo derivatives cardanolic novolac resins (BCNR) was prepared in the laboratory by bromination of cardanol-formaldehyde novolac resin (CNR) with a viscosity of 170 mPa s (at 75 8C). The synthesis was carried out by the following procedure: a 25% chloroform CNR solution was loaded in a glass flask equipped with a poly(tetrafluoroethylene) stirrer, a reflux condenser, and a thermometer. The whole device was placed in a cryostat. An amount of 30% solution of bromine in chloroform was added dropwise via an addition funnel to the CNR solution over a time period of 5 h. Throughout the process, the temperature of the mixture was maintained in the range of 0.060.5 8C. The mixture was neutralized with 5% sodium bicarbonate solution after completion of the brominating process. Then it was rinsed with demineralized water. Subsequently, the solvent (chloroform) was distilled off in vacuum. Obtained BCNR was a viscous mass of dark brown color with a weak specific smell and viscosity of 64,300 mPa s (at 75 8C).		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5: Sample Size	N/A	Process Description
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Report clearly documents its data sources.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Process Description
Overall Quality Determination		High	

Study Citation:	SIA, (2020). SIA comments on the draft scope of the risk evaluation for formaldehyde.		
HERO ID:	10384684		
Conditions of Use:	electroless copper plating		
EXTRACTION			
Parameter	Data		
Life cycle description:	"Formaldehyde may be contained in electroless copper plating solutions and in trace amount in certain leveling agents used in electrolytic copper plating." pg. 3/20"Formaldehyde is present as a byproduct of the polymerization reaction (<10 ppm) in mold compound, the plastic part of a plastic package." pg. 4/20		
Process description:	overall process flow diagram contained in Figure 1 on pg. 4/20		
Chemical concentration:	Section 2A, pgs. 7-8/20, contain concentration ranges of formaldehyde in various aspects of the process. Attachment A is an SDS for a product that contains formaldehyde at a range of 0 - 0.1 % (pg. 19/20)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		High	

Study Citation:	Sinks, T. H., Hartle, R. W. (1988). Health Hazard Evaluation Report HETA 86-456-1877, South Texas Nuclear Project, Wadsworth, Texas, March 1988.			
HERO ID:	1392386			
Conditions of Use:	Installation/Demolition of Building Materials			
EXTRACTION				
Parameter	Data			
Process description:	The fire-retardant lumber is treated by its supplier using a proprietary process. The literature indicates that this process typically involves the combination of a nitrogen source (i.e., urea, melamine, guanidine, or dicyandiamide) with formaldehyde to produce a methylolated amine. The resulting chemical product is then reacted with a phosphorus compound such as phosphoric acid. ¹ The supplier of the fire retardant lumber stated that the chemicals used in the manufacturing process are converted to a phosphate compound.			
Chemical concentration:	fire-retardant plywood sample was tested, contained 59ppm			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	report uses high quality data and from frequently used source and are generally accepted by the scientific community(NIOSH HHE)	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	Medium	Duplicate samples measured, but reported as an uncertain statistic	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Information is specific to the site, variability is not applicable. Assume that uncertainty is addressed in measurement methods.	
Overall Quality Determination		High		

Study Citation:	Smith, K.A., Williams, P.L., Middendorf, P.J., Zakraysek, N. (1984). Kidney dialysis: ambient formaldehyde levels. American Industrial Hygiene Association Journal 45(1):48-50.
HERO ID:	5938060
Conditions of Use:	Laboratory Chemical

EXTRACTION	
Parameter	Data
Process description:	Formaldehyde is the preferred chemical for sterilization of the internal hoses of dialysis machines. Two methods were encountered for sterilizing the dialyzers. In one method the 37%-40% formaldehyde is pumped from a container into a central dialysate pump, where it is mixed to produce a 2% formaldehyde solution. The dilute solution is then pumped through the dialysate lines to the dialysis machine. The presence of formaldehyde in the dialysate line at the machine can be verified by one of several different methods which will not be discussed. The second method involves diluting 200 mL of the concentrated formaldehyde to a 2% solution by manually mixing it with tap water in a 1 gallon container. The 2% formaldehyde containers are then placed at each dialysis machine and a "wand" or siphon tube is set inside the container. A "sterilizer" cycle is then activated which pulls the 2% formaldehyde into the dialysis machine. In both procedures the sterilization continues overnight. The next morning the dialysis machines are cleared of formaldehyde by allowing the solution to run into a drain while the machine is rinsed with dialysate. At the end of the drain cycle, the dialysate is checked for the presence of formaldehyde. If formaldehyde is present, the drain cycle is repeated. Another component of the dialysis process is the artificial kidney. Some dialysis clinics reuse the artificial kidneys. During storage, however, they must be kept in a sterile condition, which is maintained by packing the kidney with a dilute formaldehyde solution. To pack an artificial kidney, an employee must run 2% formaldehyde through it and then cap the openings. This is usually done in a standard sink. Ideally, the sink used is equipped with a ventilated hood, but often clean-up sinks are not so equipped. Before reuse, the formaldehyde solution is drained from the kidney and dialysate is used for rinsing.

EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	Report from 1980s.
	Metric 5:	Sample Size	N/A	Process Description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Process description.

Overall Quality Determination	Medium

Study Citation:	Smith, T.J., Quinn, M.M., Marsh, G.M., Youk, A.O., Stone, R.A., Buchanich, J.M., Gula, M.J. (2001). Historical cohort study of US man-made vitreous fiber production workers: VII. Overview of the exposure assessment. Journal of Occupational and Environmental Medicine 43(9):809-823.			
HERO ID:	5949992			
Conditions of Use:	Incorporation into articles			
EXTRACTION				
Parameter	Data			
Process description:	The production processes for making glass wool fiber and filaments are broadly similar. The major differences between glass wool and filaments are that wool is made of blown fibers that have a relatively broad range of diameters (generally <12 um in diameter) and short lengths (millimeters to centimeters), whereas glass filaments are pulled as continuous strands with well-defined, narrow ranges of diameters (6 to 25 um) and lengths of meters. Also, different types of products are made with each. The basic process units for blowing fiber to make wool are diagrammed in Fig. 1. The three important production areas are (1) the furnace and fiberizer area, where the glass is melted and blown into a large chamber over a conveyor (“forming chamber,” fiber for some products is sprayed with a binder as it is formed), after which the airborne fiber is collected by drawing the fiber-laden air through a porous metal conveyor, where it accumulates as a fiber mat; (2) the gas-fired oven, where phenol-formaldehyde binder in the mat is thermoset (“cured”); and (3) the finishing and packaging area, where the fiber product is trimmed, backings and other finishes are applied, and the product is cut to size and packaged in shipping containers that are stored in a warehouse. For some important operations, the mat is not cured in-line, such as for press-formed automotive insulation, or the final form is fabricated in another area, such as for insulation with special coatings or coverings. These processes are performed “off-line,” as shown in Fig. 1, in areas away from the fiber production- line locations. The common processes are diagrammed in Fig. 1. Variations on these basic processes and their plant settings, such as room size, other nearby processes, and local ventilation, can significantly affect the nature and intensity of exposures. The glass filaments are formed by drawing molten glass through a set of holes or nozzles in a metal block, called a bushing. After leaving the holes, the viscous glass filaments are pulled, which reduces the diameter. Filaments are cooled with a fine water spray, coated with starch or other materials, and wound on a cylinder. Continuous filaments are used to produce yarns, roving, textiles, furnace filters, and mat products, such as roofing.			
Chemical concentration:	All but two plants used heat-cured phenolformaldehyde binder to make insulation products. The percentage of binder varied by product type: home insulation fiber mat contains 3% to 5% by weight, board insulation contains 8% to 12%, and tube and automotive insulation contains 10% to 20%.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report is just over 20 years old (2001).	
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.	
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Study Citation:	Smith, T.J., Quinn, M.M., Marsh, G.M., Youk, A.O., Stone, R.A., Buchanich, J.M., Gula, M.J. (2001). Historical cohort study of US man-made vitreous fiber production workers: VII. Overview of the exposure assessment. Journal of Occupational and Environmental Medicine 43(9):809-823.		
HERO ID:	5949992		
Conditions of Use:	Incorporation into articles		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Solenis, (2020). Comment submitted by Dwight Chapman, Strategic Marketing Manager, Solenis LLC regarding the draft scope of the risk evaluation for formaldehyde.			
HERO ID:	10370212			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	”According to the American Chemistry Council in 2011 approximately 8 billion pounds of formaldehyde are produced in the USA annually.” pg. 2/7			
Life cycle description:	”Formaldehyde resins for the building products markets were the number one user (60-70% of the total) with urea formaldehyde identified as the single biggest user, consuming 2 billion pounds per year of formaldehyde.” pg. 2/7			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	PV data is from 2011
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Solomons, K., Cochrane, C., J.W. (1984). Formaldehyde toxicity. Part I. Occupational exposure and a report of 5 cases. South African Medical Journal 66(3):101-102.
HERO ID:	1978905
Conditions of Use:	Multiple

EXTRACTION

Parameter	Data
Production, import, or use volume:	65,000,000 (kg)
Life cycle description:	Formaldehyde is widely used commercially, most commonly in the manufacture of chipboard and urea-formaldehyde foam insulation. Particle- or chipboard is manufactured from groundwood with urea-formaldehyde as the adhesive, and under certain conditions releases free formaldehyde into the atmosphere. Urea-formaldehyde foam is widely used as cheap and efficient insulation in houses, schools and offices. A resinous mixture of urea, water and formaldehyde is added to a propellant and a surfactant to make a foam, which is mixed on site by the installer, and then injected into the walls of the building.³ In some instances formaldehyde may be released from these walls for up to 3 years. • The amounts released depend on a number of factors such as ventilation, temperature, quality and age of the ingredients, proportions of ingredients used in the mixture, and the skill of the installer. The use of urea-formaldehyde resin in other lacquers and adhesives such as carpet adhesive, parquet floor lacquer, plywood adhesive, paint and wooden furniture adhesives and lacquers constitute additional sources of formaldehyde contamination in the construction industry.³ Formaldehyde is also used to make concrete and plaster impermeable to water and greases. The textile industry uses formaldehyde resins in permanent-press anti-shrink fabrics and for dyeing and flame-proofing. The rubber industry uses hexamethylene tetramine as an accelerator and as a formaldehyde donor in the process of bonding rubber to the steel or textile used in tyres and rubber-metal products. The leather industry uses formaldehyde for tanning and glueing.³ Foundries use it for binding sand and during core-making, and the metal industry uses it as an anticorrosion agent. Formaldehyde is also used commercially as a preservative in cosmetics, in the preparation of drugs, vaccines, fumigants and disinfectants, in the manufacture of other chemicals (e.g. acetylenic products), in the manufacture of fertilizers and other agricultural products, and in the photographic, paper, plastics and protective-coating industries. Welding and the manufacture of electrical machinery are two instances where formaldehyde is released by thermal decomposition of the anti-corrosive resins and plastics used. Formaldehyde in the form of reinforced thermoplastic resins is utilized in the manufacture of a large number of machines, appliances and engines as a replacement for metal in many of the working parts. The medical world makes use of formaldehyde as a tissue preservative in dissecting rooms and histopathology laboratories, as a disinfectant, particularly in hemodialysis units, in the treatment of athlete's foot and, formerly, in the sterilization of hydatid cysts before surgical removal, in vasectomy and in veterinary medicine. Morticians use it as an embalming fluid.⁹ Formaldehyde has been used as a food preservative, a food processing agent and an additive to animal feeds, and as a protein denaturant in the fishing industry. Concentrations have been reported ranging from zero to 30 ppm in a variety of occupational settings.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from the South Africa.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1984)
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.
Domain 3: Accessibility/ Clarity			

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Formaldehyde

General Engineering Assessment

HERO ID: 1978905 Table: 1 of 1

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Study Citation:		Solomons, K., Cochrane, C., J.W. (1984). Formaldehyde toxicity. Part I. Occupational exposure and a report of 5 cases. South African Medical Journal 66(3):101-102.		
HERO ID:		1978905		
Conditions of Use:		Multiple		
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Low	

Study Citation:	Solt, P., Konnerth, J., Gindl-Altmutter, W., Kantner, W., Moser, J., Mitter, R., Herwijnen, H.W. (2019). Technological performance of formaldehyde-free adhesive alternatives for particleboard industry. International Journal of Adhesion and Adhesives 94:99-131.			
HERO ID:	5961865			
Conditions of Use:	Processing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	”The worldwide capacity for producing formalin is approx. 18E6 tons/year (2011) based on 100% formaldehyde, whereby the global consumption was estimated to be 13.1E6 tons/year (2011) based on 100% formaldehyde. (4/33)”			
Process description:	Formaldehyde is produced by oxidation of methanol. (4/33)			
Chemical concentration:	Formaldehyde to urea molar ratios which used to be 1.6 to 1.8 in the 1970s. Now, development of formaldehyde content of industrially produced particleboards in Europe has lowered the molar ratio as low as 0.94 for current industrially available UF or even 0.90 for industrially available melamine containing adhesives. (2/33)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Austria, an OECD country.
	Metric 3:	Applicability	High	Data are for adhesives and sealant chemicals in wood product manufacturing, am in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Assessment is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Songer, J. R., Braymen, D. T., Mathis, R. G., Monroe, J. W. (1972). The practical use of formaldehyde vapor for disinfection. Health Laboratory Science 9(1):46-55.			
HERO ID:	5938031			
Conditions of Use:	Laboratory Chemical			
EXTRACTION				
Parameter	Data			
Process description:	Among the many ways for generating formaldehyde vapor, atomization of formalin is one of the most common. Any sprayer that generates small droplets can be used for this purpose. A problem encountered with sprayers of this type is the build-up of paraformaldehyde about the motor windings. The authors were able to greatly reduce this deposit by locating a filter at the air inlet to the motor. This filter consisted of a 2” layer of coarse oil-treated fiber glass. A device consisting of a siphoning nozzle attached to a formalin reservoir was developed. A source of steam or compressed air was needed for its operation. Steam ejectors have also been used successfully to vaporize formaldehyde from formalin. Another process is vaporization of formaldehyde from paraformaldehyde with heat. This was patented in 1961 by Charles Kaitz and is now used extensively in the poultry industry. His process was to heat a fine white powder containing 91 per cent formaldehyde. Electric fry pans has also been used to vaporize paraformaldehyde. Another process is generation of formaldehyde vapor by reacting formalin with potassium permanganate. Another process is diffusion of formaldehyde vapor from formalin or paraformaldehyde.			
Chemical concentration:	Formalin is 37 per cent formaldehyde in water.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data	
	Metric 3: Applicability	High	Report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Data greater than 20 years old.	
	Metric 5: Sample Size	N/A	Mainly process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Mainly process description.	
Overall Quality Determination		High		

Study Citation:	Sousa, F.W., Cavalcante, R.M., Rocha, C.A., Nascimento, R.F., Ferreira, A.G. (2015). Carbonyl compounds from urban activities and their associated cancer risks: The influence of seasonality on air quality (Fortaleza-Ce, Brazil). Urban Climate 13:110-121.			
HERO ID:	6252277			
Conditions of Use:	Use			
EXTRACTION				
Parameter	Data			
Throughput:	The gas stations in the report are located on a fairly busy avenue (an average flow of 40,000 cars/day) and sell approximately 4000 L of fuel per day. (3/12)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Sampling/analytical methodology is equivalent to an approved [OSHA/NIOSH] method.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from Brazil, a non-OECD country.	
	Metric 3: Applicability	Low	similar to the in-scope occupational scenario use of fuels and related products.	
	Metric 4: Temporal Representativeness	High	Monitoring data were collected after the most recent PEL and no more than 10 years old.	
	Metric 5: Sample Size	Medium	Throughput distribution characterized by limited statistics (means) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Most critical metadata provided.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	Uncertainty is addressed in sampling/analytical methodology. Variability addressed by sampling during multiple seasons.	
Overall Quality Determination		Medium		

Study Citation:	Springborn Laboratories, (1981). The formaldehyde industry and industries using formaldehyde (EPA contract #68-01-6075).
HERO ID:	5901013
Conditions of Use:	Multiple COUs - Adhesives, particleboard, plywood, textiles, embalming, mobile homes.

EXTRACTION

Parameter	Data
Production, import, or use volume:	US accounts for 32% of the world's capacity for FA, producing 6 billion lbs per year on average. Consumption of FA in end use products (1980): UF - 29%, 1653 MMlbs (37% solution); PF - 25%, 1425 MMlbs; MF - 5%, 285 MMlbs; Acetal Resins - 5% 285 MMlbs; Butanediol - 7%, 399 MMlbs; Pentaerithital - 6%, 342 MMlbs; Hexamethylene-Tetramine - 4%, 228 MMlbs; Other uses including export - 19%, 1083 MMlbs. Each company, number of plants and capacity of total companies are provided in Exhibit V page 15. Urea, melamine and phenol resin PVs are in Exhibit 29 and 30 pages 79 and 80.
Life cycle description:	Major uses of FA are in the manufacture of urea, phenol, and melamine FA resins which account for nearly 60% of the total, and for a variety of industrial chemicals which account for 25-30%.
Process description:	All FA made in the US are produced from methanol. Two process are used, the silver catalyst oxidation process and the metal oxide or oxidation - hydrogenation process. The former process was the first to be used and accounts for about 80% of US production. The latter process is more efficient in terms of yield and uses on iron oxide - molybdenum oxide catalyst. Silver Catalyst process: the metallic silver catalyst process involves the production of FA from methanol according to 2 simultaneous reactions that occur at atmospheric pressure and temperatures between 600 and 650 C - $\text{CH}_3\text{OH} + 1/2 \text{O}_2 \rightarrow \text{CH}_2\text{O} + \text{H}_2\text{O}$; $\text{CH}_3\text{OH} \rightarrow \text{CH}_2\text{O} + \text{H}_2$; Between 50 and 60% of the FA is formed by the 1st reaction which is exothermic and the remainder by the second reaction, which is endothermic, resulting in a net exothermic process. Overall plant yields of 86 to 90% (based on methanol) are achieved, with CO, CO ₂ , methyl formate and formic acid as byproducts. A flow diagram for a typical plant producing FA by the metallic silver catalyst process is presented in exhibit 7. A brief outline of the processing steps follows. The incoming air (stream 1) is washed with caustic to remove impurities that might poison the catalyst, compressed, and passed through a vaporizer column. It is then heated and saturated with enough methanol vapor (stream 2) to form a mixture that is above the high explosive limit of the methanol (37 vol % methanol). The mixture (stream 3) then enters a battery of catalytic converters where the temp is maintained at about 635 C by the oxidation of either methanol or a portion of the evolved hydrogen. The hot effluent gases (stream 4) are quickly cooled by heat interchange with the feed mixture in the vaporizer and then by introducing the gas into the primary absorber. The liquid in the primary absorber is an aqueous solution of FA and methanol. A portion of this liquid is withdrawn from the bottom of the column and recirculated at the top, and the remainder (stream 5) is pumped to the production fractionation column. The uncondensed vapors from the top of the primary absorption column (stream 6) are fed to a secondary absorber for recovery by contact with demineralized water. A weak FA/ methanol solution (stream 7) is then withdrawn from the bottom of the secondary column for use as make-up solution in the primary absorber. In the product fractionation column, methanol is recovered by vacuum distillation. Methanol vapor from the top of the column is condensed and recycled (stream 9), and uncondensed vapors are vented. The FA solution from the bottom of the column (stream 10) is passed through an ion exchange system to remove trace amounts for formic acid when required, and is then pumped to product storage tanks where water is added to produce a suitable concentration. Metal oxide process: The metal oxide catalyst process, like the silver catalyst process previously described, involved the production of FA from methanol. However in this process, the methanol concentrations are kept below the lower limits of the explosive range, thus all of the FA in this process is produced by the exothermic reaction: $\text{CH}_3\text{OH} + 1/2 \text{O}_2 \rightarrow \text{CH}_2\text{O} + \text{H}_2\text{O}$; This reaction takes place at atmospheric pressure and gives overall plant yields of 88 to 91%. By products include CO, CO ₂ , dimethyl ether, and formic acid. A flow diagram for a typical plant that produces FA by the metal oxide catalyst process is presented in Exhibit 8. A brief outline of the processing steps is presented below. Incoming air (stream 1) is washed with caustic to remove impurities and compressed along with the recycle gas (stream 5). A portion of the compressed air is passed through the vaporizer column where it is saturated with methanol (stream 2). The methanol-saturated air is then mixed with the remaining air and preheated by heat exchange with the product gas leaving the converter. This feed gas mixture (stream 3) then enters the converter, which is maintained at 650 C, by boiling heat transfer fluid (Dowtherm) in the reactor shell. Steam is generated by the condensation of the Dowtherm vapors. The product gas (stream 4) is cooled by heat exchange with the feed gas mixture and then quenches in the absorber column, where the FA and methanol are stripped from the gas stream by absorption in aqueous solution. A portion (60 to 80%) of the unabsorbed gases that exit at the top of the absorber column is recycled (stream 5), and the remaining gas is vented. The product solution drawn from the bottom of the absorber column contains less than 1% of methanol and formic acid. The solution is treated by ion exchange to reduce the acidity and is then stored. Water is added to provide the desired concentration for storage and shipping. It takes 0.42-0.43 lbs of methanol to produce 1 lb of FA (37% solution) by the silver catalyst process and 0.43-0.46 lbs methanol by the metal oxide process.
Number of sites:	15 US companies produce FA at 56 plant sites. 110 firms in the US are producers of resins, plastics or adhesives with FA in formulation.

EVALUATION

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General Engineering Assessment

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Study Citation:		Springborn Laboratories, (1981). The formaldehyde industry and industries using formaldehyde (EPA contract #68-01-6075).		
HERO ID:		5901013		
Conditions of Use:		Multiple COUs - Adhesives, particleboard, plywood, textiles, embalming, mobile homes.		
Domain		Metric		EVALUATION
Domain		Metric		Rating
Domain		Metric		Comments
Domain 1: Reliability		Metric 1:	Methodology	High
				Data is high quality data as a TSCA submission to the EPA.
Domain 2: Representativeness		Metric 2:	Geographic Scope	High
		Metric 3:	Applicability	High
				Data is for US.
				Data is applicable to multiple COUs. Recommend making multiple sets of data review for each COU as it goes in depth for each one on process description, PVs, number of sites, number of workers, etc.
		Metric 4:	Temporal Representativeness	Low
		Metric 5:	Sample Size	Medium
				Data is over 20 years old.
				Characterized by a large range of data over multiple years.
Domain 3: Accessibility/ Clarity		Metric 6:	Metadata Completeness	High
				Provides production volume, process descriptions, number of workers, number of sites, life cycle description etc.
Domain 4: Variability and Uncertainty		Metric 7:	Metadata Completeness	Medium
				Addresses variability by looking at multiple COUs and data spanning multiple years.
Overall Quality Determination			High	

Study Citation:	Spångberg, L. S., Barbosa, S. V., Lavigne, G. D. (1993). AH26 releases formaldehyde. Journal of Endodontics 19(12):596-598.			
HERO ID:	6065160			
Conditions of Use:	Use in medical device			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Table 1 (units - number of ions x 10^6/mg of material) provides samples of AH26 and N2. Freshly mixed: AH26 - 0.12, N2 - 835.00; 12 hr: AH26 - 0.27, N2 - 1740.00; 24 hr: AH26 - 1.50, N2 - 1020.00; 2 days: AH26 - 22.26, N2 - 7310.00; Powder: AH26 - none, N2 - overload; Resin: AH26 - none, N2 - none.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Source is peer reviewed and appears to have high quality data.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data is from US.	
	Metric 3: Applicability	Low	Data is the use of what appears to be a medical device and does not contain applicable quantifiable concentration data. Does not ever explicitly explain what AH26 is of which they are sampling.	
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old.	
	Metric 5: Sample Size	Medium	Range with uncertain statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Documents data sources, assessment methods and results.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Does not address uncertainty or variability.	
Overall Quality Determination		Medium		

Study Citation:	Srivastava, A.K., Gupta, B.N., Bihari, V., Gaur, J.S., Mathur, N., Awasthi, V.K. (1992). Clinical studies of employees in a sheet-forming process at a paper mill. Veterinary and Human Toxicology 34(6):525-527.			
HERO ID:	6638			
Conditions of Use:	Paper Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	incorporation into an article: paper mill			
Process description:	Formaldehyde is released during the manufacture of paper when formaldehyde resins are added to pulp			
Number of sites:	1			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	Sampling or analytical methodology is not specified.y or uncertainty.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	India - not and OECD country	
	Metric 3: Applicability	Medium	The data are for paper manufacture is an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities, but there may be significant difference between operations in India in 1992 and the US now.	
	Metric 4: Temporal Representativeness	Low	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1992, around the time of the most recent PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	no other metadata were provided such as sampling and analytic method	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The monitoring study does not address variability	
Overall Quality Determination		Low		

Study Citation:	Stayner, L.T., Elliott, L., Blade, L., Keenlyside, R., Halperin, W. (1988). A retrospective cohort mortality study of workers exposed to formaldehyde in the garment industry. American Journal of Industrial Medicine 13(6):667-681.			
HERO ID:	32315			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Number of sites:	3 sites (in PA and GA)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The report uses high quality data from frequently used sources (NIOSH)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The sites captured in the study may no longer be active.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Only extracted data is the number of sites monitored in the study.
Overall Quality Determination			High	

Study Citation:	Stephenson, R. L., Aw, T. C. (1986). Health Hazard Evaluation Report HETA-1984-0132-1703 Purex Industrial Division, Marion, Ohio.			
HERO ID:	8251533			
Conditions of Use:	Processing-Reactant-All other chemical product and preparation manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The manufactured goods, mostly liquids or powders/flakes are made in quantities ranging from one quart to a semi-tractor trailer tank load containing several thousand gallons. Almost all of the products are made in a batch-type process. The basic manufacturing procedures involve manually or automatically metering or dispensing appropriate portions of the mixtures and then placing these ingredients into mixing containers of different sizes. The components are then usually blended using mixers of various capacities and speeds. Various quality control tests are performed throughout the production processes and just priorto shipment. If all specifications are met, the end-products arepackaged for shipping.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (NIOSH HHEs) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evalu-ated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		High		

Continued on next page ...

March 2024

Formaldehyde

General Engineering Assessment

HERO ID: 1320981 Table: 1 of 1

...continued from previous page

Study Citation:	Stephenson, R. L., Murphy, D. C., Habes, D. J. (1985). Health hazard evaluation report: HETA-81-369-1591 and HETA-81-466-1591 - Electric Machinery McGraw Edison Company. Minneapolis, Minnesota.
HERO ID:	1320981
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product

		EVALUATION	
Domain	Metric	Rating	Comments
Study Citation:	Stephenson, R. L., Murphy, D. C., Habes, D. J. (1985). Health hazard evaluation report: HETA-81-369-1591 and HETA-81-466-1591 - Electric Machinery McGraw Edison Company. Minneapolis, Minnesota.		
HERO ID:	1320981		
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product		

		EXTRACTION	
Parameter	Data		

Process description:

The Electric Machinery - McGraw Edison factory has been involved in manufacturing various sizes (5 1/2 - 12 1/2 diameter) of electric generators/motors since 1926. The epoxy resin materials and processes which are used for electrical component encapsulation and insulation have been in operation since 1971. There are several different types of heat setting epoxy materials used. 1. Coil Winding and Hand Taping The coil winding and hand taping areas, located on the second floor of the facility. There are about 6 employees in the coil winding department and 30 employees in the hand taping area who work on a one shift. The hand taping area is temperature and humidity controlled and "person-cooling" fans are occasionally used to enhance or provide dilution ventilation. The work processes in the coil winding area begins with the loop winding operation. In this procedure, copper wire (purchased outside: coated with fiberglass and varnish) is staped (mylar)® into a rectangular-shaped coil approximately 5' in length. The coils are then placed on one of three different sized compressed-air-powered coil forming machines. Coils are spread to appropriate lengths and widths and employees make adjustments using hand-held, steel-headed mallets and pinching/crimping tools. The hammering and crimping actions performed by the coil forming employees are a potential contributing factor to the biomechanical stresses experienced by the workers. Soldering the coil's copper leads is the last procedure done in the coil winding department. From the coil winding floor the coils are sent to the hand taping area. The mylar tape which had been previously applied, is removed from the coil. Mica-paper is manually applied to the low voltage coils in 36 1/2 wide sheets and also to the high voltage coils in 3/4", 1", or 1 1/4" tape form. The number of layers of mica-paper or mica-tape applied to the coil varies with coil voltage specifications. Epoxy impregnated felts are inserted between the leads of the coil and mylar tape is wrapped around the leads. Dacron-fiberglass "outer-binder" tape is applied to all coils for protective purposes and a special dacron tape is occasionally applied to some high voltage coils for quality control testing. In order to alleviate some of the ergonomic stresses associated with wrapping several layers of tape around the coils, several employees use a hand-held, non-powered winding spindle to apply the tapes. However, this tool is not used by all the hand taping employees. Several of the employees use wrist length, perforated leather or vinyl protective gloves (with finger slots removed) to aid in preventing blisters and/or callouses caused by the repetitive wrapping motions incurred with application of the tapes. Water soluble protective skin creams are used by some employees to avert dermatitis. The average high voltage coil process time through the hand taping department is 2 hours whereas the low voltage coil takes 25 minutes. Upon completion, the finished coils are sent to the armature winding floor or VPI room. 2. Armature Winding and VPI The VPI room and armature winding area each cover about 4000 square feet. There are about 20 employees in the armature winding area and one employee in the VPI room per shift. During the NIOSH survey, the armature winding and VPI system employees worked on a two shift, 5-day, 8-hour-per-day schedule. Occasionally, however, the armature winding department operates on a 6-day work schedule. The work processes in the armature winding area begins when the copper conductor coils, which were previously wrapped with the epoxy embedded mica tapes, are brought into the winding area and warmed to room temperature. The coils are manually inserted into the core of the generator and lashed in place with wire. The leads are soldered together using a rosin core solder and the coil is insulated with the epoxy resin embedded felts, mica tapes, and other tape-binding materials. Other work processes on the winding floor using epoxy materials include the use of an epoxy glue to adhere temperature detectors onto the generator and an epoxy resin and an epoxy resin kit and mica tape for use in making minor repairs on new and old electric generators. From the winding floor, the coil/core assemblies are sent to the VPI room where the VPI operators apply the MRV-1000, a silicon release agent, manually by brush. After warming in the preheat oven (150°F for two hours) the coil/core assemblies are placed into the VPI tank which is 10' in diameter and has a capacity of about 5000 gallons. The sequence of processes in the VPI tank includes a dry vacuum cycle (1-1 1/2 hours), wet vacuum cycle (epoxy resin - 2 1/2 hours), and pressure cycle (90-110 lbs for 6-10 hours). When coil/core assembly is removed from the VPI tank, it is placed in the final cure gas-fired baking oven for about 2 hours at 150°F and 10 hours at 300°F. Some machines are recycled through the VPI system. If the generator passes electrical tests, then excess resin is cleaned off the generator using compressed air-powered sanders and buffers and non-powered file-scrappers. Following the cleaning, the motor is sent to the assembly floor area. Due to their size, the largest generators/motors, B-stage coils, are slightly modified in regards to their processes of manufacture. The conductor coils, brought from the coil winding department, initially go through the VPI system separately, on racks, and are partially cured. On the winding floor the half cured coils are inserted into the generator cores, leads are soldered, and the insulating epoxy mica felts and tapes are put into place. Occasionally, liquid epoxy resin is painted on the completed generator manually by brush. The motor is finally cured in large gas-fired ovens as a single unit. Another VPI system, located in the VPI room, for the smaller generators, operates on a similar basic process. Unlike the large B-stage generators, the smaller generators are processed through a small VPI tank (5 1/2 diameter with 500 gallon capacity) wherein liquid epoxy resin impregnation occurs. Welding (conventional shielded metal arc or consumable flux coated electrode) is performed on the generator frames in the winding area.

Formaldehyde

General Engineering Assessment

HERO ID: 1320981 Table: 1 of 1

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Study Citation:	Stephenson, R. L., Murphy, D. C., Habes, D. J. (1985). Health hazard evaluation report: HETA-81-369-1591 and HETA-81-466-1591 - Electric Machinery McGraw Edison Company. Minneapolis, Minnesota.			
HERO ID:	1320981			
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product			
EVALUATION				
Domain	Metric		Rating	Comments
Throughput:	An average of 20 custom-built motors are produced each month.			
Number of sites:	1			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (electric motor manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1983 - more than 20 years old
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	qualitative information provided
Overall Quality Determination			Medium	

Study Citation:	Stewart, P.A., Schairer, C., Blair, A. (1990). Comparison of jobs, exposures, and mortality risks for short-term and long-term workers. Journal of Occupational Medicine 32(8):703-708.			
HERO ID:	1515720			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Number of sites: 9 - (it appears that there are 10 plants.)				
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Assessment uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for manufacture, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1990)	
	Metric 5: Sample Size	N/A	Not applicable - no sample data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - no sample data	
Overall Quality Determination		Medium		

Study Citation:	Stone, R. A., Youk, A. O., Marsh, G. M., Buchanich, J. M., Smith, T. J. (2004). Historical cohort study of U.S. man-made vitreous fiber production workers IX: summary of 1992 mortality follow up and analysis of respiratory system cancer among female workers. Journal of Occupational and Environmental Medicine 46(1):55-67.			
HERO ID:	1313829			
Conditions of Use:	Construction Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Incorporated into a formulation, mixture, or reaction product: Fiberglass manufacture			
Process description:	Glass filaments are extruded fibers with diameters between 6 and 25 um and lengths in meters, whereas glass wool is made of much shorter blown fibers with diameters < 12 um and lengths measured in millimeters or centimeters. Formaldehyde was added as a preservative in the starch sizing that was used to protect the glass filaments after they had been formed.			
Number of sites:	10 manufacturing plants			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The data are for fiberglass manufacture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The study was published in 2004 but is based on data collected from 1946-1992 prior to the 1992 PEL and over 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium		

Study Citation:	Sugata, Y., Miyaso, H., Odaka, Y., Komiyama, M., Sakamoto, N., Mori, C., Matsuno, Y. (2016). Levels of formaldehyde vapor released from embalmed cadavers in each dissection stage. Environmental Science and Pollution Research 23(16):16176-16182.			
HERO ID:	4455765			
Conditions of Use:	Lab chemical (mortuary science)			
EXTRACTION				
Parameter	Data			
Chemical concentration:	2.3% concentration of FA in preservative solution (pg 2)			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Japan, an OECD country.
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	Concentration data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Concentration data
Overall Quality Determination			High	

Study Citation:	Sussell, A. (1995). Health hazard evaluation report No. HETA-91-0239-2509, Medite Of New Mexico, Las Vegas, New Mexico. :91-0239.			
HERO ID:	1316591			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Fiberboard is a dense pressed wood product produced in boards of various thicknesses (3/16 to 1½ inch) for furniture, and in other shapes for interior applications such as baseboard moldings,cabinets, and picture frames.			
Process description:	The highly automated manufacturing process consists of: preparing wood fibers, treating fibers with urea-formaldehyde resin and drying them, forming mats of resin-treated wood fibers, pressing the mats into fiberboard, and finishing the boards with sawing and sanding. The raw materials are moved by the front loader operator from large piles outside into a wood storage shed. The wood chips are softened with steam pressure in the digester and ground into fibrous material at the refiner. A refiner operator controls the process from an isolation booth. In an enclosed process, liquid urea-formaldehyde resin is injected into the fibrous material, and the fibers are then dried to about 10% water content. During the drying process, the resin is drawn into the porous fibers. After drying, resin-treated fibers are conveyed to the former, which layers the fibers into a continuous 4-ft wide mat. The mat consists of two “face” layers on the top and bottom and two inner “core” layers; the face and core layers have resins of different composition. The continuous mat is fed onto a form line conveyer, where the mat is leveled to a specified thickness and cut into separate 8-ft mats by an automatic “flying” circular saw (form line saw). The mats are conveyed into a pre-compressor, where excess air is pressed out, and then are loaded into a 20-opening steam-heated hydraulic press. Mats are pressed at 1500-3000 pounds per square inch at 300-350 °F for specified times to cure the resin and bind the wood fibers together into a dense board. Steam and vapors are emitted when the hot press opens are exhausted through roof openings over the press. The boards are unloaded from the press onto an enclosed cooling wheel where they are cooled with outside air that is moved over the boards and then exhausted to the outside. The boards are then stacked and moved by forklift to a warehouse area, where they are allowed to continue cooling for a minimum of 24 hours. Cooled fiberboards are cut to exact dimensions (usually 4 ft x 8 ft) by an automatic in-line saw,then moved to the sander, which removes the top and bottom surfaces to produce the finished fiberboard product.			
Number of sites:	1 site studied			
Chemical concentration:	formaldehyde concentration in settled dust was measured[Table 3]: Formaldehyde in Bulk Samples of Settled Dust (Second Site Visit) Table 3Wood Storage shed- dust on catwalk railing- 0.04(BDL, MDC/2 is reported, NIOSH 5700), 0.009(Value between MDC and MQC, Elia et al.) Wood chip pile outside- 0.03(BDL, MDC/2 is reported, NIOSH 5700), 0.004(BDL, MDC/2 is reported, Elia et al.)Blender room- next to area air sample- 2.31(NIOSH 5700), 0.431(Elia et al.)Core Line- untreated dried wood fibers- 0.05(BDL, MDC/2 is reported, NIOSH 5700), 0.006(BDL, MDC/2 is reported, Elia et al.)Form Line- next to area air sample- 2.16(NIOSH 5700), 0.321(Elia et al.)Sander operator station- dust on catwalk- 0.12(Value between MDC and MQC,NIOSH 5700), 0.120(Elia et al.)Form line- fibers face mat on line- 0.15(Value between MDC and MQC, NIOSH 5700), 0.275(Elia et al.)Board cooler- dust on floor next to machine- 1.13(NIOSH 5700), 0.145(Elia et al.)Sander dust- from silo outside building- 0.91(NIOSH 5700), 0.167(Elia et al.)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or sound methods that are from frequently used sources (NIOSH HHEs).	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Study implemented from 1991 and 1993 - 28 years old	
	Metric 5: Sample Size	Medium	Statistical distribution of samples is fully characterized. Sample size appears to be low (~2 samples per location)	
Domain 3: Accessibility/ Clarity				
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Study Citation:		Sussell, A. (1995). Health hazard evaluation report No. HETA-91-0239-2509, Medite Of New Mexico, Las Vegas, New Mexico. :91-0239.		
HERO ID:		1316591		
Conditions of Use:		Compressed Wood Product Manufacturing		
Domain		Metric	EVALUATION	
			Rating	Comments
Metric 6:		Metadata Completeness	High	Clearly noted that information provided came from site visit and provided methodology that measured formaldehyde in bulk samples.
Domain 4: Variability and Uncertainty				
Metric 7:		Metadata Completeness	High	sufficient data are provided to assess variability between locations and uncertainty is addressed by discussion on appropriate sampling methodology and two different analytical methodology.
Overall Quality Determination			High	

Study Citation:	Sussell, A. L. (1990). Heta 89-335-2041 May 1990 Sheffield Lake Service Department Sheffield Lake, Ohio.			
HERO ID:	8156936			
Conditions of Use:	Fuels and related products			
EXTRACTION				
Parameter	Data			
Process description:	On a daily basis, diesel trucks are driven into the maintenance shop, consisting of a single service bay located in the southwest corner of the building. It is periodically necessary to run the truck engines in the maintenance shop during servicing. During the winter months, diesel-powered trucks are parked in the five garage bays overnight to keep the engines somewhat warmer than outside conditions. From 7:00 to 7:30 am, trucks to be used that day are started and run for 1 to 2 minutes, then pulled outside. The running time in the building reportedly is necessary to allow for the air brakes to become pressurized, and for the older-model truck engines to briefly warm up. (2/13)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources(NIOSH HHEs).	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for commercial use of fuels and related products, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination		High		

Study Citation: Sylvain, D. (1999). Health hazard evaluation report: HETA 98-0194-2721, U.S. Fish and Wildlife Service, Nashua, New Hampshire.				
HERO ID: 6558295				
Conditions of Use: commercial use				
EXTRACTION				
Parameter		Data		
Process description:		The procedure for applying formalin treatment is as follows: (1) shut-off the water supply to the tank to be treated, and drain the tank to a depth of one foot; (2) pour one gallon of formalin from a plastic jug into a pump-up, pressurized garden sprayer; (3) spray the contents a few inches above the surface of the tank; (4) turn-on tank aeration, and allow fish to be treated for one-hour; (5) fill the tank, and restart the flow of water through the tank.		
Chemical concentration:		Formalin used in hatcheries contains 37% formaldehyde, 6-15% methanol, and “inert ingredients.”		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness		Metric 2: Geographic Scope	High	data are from the United States
		Metric 3: Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
		Metric 4: Temporal Representativeness	Low	data is more than 20 years old
		Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumption
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Low	report does not address variability or uncertainty
Overall Quality Determination			Medium	

Study Citation:	Sylvain, D. C. (1996). Health Hazard Evaluation Report HETA 96-0120-2608, Acton Post Office, Acton, Massachusetts, October 1996.			
HERO ID:	1316934			
Conditions of Use:	Use of Cleaning and Furniture Care Products			
EXTRACTION				
Parameter	Data			
Number of sites:	1			
Chemical concentration:	floor wax = 0.41 % formaldehyde content			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study, using Method 3500
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (government office) within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	1996 - more than 20 olds
	Metric 5:	Sample Size	Low	A single value was provided, no statistics characterizing the results.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Method 3500 was used
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability was not discussed an a single value was provided.As NIOSH Method 3500 was used it is assumed that uncertainty was considered in the method.
Overall Quality Determination		Medium		

Study Citation:	Tang, X., Bai, Y., Duong, A., Smith, M.T., Li, L., Zhang, L. (2009). Formaldehyde in China: Production, consumption, exposure levels, and health effects. Environment International 35(8):1210-1224.		
HERO ID:	626839		
Conditions of Use:	Multiple		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	China 12,000 kt (2007) approximately 34% of global total compared to US (2.4 times higher or approximately 5,000 kt) the report also include a summary of Chinese and global uses for formaldehyde		
Life cycle description:	Global distribution of formaldehyde use [Figure 2]: 44.6% Urea-formaldehyde resin, 13.3% other, 11% phenol-formaldehyde resin, 8.8% polyacetal resin, 6.2% melamine formaldehyde resin, 5.3% diphenylmethane diisocyanate, 4.6% pentaerythritol, 3.4% 1,4-butanediol, 2.2% urotropine		
Number of sites:	354 sites for production throughout Mainland China		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	China - not an OECD member
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation
	Metric 4: Temporal Representativeness	Medium	The report captures operations, equipment, and worker activities that are expected to be reasonably representative of current conditions. The report (2009) is more than 10 but less than 20 years old.
	Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		Medium	

Study Citation:	Tapp, L., Ewers, L., Durgam, S. (2008). Evaluation of contact dermatitis among machinists at an automotive parts manufacturer.			
HERO ID:	8684532			
Conditions of Use:	Processing aids, not otherwise listed			
EXTRACTION				
Parameter	Data			
Process description:	In this plant, metal automobile parts were made using grinding machines. Some parts were dipped in nylon powder/limestone mixture to form protective coatings. Metal parts were hardened using induction heaters, and then cleaned in a hydrochloric acid bath. (10/40)			
Chemical concentration:	Formaldehyde was found in concentrations from ND-724 ug/mL in metalworking fluids. (14/40)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	Data are for the use of metalworking fluids, which is similar to the in-scope occupational scenario of functional fluids and processing aids.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	High	Statistical distribution of samples is fully characterized (discrete sampling data provided).	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is addressed in the sampling methods and LODs. Variability is not addressed.	
Overall Quality Determination		High		

Study Citation:	Taylor, A. W. (2004). Fertilizers. :111-128.		
HERO ID:	11203989		
Conditions of Use:	Commercial Uses - Chemical substances in agriculture use products - Lawn and garden products		
EXTRACTION			
Parameter	Data		
Production, import, or use volume:	Table 1 (pg 3) presents annual world consumption rates of N, P2O5, and K2O for various years 1930-1999; 138.3 Mts/yr total nutrients in 1999		
Process description:	Urea-formaldehyde (38% N) and isobutylidene diurea (IBDU, 31% N) are specialized materials developed as “slow-release” nitrogen fertilizers. Both are polymeric compounds made by reacting urea respectively with formaldehyde and isobutyraldehyde. Both are insoluble in water, and, in the soil, both hydrolyze to release urea at a rate that depends upon the granule size, which can be varied to control the rate of nitrogen release. (pg 7)Fertilizers are applied as fluids, dry bulk, or bagged granulated materials. Considerable amounts of nitrogen are used as “direct applications” of this single nutrient, either by surface applications of urea, ammonium nitrate, or sulfate or by the injection of gaseous ammonia or “aqua ammonia” solution into the soil. The use of these latter high nitrogen content fluid materials has steadily increased due to their ease of handling and application to row crops; they are also well suited for use by contract suppliers and applicators who formulate and apply fertilizers to the field as requested by the farmer.Mixed formulations containing two or three nutrients are used as dry materials made by the blending of granular materials in bulk or in fluid forms made by blending fertilizer solutions3. About one-half of the fertilizers used in the United States are applied as mixed formulations, and about three-fourths of these are used as bulk materials or in solution. The fraction used as dry bagged materials—as opposed to those supplied and used in bulk—has steadily declined over the last 30 years, reflecting the reduced transport costs of bulk materials and the growth of the contract applicators as part of the farm support industry (pg 13)There are several principal techniques for fertilizer application in the field. These include: 1) surface broadcasting without incorporation into the soil, 2) surface application with immediate incorporation and placement in the soil by an attachment to the plow or cultivator, and 3) the injection of liquids and gaseous formulations by pumping through cultivator knives. Applications are also made in irrigation water for crops grown with such water supplies. (pg 14)		
Throughput:	Amount of fertilizer nitrogen: maximal values of about 250 kg/hectare (pg. 2)		
Chemical concentration:	No concentration data for FA/Urea-FA, other than 38% N in urea-FA		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.
	Metric 3: Applicability	Medium	Data are for fertilizers, an in-scope occupational scenario; however, majority of data are not formaldehyde-specific.
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but less than 20 years old and industry conditions that are expected to be outdated.
	Metric 5: Sample Size	N/A	Not applicable no quantitative data on formaldehyde
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by providing data for different nutrient types but uncertainty is not addressed.
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Study Citation:	Taylor, A. W. (2004). Fertilizers. :111-128.		
HERO ID:	11203989		
Conditions of Use:	Commercial Uses - Chemical substances in agriculture use products - Lawn and garden products		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	Thetkathuek, A., Yingratanasuk, T., Ekburanawat, W. (2016). Respiratory Symptoms due to Occupational Exposure to Formaldehyde and MDF Dust in a MDF Furniture Factory in Eastern Thailand. 2016:3705824.		
HERO ID:	4454841		
Conditions of Use:	Medium-density fiberboard (MDF) furniture manufacturing		
EXTRACTION			
Parameter	Data		
Process description:	Medium-density fiberboard (MDF) is composed of the residues of wood production, such as hardwood sawdust (equivalent to 0–15%) and softwood sawdust (85–100%) mixed with wax, resin, or glue [1, 2] and combined with 8– 18% urea–formaldehyde resin [3]. The board is then heat pressurized to form shapes.		
Chemical concentration:	8– 18% urea–formaldehyde resin		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journal articles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	The data are from a non-OECD country, and locality-specific factors (e.g., potentially greater differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S., or the country of origin is not specified.
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results. Uncertainty is well characterized.
Overall Quality Determination		High	

Study Citation:	Thorne, P.S., Dekoster, J.A., Subramanian, P. (1996). Environmental assessment of aerosols, bioaerosols, and airborne endotoxins in a machining plant. American Industrial Hygiene Association Journal 57(12):1163-1167.				
HERO ID:	1970347				
Conditions of Use:	Use of Metalworking fluid				
EXTRACTION					
Parameter	Data				
Process description:		The article deals with aerosols in machining plants. Aerosols of metalworking fluids (MWF) are generated in the process of cooling, flushing, and lubricating machine tools and metal parts during machining operations such as drilling, grinding, honing, hobbing, and milling. While mineral oils are most commonly used for honing, these other machining processes use water-based MWF, typically containing 2 to 20% emulsified oil. These MWF systems become complex mixtures of water, emulsified oils, antifoam agents, rust inhibitors, biocides, microorganisms, and microbial products.			
EVALUATION					
Domain		Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data	
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4:	Temporal Representativeness	Low	data is greater than 20 years old	
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination			High		

Study Citation:	Thredgold, L., Gaskin, S., Heath, L., Pisaniello, D., Logan, M., Baxter, C. (2019). Understanding skin absorption of common aldehyde vapours from exposure during hazardous material incidents.			
HERO ID:	5024659			
Conditions of Use:	Various (wood processing, the production of resins, fertilisers, dyes, disinfectants, germicides and as a biological fixative in medical laboratories (pg 2))			
EXTRACTION				
Parameter	Data			
Life cycle description:	commonly used in wood processing, the production of resins, fertilizers, dyes, disinfectants, germicides and as a biological fixative in medical laboratories			
Chemical concentration:	37, 44, 50% in formalin (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data/techniques/methods that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Australia, an OECD country.
	Metric 3:	Applicability	High	Data are for various in-scope occupational scenarios
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	concentration data
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	concentration data
Overall Quality Determination			High	

Study Citation:	TOMA, (1988). Historical prospective mortality study of past and present employees of Celanese Chemical Plant located in Bishop, Texas with cover letter dated 05/02/88.			
HERO ID:	5905893			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	6 billion (lbs)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for manufacture, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1982)
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination		Medium		

Study Citation:	TVA, (1991). Formaldehyde in urea product and urea production – status report with cover letter dated 02/01/91 and attachments.			
HERO ID:	5899360			
Conditions of Use:	Processing into a formulation- Fertilizer (Urea)			
EXTRACTION				
Parameter	Data			
Process description:	Formaldehyde has been widely used in the production of urea since the mid-1970’s as a conditioning agent to harden the product; reduce dust generation during handling; and provide anti-caking properties in storage. Formaldehyde reacts with molten urea in the process to form principally methylenediurea			
Throughput:	Production rates on 5 days in 1980 were between 10,200 lbs/hr and 32,000 lbs/hr and formaldehyde concentration in these products ranged between 0.36 and 0.57 wt percent. Table II contains production rate of formaldehyde in ml/min ranges from 2340-2406.			
Chemical concentration:	Up to 0.6% formaldehyde is added to the urea melt prior to granulation or prilling commercial urea fertilizer. Total formaldehyde in urea samples ranged from 0.3 to 0.55%. Free formaldehyde was determined to be 0.01% or less in all urea samples.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and specifies the methods used for quantifying concentrations.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US data	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	Data is more than 20 years old	
	Metric 5: Sample Size	Low	no statistics	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources, assessment methods	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	U.S. Congress, (1982). Federal response to health risks of formaldehyde in home insulation, mobile homes, and other consumer products: Hearings before a subcommittee of the Committee on Government Operations, House of Representatives, Ninety-seventh Congress, second session.				
HERO ID:	6018048				
Conditions of Use:	Mobile homes				
EXTRACTION					
Parameter	Data				
Throughput:	Approximately 250,000 mobile homes are sold and manufactured in the US each year				
Number of sites:	435,000 mobile homes are insulated with Urea Formaldehyde Foam Insulation (UFFI)				
Comments:	Source is a collection of statements and articles about formaldehyde in mobile homes. The source is generally limited to exposures to occupants / residents of mobile homes (not to workers).				
EVALUATION					
Domain	Metric	Rating	Comments		
Domain 1: Reliability	Metric 1: Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.		
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.		
	Metric 3: Applicability	Low	The report is for a non-occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, such as a consumer DIY scenario that is similar to a worker scenario.		
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.		
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.		
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.		
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.		
Overall Quality Determination		Low			

General Engineering Assessment

Study Citation:	U.S. Congress, (1982). Federal response to health risks of formaldehyde in home insulation, mobile homes, and other consumer products: Hearings before a subcommittee of the Committee on Government Operations, House of Representatives, Ninety-seventh Congress, second session.			
HERO ID:	6018048			
Conditions of Use:	Urea, melamine, and phenolic resins			
EXTRACTION				
Parameter	Data			
Life cycle description:	Urea and melamine resins: 55.6% are used in particleboard bonding; 10% for laminating veneers; 9% in plywood manufacturing; 11.6% in molded plastic goods; 5-6% for coatings and treatments for textiles. Phenolic resins: 301 plywood, 39% bonding, adhesive and laminating uses such as abrasives, particle board, friction materials (brake linings), foundry molds, insulating materials (fiber glass), electrical insulation and numerous other molded plastic components. (p. 81)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).
HERO ID:	1256822
Conditions of Use:	Domestic Manufacture

EXTRACTION	
Parameter	Data
Process description:	Formaldehyde is produced in the United States by two methods: the metallic silver catalyst process and the metal oxide process. The silver catalyst process is the predominant process, accounting for 75% of formaldehyde manufactured, while the metal oxide process accounts for the remaining 25 %. Both production methods use methanol as the starting material. Silver Catalyst Process – The major products of the silver catalyst process are formaldehyde, hydrogen, and water. Actual flow diagrams for production facilities will vary. Compressed air, which has been scrubbed to remove traces of sulfur dioxide, hydrogen sulfide, and other impurities, is passed through a vaporizer column, where it is heated and saturated with methanol vapor. The heated stream must maintain a methanol concentration greater than 37 volume percent in order to be above the upper explosive limit of methanol. The mixture then enters a battery of converters that are maintained at a temperature of approximately 635°C. The hot effluent gases are cooled rapidly to prevent decomposition of the product formaldehyde. Cooling is accomplished by indirect heat interchange with the feed mixture in the vaporizer and by then introducing the gas into the primary absorber. The primary absorber liquid is an aqueous solution of formaldehyde and methanol. A portion of this liquid is withdrawn from the bottom of the absorber column and recirculated to the top. The remainder is pumped to the product fractionation column. The uncondensed vapors and noncondensable gases are withdrawn from the top of the primary absorber column and fed to a secondary absorber. The major portion of the uncondensed vapors is recovered in the secondary absorber column through contact with demineralized water, and the off-gas, consisting mostly of nitrogen with some entrained volatile organic compounds (VOC's), is vented. The weak formaldehyde/methanol solution withdrawn from the bottom of the secondary absorber column is pumped to the primary absorber column and used as makeup solution. The methanol-containing formaldehyde solution is pumped to a fractionation column, where methanol is recovered. This vacuum distillation step yields an overhead product of approximately 99% methanol for recycle to the reactor and a bottom product of formaldehyde solution containing less than 1% methanol. The methanol vapor from the top of the column is condensed and recycled to the vaporizer. Uncondensed vapors are vented or fed to the absorber. The formaldehyde solution from the bottom of the fractionation column is pumped to product storage tanks. When required by customer specifications, the solution is treated in an ion exchange system for removal of trace amounts of formic acid before being stored. As a final step, water is added to provide a suitable concentration for storage and shipping. Reported yields for the metallic silver catalyst process range from 83 to 92%. All product storage tanks are heated to prevent polymer formation and precipitation in storage. A series of tanks are used to blend and adjust the solution to the desired formaldehyde and methanol concentrations before it is shipped to the customer. Metal Oxide Catalyst Process– In the metal oxide catalyst process, the major products are formaldehyde and water. The catalyst system most often used is ferric molybdate. The process begins as incoming air, which has been scrubbed to remove dust and trace impurities, is mixed with oxygen-lean recycle gas from the process to lower the oxygen content of the air feed stream below 10.9%. This low oxygen content keeps the methanol concentration below the lower explosive limit when a portion of the air feed stream is saturated with methanol in the vaporizer column. The methanol-saturated air is then mixed with the remaining air and preheated by heat exchange with the product gas leaving the converter. The feed gas mixture then enters the converter, which is maintained at 345°C by the exothermic oxidation reaction. The product gas is cooled by heat exchange with the feed gas mixture and then quenched in the absorber column. The formaldehyde and methanol are removed from the gas stream by absorption in the aqueous solution. The unabsorbed gases and vapors exit at the top of the absorber column. A portion of this gas is recycled, and the remaining gas is vented. The product solution drawn from the bottom of the absorber column contains approximately 0.8% methanol and 0.005% formic acid. The solution generally is treated in an ion exchange system to reduce the acidity and is then stored. As a final step, water is added to provide a suitable concentration for storage and shipping. Process yields of 91 to 93% are reported for the metal oxide catalyst process.
Number of sites:	51

EVALUATION	
Domain	Metric
Rating	
Comments	
Domain 1: Reliability	Metric 1: Methodology
High EPA Locating and Estimating document	
Domain 2: Representativeness	Metric 2: Geographic Scope
High US	

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Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).
HERO ID:	1256822
Conditions of Use:	Domestic Manufacture

Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 3:	Applicability	High	The report is for an occupational scenario (formaldehyde manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Resin Manufacture			
EXTRACTION				
Parameter	Data			
Process description:	Amino resins generally are produced in a batch reactor but some are produced in closed continuous systems. The first reaction of the process, the addition of formaldehyde to the amino compound to form methylol compounds, is carried out under alkaline conditions. Caustic, formaldehyde, and the amino compounds are charged to the heated reaction vessel. Next, the reactor conditions are altered to favor the second reaction, the condensation of the methylol compounds to form a polymer chain. The condensation reaction is carried out under acidic conditions and is stopped at the desired degree of polymerization by lowering the temperature and raising the pH. At high degrees of polymerization, a solid polymer is produced. At low degrees of polymerization, a stable syrup is produced that can be used as an adhesive or laminating resin. The syrup can be combined with a filler to make a molding compound or used with other polymers in coatings formulations. The syrup can also be spray dried to form a powder for convenient storage and handling. However, some producers of U-F and M-F resins report that there are no spray drying operations at their production facilities.			
Number of sites:	176			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination		High		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).
HERO ID:	1256822
Conditions of Use:	Reactant Resin Manufacture

EXTRACTION	
Parameter	Data
Process description:	Phenol-formaldehyde resins are formed by polymerization of phenol and formaldehyde. The two major resin types are resols and novolaks. Resols are formed in an alkaline medium with an excess of formaldehyde and are marketed as thermosetting resins, bonding resins, varnishes, and laminates. Novolaks are formed in an acid medium deficient in formaldehyde. These are thermoplastic resins that require mixing with formaldehyde or a formaldehyde donor such as hexamethylenetetramine to produce a thermosetting product. Resol Production Process– Resols are commonly produced in a batch process. Major products of the resol production process are phenol-formaldehyde resin and water. Phenol, formaldehyde, and sodium hydroxide are charged to an agitating reactor. Steam is then fed to the kettle jacket and to internal coils to initiate the reaction. As the exothermic reaction begins, cooling water is supplied to the kettle to maintain temperature control. Additional cooling is accomplished by using a reflux condenser. The degree of polymerization is monitored by withdrawing samples and testing them. The degree of polymerization determines the physical properties of the product. The reaction can be halted at a point where the polymer is still water soluble enough that it can be incorporated into bonding resins. Alternatively, the reaction can be allowed to progress to the point at which the polymer precipitates. In this case, the water is removed and an organic solvent can be added to form a varnish. If the polymerization reaction is allowed to continue until the resin reaches a brittle stage, a thermosetting molding powder can be produced. The polymerization reaction is stopped by rapid cooling and neutralization with sulfuric acid. The mixture is then distilled in the reactor kettle to purify the resin. If the resin application requires a low concentration of water, the resin is dehydrated, often under vacuum. The production of dry product requires discharge of the resin from the reactor through a special quick-discharge valve to prevent it from becoming an insoluble, infusible solid. Cooling must be accomplished by spreading the material in thin layers because of its low thermal conductivity. Cooling devices include water-cooled or air-cooled floors, trays in racks, and moving belts. After cooling, the solid is ground, screened, and packaged. Some of the solid resols require several water washing steps. This procedure necessitates drying the resin before it is packaged. The solid resin may be blended with fillers and additives before it is readied for marketing. Novolak Production Process – The production of novolak resins is also commonly performed by a batch process. As in the production of resols, phenol and formaldehyde are charged to a jacketed batch reactor. However, sulfuric or hydrochloric acid is added instead of a base. The temperature is raised to initiate the reaction. If strongly acidic conditions are used, a vacuum reflux system must be used for cooling, but in many cases atmospheric reflux is sufficient. Additional cooling is provided by circulating cooling water in the jacket and in the internal coils of the reactor. When the reaction is completed, the resin is purified by distillation in the reactor kettle and subsequent dehydration. In some cases, the polymer is neutralized before it undergoes further processing. In solid resin production, the reactor charge is dumped onto cooling surfaces in thin layers. Water-cooled or air-cooled floors, trays in racks, and moving belts are used for rapid cooling. The solid resin is then ground, and screened. Fillers, coloring agents, and hexamethylenetetramine may be blended with the resin, which can then be fused on hot rollers, ground and packaged as a finished thermosetting resin product. During the production of solutions used in varnishes and laminating agents, solvent is also added in the reactor. The solutions are packaged in drums or tanks.
Number of sites:	105

		EVALUATION		
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.

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Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).		
HERO ID:	1256822		
Conditions of Use:	Reactant Resin Manufacture		
Domain	Metric	EVALUATION Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination		High	

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Resin Manufacture			
EXTRACTION				
Parameter	Data			
Process description:	POLYACETAL RESIN PRODUCTIONAcetal resins are produced by the polymerization of anhydrous formaldehyde or its trimer, trioxane. Formaldehyde and trioxane homopolymers and copolymers of these compounds and other monomers are produced. The homopolymer is a chain of repeating oxymethylene structures (-OCH2-), while the copolymer has the oxymethylene structure occasionally interrupted by a comonomer unit such as ethylene. Where formaldehyde is to be polymerized, the first step in the process is the production of anhydrous formaldehyde vapor from formaldehyde solution. Water is first evaporated from aqueous formaldehyde solution to form semiformals, paraformaldehyde, and polyoxymethylene which are purified and thermally decomposed to produce anhydrous formaldehyde. Impurities such as methanol, formic acid, and water are removed by washing with nonvolatile polyols or by freeze-trapping slightly above the boiling point of formaldehyde.Anhydrous formaldehyde monomer is then fed to an agitated batch reactor with an inert diluent, initiators, and dispersants, where it is polymerized at a low temperature. The polymer molecular weight is controlled by the addition of chain-termination and transfer agents. The reaction is terminated by stopping the flow of monomer. The solid polymer is separated from the diluent by filtration and centrifugation. Chain ends are stabilized by treatment with acetic anhydride and refluxing to form acetyl groups. The final product is then washed and dried. In trioxane polymerization, trioxane is prepared from aqueous formaldehyde by acidification and distillation. The trimer is then separated from the aqueous distillate by extraction or crystallization before it is further purified by fractional distillation. Trioxane may then be polymerized by bulk, suspension, or solution methods in the production of the copolymer. Stabilization is accomplished by copolymerization with cyclic ethers.The final polymer is extruded. Additives may be added during extrusion. Extruded molten polymer strands are quenched in a water bath and then pelletized and stored.			
Number of sites:	2			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Resin Manufacture			
EXTRACTION				
Parameter	Data			
Process description:	Trimethylolpropane can be produced by the reaction of n-butyraldehyde with formaldehyde and alkali.			
Number of sites:	2			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	EPA Locating and Estimating document	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	N/A	Qualitative information provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Qualitative information provided	
Overall Quality Determination		High		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Plastic Manufacture			
EXTRACTION				
Parameter	Data			
Process description:	1,4-BUTANEDIOL PRODUCTION 1,4-Butanediol, also known as 1,4-butylene glycol, is produced by a two-step process. The first step involves the high-pressure reaction of acetylene and aqueous formaldehyde solution to form 1,4-butyndiol. In the second step, 1,4-butyndiol is hydrogenated to form 1,4-butanediol. Excess hydrogen is added during the exothermic hydrogenation reaction to control the reaction temperature.			
Number of sites:	4			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (plastics manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	external combustion - boilers			
EXTRACTION				
Parameter	Data			
Process description:	The boiler and space heating category includes steam-electric generating (utility) plants, industrial boilers, and commercial, institutional, and domestic combustion units. These unit are mainly fired by coal, oil, and natural gas. Other fuels used in relatively small quantities include liquefied petroleum gas, wood, coke, and waste and by-product fuels.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	EPA Locating and Estimating document	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	N/A	Qualitative information provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Qualitative information provided	
Overall Quality Determination		High		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).
HERO ID:	1256822
Conditions of Use:	combustion - oil refinery

EXTRACTION	
Parameter	Data
Process description:	Combustion Oil RefiningFormaldehyde is produced as a combustion product in a number of refinery operations. The major sources of formaldehyde emissions from oil refining are catalytic cracking, coking operations, and fuel combustion.Process heaters are used in almost every refinery unit operation to heat feed materials or to supply heat in distillation operations. They are designed to provide temperatures up to 510°C and can be fired by refinery fuel gas (usually CO-rich), natural gas, fuel oil, or oil/gas mixtures.Heat for refinery operations is also provided by steam, which is produced in boilers in the refinery utilities plant. These boilers generally are fired by fuel oil or oil/gas mixtures.At older refineries, high-pressure compressors are often run by natural gas-fired internal combustion engines. High-pressure compressors are used in hydrodesulfurization, reformation, and other refinery unit operations. Because of their greater reliability, electric motors and steam engines are used at most newer refineries in place of gas-fired engines. The total amount of fuel burned at a refinery dependson the size and complexity of the refinery. The breakdown of fuel use between fuel oil and gas depends on the availability of fuels, the particular requirements of various burners or engines, and applicable environmental (e.g., fuel sulfur) regulations. It is estimated that for a large complex refinery, the total fuel requirement is 230 Gigajoules (GJ) heat input per barrel (bbl) of crude feed, of which on the average about 70 percent is provided by fuel oil combustion and 30 percent by fuel gas combustion.Catalytic Cracking– In catalytic cracking, catalysts are used to break down heavy oils to lighter products. Feedstocks to catalytic cracking typically have a boiling range of 340 to 540°C. Catalytic cracking Processes currently in use can be classified as either fluidized catalytic cracking (FCC) units or moving-bed catalytic cracking units. In both processes, fresh and recycled oil are fed to a cracking reactor with hot regenerated catalyst. The reactor temperature for both processes is 470 to 525°C.In the FCC process, the oil vaporizes, and the catalyst, made up of very fine particles, becomes entrained in the vapor. The cracking reaction takes place as the fluidized-catalyst/oil-vapor stream flows up a riser in the center of the reactor. The catalyst and oil vapor are separated by cyclones at the top of the reactor. Spent catalyst from the cyclones falls to the reactor bottom where it is steam-stripped to remove adsorbed hydrocarbons before flowing out of the reactor.In the moving-bed process, catalyst beads (about 0.5 cm in diameter) are fed to the top of the reactor along with a mixed-phase oil feed. Cracking occurs as the catalyst and oil move concurrently downward through the reactor. Hydrocarbons are separated from the catalyst in a zone near the reactor bottom. Spent catalyst is then steam-stripped of adsorbed hydrocarbons and flows out of the reactor.Oil removed from the FCC catalytic cracking process is fed to a fractionation column, where it is split into gas and liquid product streams and a recycle stream. Spent catalyst in both processes is transferred to a regenerator, where coke deposits are removed from the catalyst surface by partial combustion with air at 590 to 675°C. Regenerated catalyst is separated from combustion products by cyclones and returned to the cracking reactor. Because the combustion process in the regenerator is incomplete, flue gas from the regenerator generally has a high CO concentration. Coking–Coking involves the thermal cracking of heavy residual oil to form lighter products and petroleum coke. Two types of coking processes are currently in use: fluid coking and delayed coking. In delayed coking, feed oil is heated to 480 to 580°C in a process heater and then fed to one of two coke drums. Cracking occurs as the oil flows through the heater, and light products are removed as an overhead vapor stream from the drum. Heavy liquids remain in the drum to form coke. The delayed coking process is a batch process. When the drum in use is filled to capacity with coke, the stream from the process heater is fed to the second drum. Meanwhile, coke is removed from the first drum with high-pressure water jets.In the fluid coking process, feed oil is contacted with hot pellets or seed coke particles in a fluidized bed reactor. The feed oil cracks, forming coke, which remains on the particles, and light products, which flow out of the reactor in an overhead stream. Fluid bed particles are removed continuously from the reactor and circulated through a burner. In the burner, the coke is partially combusted with air. A portion of the coke leaving the burner is removed as product, and the remainder is returned to the reactor. The continuous circulation of reactor bed material through the burner provides heat for the cracking reaction, transferred as sensible heat in the bed material. The reactor temperature is maintained at 525to 580°C. Flue gas from the fluid coker burner off-gas contains incomplete combustion products including a large amount of CO. Carbon monoxide emissions generally are controlled by passing the flue gas through a CO waste heat boiler.
Number of sites:	236

EVALUATION	
Domain	Metric
Rating	Comments
Domain 1: Reliability	
Metric 1:	Methodology
High	EPA Locating and Estimating document
Domain 2: Representativeness	
Metric 2:	Geographic Scope
High	US

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Study Citation:		U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).		
HERO ID:		1256822		
Conditions of Use:		combustion - oil refinery		
Domain		Metric	EVALUATION	
			Rating	Comments
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	combustion - Asphalt Concrete			
EXTRACTION				
Parameter	Data			
Process description:	Asphalt plants or asphaltic concrete plants are used to produce hot mix asphalt paving. This product is a mixture of well graded, high quality aggregate and liquid asphaltic cement which is heated and mixed in measured quantities to produce bituminous pavement material. Hot mix asphalt paving can be manufactured by batch mix, continuous mix, or drum mix process.In recent years, recycling of old asphalt paving has been initiated in the asphaltic concrete industry. In recycling, old asphalt pavement is broken up at a job site and is removed from the road base. This material is then transported to the plant, crushed, and screened to the appropriate size for furtherprocessing. The paving material is then heated and mixed with new aggregate, to which the proper amount of new asphaltic cement is added, to produce a grate of hot asphalt paving suitable for laying.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).
HERO ID:	1256822
Conditions of Use:	Reactant process aid

EXTRACTION	
Parameter	Data
Process description:	SOLID UREA AND UREAFORM PROCESSINGProcess Formaldehyde is used in the production of conditioning agents for solid urea and in the production of ureaform fertilizers.Solid urea is produced by first reacting ammonia and CO2 to form an aqueous urea solution. This solution is sold as an ingredient in nitrogen-solution fertilizers or further concentrated to produce solid urea. Urea solids are produced from the concentrated solution by two methods: prilling and granulation. Prilling is a process by which solid, nearly spherical particles are produced from molten urea. Molten urea is sprayed from the top of a prill tower, and as the droplets fall through a countercurrent air flow, they cool and solidify into nearly spherical particles. There are two types of prill towers: fluidized bed and nonfluidized bed. The major difference between these towers is that a separate solids cooling operation may be required to produce agricultural-grade prills in a nonfluidized bed prill tower.There are two granulation methods: drum granulation and pan granulation. In drum granulation, solids are built up in layers on seed granules in a rotating drum granulator/cooler approximately 14 feet in diameter. Pan granulators also form the product in a layering process, but different equipment is used. Pan granulators are not common in this country.Just prior to solids formation, formaldehyde-based additives (FBA's) are injected into the liquid or molten urea to harden the product, reduce dust generation during handling, and provide anticaking properties for storage. The two most commonly used FBA's in the fertilizer industry are formalin and urea-formaldehyde (U-F) concentrates. Formalin is an aqueous formaldehyde solution stabilized with methanol, whereas U-F-concentrates are a solution of 25 weight percent urea, 60 weight percent formaldehyde, and 15 weight percent water. Upon injecting FBA into the liquid or molten urea, formaldehyde reacts with urea to form methylenediurea (MDU), which is the true conditioning agent. FBA is usually added to urea at a level of 0.3 to 0.5 weight percent formaldehyde.Ureaform is a slow-release fertilizer produced from a mixture of urea, U-F-concentrate, sodium hydroxide, and water. The reaction to produce ureaform is initiated by adding acid, forming a wide distribution of methylene-urea polymers, similar to the MDU in solid urea. The initial concentration of formaldehyde in the ureaform process is much higher than in solid urea production.Emission sources
Number of sites:	8

		EVALUATION	
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High US
	Metric 3:	Applicability	High The report is for an occupational scenario (process aid) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low 1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A Qualitative information provided

Overall Quality Determination	High

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Resin Manufacture			
EXTRACTION				
Parameter	Data			
Process description:	HEXAMETHYLENETETRAMINE PRODUCTION Aqueous formaldehyde solution is first charged to a reaction kettle, followed by ammonia gas in a 3:2 formaldehyde/ammonia mole ratio. During addition of the reactants, the temperature is maintained at about 20 to 30°C. The reaction mixture is then fed to a vacuum evaporator, where it is maintained at a temperature between 30 and 50°C and at a pH of 7 to 8. As water is removed, the reactants condense to form hexamethylenetetramine. After most of the water has been removed, the product forms crystals, which are centrifuged, washed with water, and dried to yield the final product. The water from the centrifuge and the wash water are recycled to the system.			
Number of sites:	6			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant wood products			
EXTRACTION				
Parameter	Data			
Process description:	Pressed-wood Manufacturing Resins produced from formaldehyde find a wide range of applications. Over 65 percent of U-F resins are used as adhesives in the production of particleboard, medium-density fiberboard, and hardwood plywood. Almost 50 percent of phenol-formaldehyde (P-F) resins are used in the production of structural wood pane –			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (wood products manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination		High		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Resin Manufacture			
EXTRACTION				
Parameter	Data			
Process description:	PENTAERYTHRITOL PRODUCTION Formaldehyde is produced onsite at some plants for direct use as a feedstock in this process. Pentaerythritol is made by the condensation reaction of formaldehyde and acetaldehyde in the presence of an alkali solution. Most plants use a batch process.A sodium hydroxide solution or a calcium hydroxide slurry is added to a formaldehyde solution in a reactor in which the temperature is controlled at 15° to 20°C. Liquid acetaldehyde is then added to the mixture and an exothermic reaction takes place. External cooling is used to control the temperature at about 25°C for several hours, and it is then raised to about 60°C.When the aldehyde content of the mixture is less than 0.1 percent, the reaction mixture is fed to the neutralizer tank where formic acid, sulfuric acid, or oxalic acid is added to neutralize the excess alkali. The acid also reacts with the metallic ion of the alkali solution to form a salt, which can be removed by filtration. Next, the solution is fed to an evaporator, where water is removed to achieve a specific gravity of about 1.27. Lowering the temperature results in the crystallization of pentaerythritol, which is removed from the slurry by filtration. The mother liquor is fed to a recovery system. The filter cake can be dried to yield a technical grade of the product or it may be purified further by conventional methods. Byproducts of the reaction include polypentaerythritols (mainly dipentaerythritol and tripentaerythritol) and linear and cyclic formals of the various pentaerythritols.			
Number of sites:	4			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (resin manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	internal combustion - stationary sources			
EXTRACTION				
Parameter	Data			
Process description:	Internal combustion Stationary SourcesStationary internal combustion engines are used to generate electricity, to pump gas or other fluids, to compress air for pneumatic equipment, and to compress other gases for industrial processes. These engines include gas turbines and heavy-duty reciprocating engines.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability				
	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness				
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination		High		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	external combustion - industrial processes			
EXTRACTION				
Parameter	Data			
Process description:	External combustion – Industrial processesIn a number of industrial processes, heat requirements are satisfied by direct firing or by process heaters. In direct firing, hot gases from fuel combustion are contacted with the material to be heated. Process heaters are used to heat the material indirectly, either through the walls of a vessel orthrough a heat exchanger. Indirect contact process heating units are generally fired by natural gas, process gas, fuel oil, or oil-gas mixtures. Direct-fired units, such as rotary kilns, may also use coal.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant construction material			
EXTRACTION				
Parameter	Data			
Process description:	InsulationThe U-F resins are also used to produce home insulation, which accounted for over 6 percent of the resin use in 1977. About 17 percent of P-F resins are used as binders in the production of insulation. Urea-formaldehyde Foam Insulation Manufacturing-Formaldehyde may evolve from urea-formaldehyde foam insulation (UFFI) used in residential applications. The insulation is formed by the combination of the resin with a foaming agent and air, producing a liquid foam that is sprayed into the outer walls of existing homes. The foam fills the space between the walls and hardens in less than a minute.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	EPA Locating and Estimating document	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The report is for an occupational scenario (construction material) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	N/A	Qualitative information provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Qualitative information provided	
Overall Quality Determination		High		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant plastics Manufacture			
EXTRACTION				
Parameter	Data			
Process description:	PHTHALIC ANHYDRIDE PRODUCTIONProduction of phthalic anhydride is achieved by the catalytic air oxidation of o-xylene or naphthalene. Formaldehyde and other oxygenated compounds are produced as a byproduct of this reaction.Process Description Either naphthalene or o-xylene is fed to a reactor and converted, with air, to phthalic anhydride by vapor-phase oxidation in the presence of a vanadium pentoxide catalyst. The gaseous product is condensed and dehydrated to remove water formed during the reaction. The crude phthalic anhydride is then stripped of light ends and distilled under vacuum for final purification.			
Number of sites:	8			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	EPA Locating and Estimating document	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US	
	Metric 3: Applicability	High	The report is for an occupational scenario (plastics manufacture) within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.	
	Metric 5: Sample Size	N/A	Qualitative information provided	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Qualitative information provided	
Overall Quality Determination		High		

Study Citation:	U.S. EPA (1991). Locating and estimating air emissions from sources of formaldehyde (revised).			
HERO ID:	1256822			
Conditions of Use:	Reactant Plastic Manufacture			
EXTRACTION				
Parameter	Data			
Process description:	4,4-METHYLENEDIANILINE PRODUCTION4,4 1-Methylenedianiline (MDA) is formed by condensation of aniline and formaldehyde. MDA is usually converted into methylenediphenyl isocyanate (MDI) by phosgenation of the MDA salt. The production of MDA is a two-stage process. First, aniline is neutralized with concentrated hydrochloric acid in aqueous solution at 100°C to form aniline hydrochloride. This solution is cooled to 15°C, a 40 percent formaldehyde solution is added, and the resulting mixture is then heated at 55 to 60°C for 4 hours. The reaction mixture is chilled again, and the product is precipitated out with dilute ammonium hydroxide. The product may be purified further by recrystallization from alcohol or water.			
Number of sites:	4			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA Locating and Estimating document
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (plastics manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1991 - Prior to the PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, noting important assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	U.S. EPA (1985). Tumor of the nose and nasal sinuses - a case-control study with cover letter dated 033085.			
HERO ID:	5901018			
Conditions of Use:	Multiple COUs - leather, wood, metal working and floral industries.			
EXTRACTION				
Parameter	Data			
Life cycle description:	Early uses had largely to do with its disinfectant properties. It found uses as an embalming fluid and in disinfectant soaps and cleaning agents. In the furniture industry, it was incorporated in animal products: glues as a bactericide and as a preservative of wood. And, in the leather industry it is used as a disinfectant and tanning agent. An early use, developed in the Netherlands, was the treatment of flowers, in particular narcissus, bulbs against fungal rot. Formaline has been and is still extensively used as a ground disinfectant in the flower bulbs industry and is incorporated in disinfectants, insecticides and fungicides. The major uses of FA and its polymers are in the synthetic resin industry and in the manufacture of pentaerythritol and hexamethylenetetramine. Over 50% of the FA produced is used in the manufacture of resins. The resins have a wide variety of uses in glues, formed plastics, coatings, etc.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	TSCA submission for the department of public health and social medicine so likely contains high quality data.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data is from Netherlands, an OECD country.	
	Metric 3: Applicability	High	Data is applicable to exposure in various FA industries.	
	Metric 4: Temporal Representativeness	Low	Data is over 20 years old (1985)	
	Metric 5: Sample Size	Low	Data is qualitative.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Only contains life cycle description and worker activities.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Does not address variability or uncertainty.	
Overall Quality Determination		Low		

Study Citation:	U.S. EPA, (2020). 2020 CDR: Commercial and consumer use.			
HERO ID:	10366189			
Conditions of Use:	Manufacture and Import			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	2019 Nationally aggregated PV 1-5 million pounds			
Throughput:	Domestics or imported lbs/yr-site provided with some sites reported it as CBI.			
Number of sites:	45 manufacturing and import sitesIndustrial Sites: <10, 10-24, 25-99			
Chemical concentration:	filtering just for Formaldehyde maximum concentrations by product type range :Other articles with routine direct contact during normal use, including paper articles 1 - 30%Agricultural non-pesticide products 30-60%Solvent-based paint 30-60%Two-component glues and adhesives 1 - <30%Lacquers, stains, varnishes and floor finishes 1 - <30%Laboratory Use 1 - <30%Textile finishing and impregnating/surface treatment products 1-<30%Construction and building materials covering large surface areas, including wood articles, metal articles, paper articles <1% and 1-<30%Exterior car waxes, polishes, and coatings 1 - <30%			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA 2020 CDR requires manufacturers and importers to submit information to the best of their knowledge, and is generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The data is directly applicable across COUs within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data is submitted to the Agency in 2020.
	Metric 5:	Sample Size	Medium	Individual records are provided to allow for the development of appropriate statistics. Concentration are provided in ranges.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Report clearly documents results, and data sources. Methods and assumptions are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Detailed data are provided that can be used to assess variability and uncertainty.
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (2022). DMR Data for TCEP, formaldehyde, trans-1,2-dichloroethylene, 1,1-dichloroethane, and 1,2-dichloroethane.				
HERO ID:	11181053				
Conditions of Use:	All				
EXTRACTION					
Parameter	Data				
Number of sites: The dataset provides the number of sites with NPDES permits that are required to report to DMR.					
EVALUATION					
Domain	Metric		Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Data is from DMR, a frequently used EPA source.	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	DMR data are from the U.S.	
	Metric 3:	Applicability	High	Data are for all in-scope COUs.	
	Metric 4:	Temporal Representativeness	High	Data are less than 10 years old.	
	Metric 5:	Sample Size	N/A	Number of sites not based on sampling data.	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Submissions do not include method of how number of sites were determined or reported. There may be sites that release the chemical of interest, but do not report to DMR.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability is addressed by including number of site data from multiple reporting years. Uncertainty isn't addressed.	
Overall Quality Determination			High		

Study Citation:	U.S. EPA, (2023). National Analysis TRI dataset (TRI): Formaldehyde (CAS RN: 50-00-0), reporting years 2016-2021.			
HERO ID:	11204097			
Conditions of Use:	All			
EXTRACTION				
Parameter		Data		
Number of sites:		706-753 reports depending on the year		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., European Union or OECD reports, NIOSH HHEs, journalarticles, Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	High	Total number provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, andassumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report addresses variability but does not address uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (2008). Interim acute exposure guideline levels (AEGLs) for formaldehyde (CAS reg. no. 50-00-0).			
HERO ID:	5113354			
Conditions of Use:	Multiple COUs.			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Total annual capacity for production in the United States in 1998 was 11.3 billion 11 pounds. The primary method of manufacture is from methanol with either silver or a metal oxide as catalyst (ATSDR 1999). Most formaldehyde produced in the United States (23%) is used in /urea-formaldehyde resins. Other uses include phenolic resins (19%), acetylenic chemicals (12%), polyacetal resins (11%), methylene diisocyanate (6%), pentaerythritol (5%), urea formaldehyde concentrates (4%), hexamethylenetetramine (4%), melamine resins (4%), and miscellaneous (12%) (ATSDR 1999). The phenolic, urea, and melamine resins are used in the manufacture of plywood, fiberboard, and particle board. Worldwide production in 2000 was 21, 547 thousand tons (IARC 2006).”			
Comments:	Production data is ATSDR and IARC.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (e.g., ASTDR & IARC) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States.
	Metric 3:	Applicability	High	The data is applicable for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The data is more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent(Lack of clarity on how production volume is determined).
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Uncertainty is not discussed, nor variability in use percentage.
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (1985). Preliminary assessment of health risks to garment workers and certain home residents from exposure to formaldehyde (draft).			
HERO ID:	5901066			
Conditions of Use:	commercial use			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Over the last 30 years, the annual production and domestic use of formaldehyde in the United States has gone up fivefold from 1 billion pounds. The chemical is not imported in any appreciable quantities. The 1983 commercial production of HCHO amounted to about 6 billion pounds. The major derivatives are urea-HCHO resins, phenol-HCHO resins, acetal resins, and butanediol. The urea- and phenol-HCHO resins account for about 53 percent of HCHO production. Adhesives and plastics are the major end uses.			
Life cycle description:	HCHO's major non-consumptive uses (the chemical identity of the HCHO does not change) are (1) disinfectant, (2) preservative, (3) deodorant, and (4) textile and paper uses. The major pseudo-consumptive uses (the chemical identity of HCRO does change, but it is not irreversibly altered) are (1) urea-HCHO resins which are used in fiberboard, particleboard, plywood, laminates, urea-HCHU foams, r molding compounds, and paper, textiles, and protective coatings: (2) urea-HCHO concentrates which are used to produce time-release fertilizers, and (3) nexamethylenetetramine which is used as a special anhydrous form of HCHO to cure resins and to treat textiles and rubber. The major consumptive uses (uses in which HCHO serves as a feedstock for the preparation of other chemicals) are (1) melamine-HCHO resins which are used for molding compounds, fiberboard, particleboard, plywood, laminates, paper and textiles, (2) phenol-HCHO resins which are used in fiberboard, particleboard, plywood molding compounds, and insulation: (3) pentaerythritol which is used to produce alkyd resins, (4) 1,4-butanediol which is used to produce tetrahydrofuran, (5) acetal resins which are used in the manufacture of engineering plastics, and (6) trimethylolpropane which is used in the production of urethanes.			
Process description:	Commercially, HCHO is produced from the catalytic oxidation of methanol, using either silver oxide or a mixed-metal oxide as the catalyst. Processes accounting for the indirect production of HCHO include the photochemical oxidation of airborne hydrocarbons released from incomplete combustion processes. The direct production of HCHO during incomplete combustion of hydrocarbons in fossil fuels and refuse, and certain natural processes.			
Chemical concentration:	Pure monomeric formaldehyde is a colorless, pungent gas at ordinary temperatures. Aqueous formaldehyde, called formalin, is a clear, colorless solution containing about 37 percent by weight of dissolved formaldehyde in water, usually with 10 to 15 percent methanol added to prevent polymerization.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report does not document its data sources, assessment methods, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	report does not address variability or uncertainty
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Study Citation:	U.S. EPA, (1985). Preliminary assessment of health risks to garment workers and certain home residents from exposure to formaldehyde (draft).		
HERO ID:	5901066		
Conditions of Use:	commercial use		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		Medium	

Study Citation:	U.S. EPA, (1979). USEPA status report: Formaldehyde with cover letter dated 101679.			
HERO ID:	5901271			
Conditions of Use:	manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Between 2 billion and 7.9 billion pounds of formaldehyde were reported as produced/imported in 1977. This production range information does not include any production/information data claimed as confidential by the person(s) reporting for the TSCA inventory, nor does it include any information which would compromise CBI.			
Life cycle description:	Formaldehyde has uses in urea and melamine resins; polyacetal resins; phenolic resins; ethylene glycol; pentaerythritol; hexamethylenetetramine; fertilizer dyes; medicine (disinfectant, germicide); embalming fluids; preservative; hardening agent; reducing agent, as in recovery of gold and silver; corrosion inhibitor in oil wells; durable-press treatment of textile fabrics; possible condensation to sugars and other carbohydrates for food use (experimental); industrial sterilant; treatment of grain smut.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	data greater than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	report does not address variability or uncertainty
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1984). Letter from Wycon Chemical co. to USEPA regarding comments on methylourea and urea-formaldehyde resins.			
HERO ID:	5906957			
Conditions of Use:	processing			
EXTRACTION				
Parameter		Data		
Production, import, or use volume:		During the time of the article, Wycon was producing 28,000 tons of urea prills annually. The yearly consumption of UF-71 mixture was about 240 tons.		
Life cycle description:		Urea/formaldehyde concentrate, known as UF-21, was utilized to promote anticaking urea prill product.		
Process description:		The UF-71 is shipped to the Wycon plant by truck in completely enclosed tanks. From the truck, the material is pumped into an enclosed tank for storage until needed. F-71 is then piped from the storage tank into the urea plant where the UF-71 is injected into the urea product just prior to the prilling operation. During the prilling processing, the heat involved with drying and hardening the molten solid urea into spherical pellets also polymerizes virtually all of the UF resin. The small resulting percentage of chemically inert polymerized resin in the urea prills prevents the caking of the prills.		
Chemical concentration:		UF-71 is a mixture of 50.5% formaldehyde, 20.5% urea, and 29% water.		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	High	report uses high quality data
Domain 2: Representativeness		Metric 2: Geographic Scope	High	data are from the United States
		Metric 3: Applicability	High	report is for an occupational scenario within the scope of the risk evaluation.
		Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.
		Metric 5: Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	Low	data sources for this report are not fully transparent.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2004). Additives in plastics processing (compounding) – Generic scenario for estimating occupational exposures and environmental release – Draft.				
HERO ID:	6311218				
Conditions of Use:	Generic article which does not specifically address formaldehyde or polyacetal plastics which is a formaldehyde based product but it does describe plastic manufacturing process used in polyacetal processing.				
EXTRACTION					
Parameter	Data				
Process description:	Extruders: Polymer and additives are preblended in a hopper or tumbler then the mixture is fed into an extruder comprised of one or two screws. The material is heated in the extruder and the screws shear the material and transport it through the extruder.				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	EPA report	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US	
	Metric 3:	Applicability	Low	The description of plastic extrusion is relevant for formaldehyde based plastics not considered in this report	
	Metric 4:	Temporal Representativeness	Medium	2004 - more than 10 years old but less than 20	
	Metric 5:	Sample Size	N/A	qualitative information provided	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	EPA study	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative information provided	
Overall Quality Determination			High		

Study Citation:	U.S. EPA, (1999). Flexographic printing - generic scenario for estimating occupational exposures and environmental releases: Draft.		
HERO ID:	6385709		
Conditions of Use:	commercial use: chemical substances in packaging, paper, plastics and hobby products.		
EXTRACTION			
Parameter	Data		
Process description:	Printing ink is typically received at a flexographic facility in 55 gallon drums and is pumped into a dispensing system or poured into 5 gallon ink cans in the ink preparation room. Each 5 gallon can is capped and carried to the press where it is opened and poured into an enclosed ink sump at press side. The ink can itself may alternatively serve as the sump. The ink is then pumped from the ink sump to an enclosed chamber which may or may not empty into an open drain pan.Next, the press is prepared for production (i.e., the makeready process). During makeready, a sample of the substrate is run through the press to allow for correction of the printing quality and the sample is then recycled or disposed. The substrate is then run through the press for the actual production run. At the conclusion of the run, the unused ink is pumped out of the ink chamber back into the sump. The “ink consumed” during makeready and production (i.e., the difference between the amount of ink added to the ink chamber and the amount removed from the ink chamber at the end of the run) either remains on the rollers, is released to the air, or is printed onto the substrate. For purposes of the CTSA, “ink consumed” includes only the ink printed on the substrate or released to air (all other releases, including container residual were considered negligible and were outside the scope of the study). Following a production run, the ink rollers and ink chamber are cleaned with solvent (for solvent-based and UV-cured inks) or water (for water-based inks). The solvent cleaning solutionmay be reused and is eventually disposed as a hazardous waste and incinerated or burned for energy recovery. The water cleaning solution may be reused and is eventually disposed as a hazardous or non-hazardous waste.		
Throughput:	Ink consumption rates vary by color of the ink; white inks have significantly higher consumption rates than the other colors, with green and blue inks having slightly higher consumption rates than magenta and cyan inks. Press speed also greatly affects the amount of ink consumed. All estimates in the CTSA assumed a press speed of 500 feet per minute for all three formulation types, which will result in the highest consumption, release, and exposurelevels. With this press speed, ink consumption rates are approximately the same between different formulation types. Model runs using industry-supplied data associated with varyingpress speeds of 336 ft/min, 380 ft/min, and 466 ft/min for UV-cured, water-based, and solvent-based formulations, respectively, show a reduction in ink consumption rates and environmental releases of 32.8%, 24%, and 6.8%, respectively.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The report uses sound methods that are from frequently used sources (EPA) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.
	Metric 3: Applicability	Medium	Printing inks, is for an occupational scenario within the scope of the risk evaluation, but no formaldehyde specific information.
	Metric 4: Temporal Representativeness	Low	1999, the report is more than 20 years old.
	Metric 5: Sample Size	Low	No statistics are provided.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources (most of the information is from the CTSA), assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty			
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Study Citation:		U.S. EPA, (1999). Flexographic printing - generic scenario for estimating occupational exposures and environmental releases: Draft.		
HERO ID:		6385709		
Conditions of Use:		commercial use: chemical substances in packaging, paper, plastics and hobby products.		
		EVALUATION		
Domain		Metric	Rating	Comments
	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination				

Study Citation:	U.S. EPA, (2003). Estimating 2003 building-related construction and demolition materials amounts.			
HERO ID:	6388382			
Conditions of Use:	construction and demolition materials			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	In 2003, the value of new residential construction put-in-place totaled \$353 billion. Average construction cost per area was \$76.80/ft2. The total estimated C&D generation amount for residential construction of 10 million tons in 2003. (section 2.1.1). The 2003 value of new nonresidential building construction put-in-place was almost \$257 billion. Average construction costs in 2003 was \$111/ft2. C&D materials estimated generation was 5.01 million tons for nonresidential construction (section 2.1.2). The total amount of residential demolition materials generated in 2003 was estimated to be 19 million tons (section 2.1.4). It is assumed that 65 million tons of nonresidential demolition materials were generated in 2003 (section 2.1.4). The total residentialrenovation generation, from the improvement or replacement projects itemized above, was estimated to be 37.8 million tons in 2003 (section 2.1.5). Total nonresidential renovation materials generated was estimated to be 29 million tons in 2003 (section 2.1.6).			
Process description:	Construction and demolition (C&D) materials are generated when new structures are built and when existing structures are renovated or demolished (including deconstruction activities).Structures include all residential and nonresidential buildings, as well as public works projects, such as streets and highways, bridges, utility plants, piers, and dams. (pg 5 of 60)			
Throughput:	Throughput of Mixed C&D Plants• Tons Processed (All): 1,768,000 TPY• Size Range: 7,000 – 485,000 TPY• Annual Throughput Reported:– Avg. Throughput (All): 110,500 TPYThroughput of Concrete/Inerts Plants• Tons Processed (All): 5,415,000 TPY• Size Range: 20,000 – 250,000 TPY• Annual Throughput Reported:– Avg. Throughput (All): 150,000 TPY (pg B-12 - B-14)			
Number of sites:	Tables 2-1 through 2-5 provides the number of sites			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The report uses high quality data as it is published by EPA	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	High	The report addresses variability and uncertainty in the results.	
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (1995). Chapter 6: Organic chemical process industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7310513			
Conditions of Use:	Paint/Varnish Manufacturing (6.4)			
EXTRACTION				
Parameter	Data			
Process description:	”The manufacture of paint involves the dispersion of a colored oil or pigment in a vehicle, usually an oil or resin, followed by the addition of an organic solvent for viscosity adjustment. Only the physical processes of weighing, mixing, grinding, tinting, thinning, and packaging take place. No chemical reactions are involved. These processes take place in large mixing tanks at approximately room temperature. The manufacture of varnish also involves the mixing and blending of various ingredients to produce a wide range of products. However in this case, chemical reactions are initiated by heating. Varnish is cooked in either open or enclosed gas-fired kettles for periods of 4 to 16 hours at temperatures of 93 to 340°C (200 to 650°F).” pg. 29/162			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	The report was published by U.S. EPA, it uses high quality data and is a frequently-used sources (AP-42).	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	Medium	Data are for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	N/A	Data extracted is qualitative	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by discussing different paints and varnishes but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Formaldehyde

General Engineering Assessment

HERO ID: 7310513 Table: 2 of 3

Study Citation:	U.S. EPA, (1995). Chapter 6: Organic chemical process industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7310513			
Conditions of Use:	Printing Ink Manufacturing (6.7)			
EXTRACTION				
Parameter	Data			
Process description:	There are 3 general processes in the manufacture of printing inks: (1) cooking the vehicle and adding dyes, (2) grinding of a pigment into the vehicle using a roller mill, and (3) replacing water in the wet pigment pulp by an ink vehicle.			
Throughput:	The ink ”varnish” or vehicle is generally cooked for an average of 8 to 12 hours.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality information/data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	AP-42 is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	N/A	Qualitative only	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability but does not address uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1995). Chapter 6: Organic chemical process industry. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7310513			
Conditions of Use:	Pharmaceutical Production (6.13)			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	Provides amount of various solvents purchased by 26 U.S. pharmaceutical companies (makes up 53% of sales in 1975).			
Process description:	In a typical batch process, solid reactants and solvent are charged to a reactor where they are held (and usually heated) until the desired product is formed. The solvent is distilled off, and the crude residue may be treated several times with additional solvents to purify it. The purified material is separated from the remaining solvent by centrifuge and finally is dried to remove the last traces of solvent.			
Number of sites:	26			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	AP-42 is based on U.S. data
	Metric 3:	Applicability	Medium	The report is for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation, in terms of the type of industry, operations, and work activities.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (discrete use amounts provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty isn't addressed. Variability addressed by listing production volumes for many different solvents.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (2016). Chemical Data Reporting (CDR): Cyclotetrasiloxane, 2,2,4,4,6,6,8,8-octamethyl-; CAS Number 556-67-2.			
HERO ID:	7315471			
Conditions of Use:	manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	2015 aggregate PV (Lbs.) 1,000,000,000 - 5,000,000,000 lb. Data for 2014, 2013, and 2012 also available and indicated as the same.			
Throughput:	Number of sites varies with the industrial sector			
Number of sites:	Number of sites varies with the industrial sector			
Chemical concentration:	Typically At least 30 but less than 60% by weight			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report is generally no more than 10 years old.
	Metric 5:	Sample Size	High	Sample size is sufficiently representative
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7315820			
Conditions of Use:	Application of paints and coatings (4.2.2.8)			
EXTRACTION				
Parameter	Data			
Process description:	Solvent wipe, phosphating treatment, application of prime coat, curing of prime coat, application of guide coat, curing of guide coat, application of topcoat, curing of topcoat, final repair operations			
Throughput:	Table 4.2.2.8-2 provides area coated per vehicle for various coating steps.Plants may stop production for a vacation of one-and-a-half weeks at Christmas through New Year’s Day and may stop for several weeks in summer for model changeover.Assembly lines for spray coating of automobiles operate at a speed of 3 to 8 meters per minute and usually produces 30 to 70 units per hour.			
Chemical concentration:	Waterborne primer is most often applied in an electrodeposition bath. The composition of the bath is about 5-15% solids, 2-10% solvent, and the rest water. Table 4.2.2.8-2 provides VOC content for various types of coatings.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	AP-42 is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability is addressed by considering different paint types and different vehicles.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7315820			
Conditions of Use:	Application of paints and coatings (4.2.2.5)			
EXTRACTION				
Parameter	Data			
Process description:	”Various forms of roll coating are the preferred techniques for applying coatings to flat woods. Coatings used for surface cover can be applied with a direct roller coater, and reverse roll coaters are generally used to apply fillers, forcing the filler into panel cracks and voids. Precision coating and printing with offset gravure grain printers are also forms of roll coating, and several types of curtain coating may be employed. Various spray techniques and brush coating may be used, too.Sealers may be of water or solvent base, usually applied by airless spray or direct roll coating, respectively. Inks are applied by an offset gravure printing operation similar to direct roll coating. After printing, a board goes through 1 or 2 direct or precision roll coaters for application of the clear protective topcoat.”			
Throughput:	Table 4.2.2.5-1 provides typical amounts of coating used in L/100m2 for waterborne and conventional coatings.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	AP-42 is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (average values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability is addressed by considering different paint types (fillers, basecoat, etc.).
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7315820			
Conditions of Use:	Application of paints and coatings (4.2.2.12)			
EXTRACTION				
Parameter	Data			
Process description:	3-5 stage washer, dryoff oven bake, spray booth application, flashoff, main oven bake			
Throughput:	Waterborne primer is most often applied in an electrodeposition bath. The composition of the bath is about 5-15% solids, 2-10% solvent, and the rest water. Table 4.2.2.8-2 provides VOC content for various types of coatings.Line speeds for small, medium, and large plants are 2.5, 2.4, and 4.6 m/min, respectively.			
Chemical concentration:	Typical coatings that have been used in the industry contain 65% solvent and 35% solids.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	AP-42 is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (average values) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent (only one source provided for entire chapter).
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability is addressed by considering different plant sizes.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7315820			
Conditions of Use:	Application of paints and coatings (4.2.2.1)			
EXTRACTION				
Parameter	Data			
Process description:	”Toll operations fill orders to various manufacturer specifications, and thus change coating and solvent conditions more frequently than do captive companies, which fabricate and coat products within a single facility and which may operate continuously with the same solventsPDF pg 1-2 describe conventional spray, hot airless spray, roller coating, knife coating, rotogravure printing and dip coating”			
Chemical concentration:	”Conventional coatings contain at least 30 volume percent solvents to permit easy handling and application. They typically contain 70 to 85 percent solvents by volume. These solvents may be of 1 component or of a mixture of volatile ethers, acetates, aromatics, cellosolves, aliphatic hydrocarbons, and/or water. Coatings with 30 volume percent of solvent or less are called low solvent or ””high solids”” coatings. Waterborne coatings, which have recently gained substantial use, are of several types: water emulsion, water soluble and colloidal dispersion, and electrocoat. Common ratios of water to solvent organics in emulsion and dispersion coatings are 80:20 and 70:30.Two-part catalyzed coatings to be dried, powder coatings, hot melts, and radiation cured (ultraviolet and electron beam) coatings contain essentially no volatile organic compounds (VOC), although some monomers and other lower molecular weight organics may volatilize. (Pg 1)”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources (AP-42).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	Medium	Data are for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by discussing different coating application types but uncertainty is not addressed.
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7315820			
Conditions of Use:	Application of paints and coatings (4.2.2.6)			
EXTRACTION				
Parameter	Data			
Process description:	”A variety of low solvent coatings, with negligible emissions, have been developed for some uses to form organic resin films equal to those of conventional solventborne coatings. They can be applied up to 1/8 inch thick (usually by reverse roller coating) to products like artificial leather goods, book covers, and carbon paper. Smooth hot melt finishes can be applied over rough textured paper by heated gravure or roll coaters at temperatures from 65 to 230°C (150 to 450°F).Plastic extrusion coating is a type of hot melt coating in which a molten thermoplastic sheet (usually low or medium density polyethylene) is extruded from a slotted die at temperatures of up to 315°C (600°F). The substrate and the molten plastic coat are united by pressure between a rubber roll and a chill roll which solidifies the plastic. Many products, such as the polyethylene-coated milk carton, are coated with solvent-free extrusion coatings.Figure 4.2.2.6-1 shows a typical paper coating line that uses organic solventborne formulations. The application device is usually a reverse roller, a knife, or a rotogravure printer.Knife coaters can apply solutions of much higher viscosity than roll coaters can, thus emitting less solvent per pound of solids applied. The gravure printer can print patterns or can coat a solid sheet of color on a paper web.Ovens may be divided into from 2 to 5 temperature zones. The first zone is usually at about 430°C (110°F), and other zones have progressively higher temperatures to cure the coating after most solvent has evaporated. The typical curing temperature is 120°C (250°F), and ovens are generally limited to 200°C (400°F) to avoid damage to the paper. ”			
Chemical concentration:	conventional coating containing 35% solids and 65% organic solvent by volume (pg 3)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	AP-42 is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability addressed by discussing different coating application types but uncertainty is not addressed.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (1995). Chapter 4.2: Introduction to surface coating. Compilation of air pollutant emission factors. Volume I: Stationary point and area sources, fifth edition, AP-42.			
HERO ID:	7315820			
Conditions of Use:	Application of paints and coatings (4.2.2.2)			
EXTRACTION				
Parameter	Data			
Process description:	”Three-piece can sheet coating includes base coating and printing or lithographing, followed by curing at temperatures of up to 220°C . When the sheets have been formed into cylinders, the seam is sprayed, usually with a lacquer, to protect the exposed metal. If they are to contain an edible product, the interiors are spray coated, and the cans baked at up to 220°C. Two-piece can exteriors may be reverse roll coated in white and cured at 170 to 200°C. Several colors of ink are then transferred to the cans as they rotate on a mandrel. A protective varnish may be roll coated over the inks. The coating is then cured in a single or multipass oven at temperatures of 180 to 200°C. The cans are spray coated on the interior and spray and/or roll coated on the exterior of the bottom end. A final baking at 110 to 200°C completes the process.”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Assessment uses high quality information/data from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	AP-42 is based on U.S. data	
	Metric 3: Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.	
	Metric 4: Temporal Representativeness	Low	Assessment is based on data greater than 20 years old.	
	Metric 5: Sample Size	N/A	This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty not addressed. Variability is addressed by considering different can coating types (2 vs 3-pc) and operations.	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (1995). AP-42: Chapter 4.12 - Manufacture of Rubber Products.			
HERO ID:	7315841			
Conditions of Use:	Rubber Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Many of the rubber manufacturing facilities in the United States produce pneumatic tires for automobile, trucks, airplanes and farm machinery. However, many rubber manufacturing facilities produce other engineered rubber products.			
Process description:	Initially, the raw rubber is mixed with several additives. The mixed rubber is often milled and transferred to an extruder where it can be combined with other rubbers. Strengthening fibers are typically coated with mixed rubber using a calendar. The extruded rubber and rubber coated materials are then assembled into a final shape and cured. It is during the curing process that the rubber vulcanizes (crosslinks), producing the characteristic properties of finished rubber. Once the final product is cured, it is often ground to remove rough surfaces and/or to achieve symmetry.			
Throughput:	Batches ranging from a two-pound laboratory mixer, to a 200-pound pilot scale system up to a 500-pound production mixer.			
Chemical concentration:	Provides 23 rubber compound recipes, including amounts of each chemical used.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	AP-42 is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment was published in 2008, but is based on data that is greater than 20 years old.
	Metric 5:	Sample Size	High	Statistical distribution of samples is fully characterized (all rubber formulations provided).
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty isn’t addressed. Variability is addressed by comparing 23 formulations of rubber.
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (1995). AP-42: Chapter 8 - Inorganic chemical industry.			
HERO ID:	7315933			
Conditions of Use:	Processing as a reactant: Intermediate in: Pesticide, fertilizer, and other agricultural chemical manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Urea Product Manufacturing: Injection of formaldehyde additives into the liquid or molten urea before solids formation. Formaldehyde reacts with urea to form methylenediurea, which is the conditioning agent. Additives reduce solids caking during storage and urea dust formation during transport and handling. The majority of solid urea product is bulk shipped in trucks, enclosed railroad cars, or barges, but approximately 10 percent is bagged. (pdf pg. 2) Solid urea product is used for use as fertilizer or protein supplement in animal feed, and in plastics manufacturing.Normal Superphosphates: Phosphate rock and sulfuric acid reaction, product is granulated then sold as fertilizer. Full process on pdf pg. 1			
Comments:	Chapter 8 contains 13 subsections, a word search for 'formaldehyde' only returned hits in Section 8.2 Urea, 8.5.1 Normal Superphosphates ,8.5.2 Triple Superphosphates. Only these subsections were reviewed for extraction and evaluation.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data that are from frequently used sources (EPA) and are generally accepted by the scientific community.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	Report is for an occupational scenario (fertilizer manufacturing), which is in scope but most of the information is not specific to formaldehyde
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A- only process description extracted.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty is not addressed. Report provides only a limited discussion of variability in different process operations.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (1995). AP-42: Chapter 11.1 - Hot mix asphalt plants.			
HERO ID:	7315971			
Conditions of Use:	Asphalt Production			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	500 million tons of asphalt			
Process description:	Hot mix asphalt paving materials can be manufactured by: (1) batch mix plants, (2) continuous mix (mix outside dryer drum) plants, (3) parallel flow drum mix plants, and (4) counterflow drum mix plants. A detailed description of each process is provided in the document.			
Number of sites:	3600			
Chemical concentration:	Aggregate and reclaimed asphalt constitute over 92 percent by weight of the total mixture.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Assessment uses high quality information/data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	AP-42 is based on U.S. data
	Metric 3:	Applicability	Medium	Data is for an in-scope occupational scenario; however, data is general and not specific to a chemical.
	Metric 4:	Temporal Representativeness	Low	Assessment was published in 2004, but is based on data that is greater than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Uncertainty not addressed. Variability is addressed by considering different asphalt plant types and processing methods.
Overall Quality Determination			Medium	

Study Citation:	U.S. EPA, (2016). Federal research action plan on recycled tire crumb used on playing field and playgrounds. Status report.			
HERO ID:	9102524			
Conditions of Use:	Toys, playground, and sporting equipment			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	An estimated 4.77 million tons of waste tires were generated in 2013, and 40.5 percent, or 1.93 million tons, were recoveredthrough recycling and production of retreaded tires.Approximately 975,000 tons of scrap tires (i.e., approximately 59.5 million tires) were used in the ground rubber applications market, which includes the manufacture of new rubber products, rubber-modified asphalt, and playground and sports surfacing.			
Process description:	Two tire recycling processes, (1) ambient and (2) cryogenic, are used to create tire crumb rubber in the 10- to 20-mesh (0.84- to 2.0-mm) size, which is generally the size used in synthetic turfinfill.The ambient process uses granulation or cracker mills to produce tire crumb rubber at room temperature (Scrap Tire News, 2016). Cracker mills use revolving rollers with serrations in themto size-reduce the tires. Once the granules are produced, they are fed through screens and sorted to the appropriate size (Scrap Tire News, 2016). The cryogenic process uses liquid nitrogen to freeze partially shredded tires, which then are fed into a hammer mill to create tire crumb rubber.Current generation synthetic turf fields are typically constructed with a bottom gravel/stone base layer to allow for drainage (STC, 2011). On top of the drainage layer lies the turf component,which is composed of multi-layered polypropylene and urethane backing material with polyethylene fiber blades. Sometimes a pad can be used for additional cushioning on a field (STC, 2011).			
Number of sites:	Currently, there are between 12,000 and 13,000 synthetic turf recreational fields in the United States, with 1,200 – 1,500 new installations each year.There are approximately eight major synthetic field installers in the United States.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data/techniques/methods from frequently-used sources.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data are from the U.S.	
	Metric 3: Applicability	High	Data are for toys, playground, and sporting equipment, an in-scope occupational sce- nario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.	
	Metric 5: Sample Size	Low	Sample distribution is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Variability and uncertainty are not addressed.	
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (n.d.). AP-42: Chapter 5 - Petroleum industry.			
HERO ID:	9102566			
Conditions of Use:	Distribution in commerce - Petroleum products			
EXTRACTION				
Parameter	Data			
Process description:	Crude oil is transported from production operationsto a refinery by tankers, barges, rail tank cars, tank trucks, and pipelines. Refined petroleum products are conveyed to fuel marketing terminals and petrochemical industries by these same modes. From the fuel marketing terminals, the fuels are delivered by tank trucks to service stations, commercial accounts, and localbulk storage plants. The final destination for gasoline is usually a motor vehicle gasoline tank.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report is from a frequently used source (EPA) and are generally accepted by the scientific community.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	U.S. data	
	Metric 3: Applicability	Medium	The report is for an occupational scenario (Distribution in commerce - Petroleum products) within scope but is not specific to formaldehyde.	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old(1995). The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A- qualitative information	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A- qualitative information	
Overall Quality Determination		High		

Study Citation:	U.S. EPA, (n.d.). AP-42: Chapter 5 - Petroleum industry.
HERO ID:	9102566
Conditions of Use:	incorporation into a formulation - petrochemical manufacture : Refinery

EXTRACTION

Parameter	Data
Process description:	Separation Processes - The first phase in petroleum refining operations is the separation of crude oil into its major constituents using 3 petroleum separation processes: atmospheric distillation, vacuum distillation, and light ends recovery (gas processing). Crude oil consists of a mixture of hydrocarbon compounds including paraffinic, naphthenic, and aromatic hydrocarbons with small amounts of impurities including sulfur, nitrogen, oxygen, and metals. Refinery separation processes separate these crude oil constituents into common boiling-point fractions. Conversion Processes - To meet the demands for high-octane gasoline, jet fuel, and diesel fuel, components such as residual oils, fuel oils, and light ends are converted to gasolines and other light fractions. Cracking, coking, and visbreaking processes are used to break large petroleum molecules into smaller ones. Polymerization and alkylation processes are used to combine small petroleum molecules into larger ones. Isomerization and reforming processes are applied to rearrange the structure of petroleum molecules to produce higher-value molecules of a similar molecular size. Fluidized-bed Catalytic Cracking (FCC) - The FCC process uses a catalyst in the form of very fine particles that act as a fluid when aerated with a vapor. Fresh feed is preheated in a process heater and introduced into the bottom of a vertical transfer line or riser with hot regenerated catalyst. The hot catalyst vaporizes the feed, bringing both to the desired reaction temperature, 470 to 525°C (880 to 980°F). The high activity of modern catalysts causes most of the cracking reactions to take place in the riser as the catalyst and oil mixture flows upward into the reactor. The hydrocarbon vapors are separated from the catalyst particles by cyclones in the reactor. The reaction products are sent to a fractionator for separation. The spent catalyst falls to the bottom of the reactor and is steam stripped as it exits the reactor bottom to remove absorbed hydrocarbons. The spent catalyst is then conveyed to a regenerator. In the regenerator, coke deposited on the catalyst as a result of the cracking reactions is burned off in a controlled combustion process with preheated air. Regenerator temperature is usually 590 to 675°C (1100 to 1250°F). The catalyst is then recycled to be mixed with fresh hydrocarbon feed. Moving-bed Catalytic Cracking- In the moving-bed system, typified by the Thermafor Catalytic Cracking (TCC) units, catalyst beads (~0.5 centimeters [cm] [0.2 inches (in.)]) flow into the top of the reactor, where they contact a mixed-phase hydrocarbon feed. Cracking reactions take place as the catalyst and hydrocarbons move concurrently downward through the reactor to a zone where the catalyst is separated from the vapors. The gaseous reaction products flow out of the reactor to the fractionation section of the unit. The catalyst is steam stripped to remove any adsorbed hydrocarbons. It then falls into the regenerator, where coke is burned from the catalyst with air. The regenerated catalyst is separated from the flue gases and recycled to be mixed with fresh hydrocarbon feed. The operating temperatures of the reactor and regenerator in the TCC process are comparable to those in the FCC process. Treating Processes - Petroleum treating processes stabilize and upgrade petroleum products by separating them from less desirable products and by removing objectionable elements. Undesirable elements such as sulfur, nitrogen, and oxygen are removed by hydrodesulfurization, hydrotreating, chemical sweetening, and acid gas removal. Treating processes, employed primarily for the separation of petroleum products, include such processes as deasphalting. Desalting is used to remove salt, minerals, grit, and water from crude oil feedstocks before refining. Asphalt blowing is used for polymerizing and stabilizing asphalt to improve its weathering characteristics. Feedstock And Product Handling - The refinery feedstock and product handling operations consist of unloading, storage, blending, and loading activities. Auxiliary Facilities - A wide assortment of processes and equipment not directly involved in the refining of crude oil is used in functions vital to the operation of the refinery. Examples are engines and boilers, waste water treatment facilities, hydrogen plants, cooling towers, and sulfur recovery units. Products from auxiliary facilities (clean water, steam, and process heat) are required by most process units throughout the refinery. Compressor Engines - Many older refineries run high-pressure compressors with reciprocating and gas turbine engines fired with natural gas. Natural gas has usually been a cheap, abundant source of energy. Examples of refining units operating at high pressure include hydrodesulfurization, isomerization, reforming, and hydrocracking. Internal combustion engines are less reliable and harder to maintain than are steam engines or electric motors. For this reason, and because of increasing natural gas costs, very few such units have been installed in the last few years. More process descriptions in source.

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (EPA AP-42 section (5.1)) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness			

Continued on next page ...

Formaldehyde

General Engineering Assessment

HERO ID: 9102566 Table: 2 of 3

...continued from previous page

Study Citation:	U.S. EPA, (n.d.). AP-42: Chapter 5 - Petroleum industry.			
HERO ID:	9102566			
Conditions of Use:	incorporation into a formulation - petrochemical manufacture : Refinery			
		EVALUATION		
Domain		Metric	Rating	Comments
	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (refinery) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Though date is not specified it appears to be updated in April 2015 - less than 10 years old
	Metric 5:	Sample Size	N/A	Qualitative information provided
Domain 3: Accessibility/ Clarity				
	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty				
	Metric 7:	Metadata Completeness	N/A	Qualitative information provided
Overall Quality Determination			High	

Study Citation:	U.S. EPA, (n.d.). AP-42: Chapter 5 - Petroleum industry.			
HERO ID:	9102566			
Conditions of Use:	Processing aids, specific to petroleum production in all other basic chemical manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Natural gas is considered "sour" if hydrogen sulfide (H2 S) is present in amounts greater than 5.7 milligrams per normal cubic meters (mg/Nm3) (0.25 grains per 100 standard cubic feet [gr/100 scf]). The H2S must be removed (called "sweetening" the gas) before the gas can be utilized. If H2S is present, the gas is usually sweetened by absorption of the H2S in an amine solution. Amine processes are used for over 95 percent of all gas sweetening in the United States. Other methods, such as carbonate processes, solid bed absorbents, and physical absorption, are employed in the other sweetening plants.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report is from a frequently used source (EPA) and are generally accepted by the scientific community.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	U.S. data	
	Metric 3: Applicability	Low	The report is for an occupational scenario (natural gas processing) but is not specific to formaldehyde and only similar to scenarios within the scope of the risk evaluations (Processing aids, specific to petroleum production in all other basic chemical manufacturing)	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old(1995). The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	N/A	N/A- qualitative information	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	N/A- qualitative information	
Overall Quality Determination		Medium		

Study Citation:	U.S. EPA, (n.d.). AP-42: Chapter 10 - Wood products industry.			
HERO ID:	9263849			
Conditions of Use:	Adhesives and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Softwood plywood is used for wall siding, sheathing, roof decking, concrete formboards, floors, and containers. Hardwood plywood is used for interior applications such as furniture, cabinets, architectural millwork, paneling, flooring, store fixtures, and doors. Fiberboard is a low-density insulation board used for housing, roofing, and office furnishings. Hardboard is similar to fiberboard, except that hardboard is more dense than fiberboard. Hardboard is used for applications in housing (e.g., exterior siding, garage doors, and interior door facings), furniture, store fixtures, automotive interiors, and toys.			
Process description:	Softwood plywood is manufactured by gluing several layers of dry softwood veneers together with an adhesive. Hardwood plywood is made of hardwood veneers bonded with an adhesive. The outer layers (face and back) surround a core which is usually lumber, veneer, particleboard, or medium density fiberboard. Hardwood plywood may be pressed into panels or plywood components (e.g., curved hardwood plywood, seat backs, chair arms, etc.). Full process descriptions for plywood manufacturing are in section 10.5.2 pg 2-3. Particleboard is defined as a panel product manufactured from lignocellulosic materials, primarily in the form of discrete particles, combined with a synthetic resin or other suitable binder and bonded together under heat and pressure. Full process descriptions for plywood manufacturing are in section 10.6.2 pg 1-3. Fiberboard and Hardboard is made from wood chips which are first softened in a pressurized steam vessel (digester) and then refined or pulped into wood fibers. The fibers may then be mixed with resin, formed into mats, and pressed and/or dried to form panel products. Full process descriptions in section 10.6.4.2 pg. 1-8. Waferboard (WB) and oriented strandboard (OSB) belong to the subset of reconstituted wood panel products called flakeboards. They are structural panels made from wood wafers specially produced from logs at the plant. Full process descriptions in section 10.6.1.2 pg. 1-3.			
Comments:	Evaluated only sections expected to be relevant to formaldehyde COUs.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	EPA report that is generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	N/A	Process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Unwin, J., Coldwell, M.R., Keen, C., Mcalinden, J.J. (2013). Airborne emissions of carcinogens and respiratory sensitizers during thermal processing of plastics. Annals of Occupational Hygiene 57(3):399-406.			
HERO ID:	1477715			
Conditions of Use:	Plastic Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Process descriptions of various thermoplastic processes given in Table 2			
Number of sites:	10			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from the United Kingdom, an OECD country.	
	Metric 3: Applicability	High	Data are for plastic material and resin manufacturing, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2012)	
	Metric 5: Sample Size	N/A	Not applicable - process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	Not applicable - process description.	
Overall Quality Determination		High		

Study Citation:	USTMA, (2019). U.S. Tire Manufacturers Association: Tire manufacturing and tire materials overview slides.		
HERO ID:	10370205		
Conditions of Use:	Processing, Incorporation into article, Rubber manufacturing		
EXTRACTION			
Parameter	Data		
Process description:	Tire manufacturing is briefly described on slides 10-12/38 and include the major steps of mixing, calendering, extruding, tire building, tire curing, and inspection. Slide 18 describes processing aids to assist in manufacturing process, one of which is resins which may be formaldehyde based. See slide 19 of 38 for description of formaldehydes place in the resin processing aids. Formaldehyde is expected to be fully reacted during the tire curing processSlide 23-24 of 38 describes textiles in tires that are pretreated with a resorcinol formaldehyde latex dip to facilitate adhesion to rubber, however the pretreatment of textiles is not done at tire manufacturing plants.		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues. From the U.S. Tire Manufacturers Association
Domain 2: Representativeness	Metric 2: Geographic Scope	High	From USA
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation, tire manufacturing.
	Metric 4: Temporal Representativeness	High	From 2019
	Metric 5: Sample Size	N/A	qualitative information
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent. Data is from the various industries involved in the powerpoint’s creation assumedly but there are no references in the powerpoint itself.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		High	

Study Citation:	USTMA, (2020). Comment submitted by U.S. Tire Manufacturers Association (USTMA), dated 06/08/2020.			
HERO ID:	8802196			
Conditions of Use:	Incorporation into Article- Tire Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Formaldehyde is used to make reinforcing and tackifying resins, they may contain residual impurity. Reinforcing resins are designed to be used as crosslinking agents; conferring the necessary technical properties to the final cured product in terms of durability and resistance. Tackifying resins are used in tires to build proper adhesion between different tire components. Some tackifying resins are made with formaldehyde and may contain low levels of formaldehyde as a residual impurity. In addition, fabric belts are pretreated with a resorcinol formaldehyde latex dip to facilitateadhesion to rubber. Mold release agents may bemanufactured with formaldehyde.Full process descriptions details are on pdf pg. 4-5			
Number of sites:	58 sites (managed by 13 companies) (pdf pg. 1)			
Chemical concentration:	Formaldehyde is not detected by USTMA members from cords that have been pretreated with a resorcinol formaldehyde latex dip.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from a frequently used source and associated information does not indicate flaws or quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	The data are from the United States.	
	Metric 3: Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.	
	Metric 5: Sample Size	N/A	Process description.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Uncertainty is not addressed. Variability is briefly considered in differences between companies.	
Overall Quality Determination		High		

Study Citation:	Vaajasaari, K., Kulovaara, M., Joutti, A., Schultz, E., Soljamo, K. (2004). Hazardous properties of paint residues from the furniture industry. Journal of Hazardous Materials 106(2-3):71-79.			
HERO ID:	1942308			
Conditions of Use:	Use of Paints/Coatings			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances in paint (acid-curable two-component lacquers or paints			
Process description:	In the dry booths, the excess paint residue is collected in a carton or fiber filter placed at the back-wall of the booth. In water-curtain booths, water is flowing continuously in the booth collecting the excess paint, which with the help of chemicals is then precipitated into the water pool of the booth. The water-curtain boothresidues were porous and amorphous material which contained 20–30 wt.% free liquid.			
Number of sites:	8			
Chemical concentration:	paint residual waste: dry booth- 44-9600 mg/kg TS; water curtain booth: 27-120 mg/kgTS			
Comments:	the study was financially supported by the Association of Finnish Furniture and Joinery Industries.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The total concentrations of formaldehyde in solid wastesand in the leaching-test eluates were analyzed photometrically according to standard SFS-EN 4996.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Finland - an OECD country.
	Metric 3:	Applicability	High	The report is for spray painting of wooden furniture which is an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	The data were published in 2004, after the most recent PEL (1992) and more than 10 but less than 20 years old.
	Metric 5:	Sample Size	High	concentrations for 8 different locations and operations were provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	no metadata were provided
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The study provided composition data that for 4 facilities using dry booth and 4 facilities using water curtains that can be used to evaluate variability. Information about uncertainty was not provided.
Overall Quality Determination			Medium	

Study Citation:	Vaart, V.d., D. R., Vatvuk, W. M., Wehe, A. H. (1991). Thermal and catalytic incinerators for the control of VOCs. Journal of the Air and Waste Management Association 41(1):92-98.			
HERO ID:	1376226			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Process description:	It is common for the waste stream combusted to be a complex mixture of organic compounds rather than a single component. This mixture is typically analyzed for carbon, hydrogen, oxygen, and other elements so that an empirical formula can be developed which represents the mixture. Combustion of such a mixture of organic compounds containing carbon, hydrogen, and oxygen is described by the overall exothermic reaction: (Chemical equation provided) The complete combustion products CO2 and H2O are generally considered to be less objectionable than the waste components, making incineration an attractive waste disposal method.			
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Medium	The report uses clearly defined methods that are consistent with other similar assessments and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Low	too generic to be useful for this effort.
	Metric 4:	Temporal Representativeness	Low	The data were published in 1991, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	no specific data were provided.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	The report clearly documents results, methods, and assumptions. but there is insufficient data provided to estimate level of formaldehyde control.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Vangronsveld, E., Berckmans, S., Verbinnen, K., Leeuw, C.V., Bormans, C. (2010). Isocyanate and total inhalable particulate air measurements in the European wood panel industry. International Journal of Hygiene and Environmental Health 213(6):475-488.			
HERO ID:	1075984			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	Process description shown in figure 1 on PDF Pg. 476.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Belgium, an OECD country.
	Metric 3:	Applicability	High	Data are for building/construction materials (wood and wood engineered products), an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
	Metric 5:	Sample Size	N/A	Not applicable - process description.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - process description.
Overall Quality Determination			High	

Study Citation:	Verma, T.N., Sahu, A.K., Sinha, S.L. (2018). Numerical Simulation of Air Pollution Control in Hospital. :185-206.			
HERO ID:	5953532			
Conditions of Use:	Laboratory chemical			
EXTRACTION				
Parameter	Data			
Life cycle description:	Formaldehyde (HCHO) resins are used as bonding and laminating agents, as adhesives in compressed wood products, and as plastic foam insulation and packaging products. It is widely used in touching up, lavatory, comestible packaging with 1% concentration. It is also extremely used in construction materials and building appliances. Most commonly used as a binder in the production of plywood, wood chip board, plaster board, and fibreboards.			
Chemical concentration:	It is widely used in touching up, lavatory, comestible packaging with 1% concentration.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	Data are from India, a non-OECD country.
	Metric 3:	Applicability	High	Data are for laboratory chemical use, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2018)
	Metric 5:	Sample Size	N/A	Not applicable - no sample data.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	Not applicable - no sample data.
Overall Quality Determination		Medium		

Study Citation:	Viegas, S., Ladeira, C., Gomes, M., Nunes, C., Brito, M., Prista, J. (2013). Exposure and genotoxicity assessment methodologies - the case of formaldehyde occupational exposure. Current Analytical Chemistry 9(3):476-484.				
HERO ID:	2454064				
Conditions of Use:	Manufacture				
EXTRACTION					
Parameter	Data				
Production, import, or use volume:	According to the Report on Carcinogens, formaldehyde ranks 25th in the overall U.S. chemical production, with more than 5 million tons produced each year. The most extensive use of formaldehyde is in production of resins containing urea, phenol and melamine, including polyacetal resins.				
EVALUATION					
Domain	Metric		Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data	
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation	
	Metric 4:	Temporal Representativeness	Medium	data is between 10 and 20 years old	
	Metric 5:	Sample Size	Low	no statistics	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination			High		

Study Citation:	Viegas, S., Prista, J. (2010). Aspects to consider for selection of chemical risk assessment methodology: The case of formaldehyde occupational exposure. WIT Transactions on Ecology and the Environment 132:23-32.			
HERO ID:	5953568			
Conditions of Use:	lab chemical (anatomy/pathology labs)			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	U.S. production with more than 11 billion pounds produced each year			
Chemical concentration:	37% formaldehyde in formalin (pg 2)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from Portugal, an OECD country.	
	Metric 3: Applicability	High	Data are for lab chemical, an in-scope occupation scenario.	
	Metric 4: Temporal Representativeness	Medium	Report is based on data greater than 10 years old but no more than 20 years old and industry conditions that are expected to be representative of current industry conditions.	
	Metric 5: Sample Size	N/A	concentration data	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	N/A	concentration data	
Overall Quality Determination		High		

Study Citation:	Voncina, B., Bezek, D., Marechal, A.M. (2002). Eco-friendly durable press finishing of textile interlinings. 10(3):68-71.			
HERO ID:	5940915			
Conditions of Use:	Processing (textile finishing)			
EXTRACTION				
Parameter	Data			
Chemical concentration:	”Experiment A(conventional): 112+-9.4 ppm Experiment B(low FA): 77.0+-9.2 ppm Experiment C(FA free): 12.2+-2.4 ppm (4/4)”			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Methodology is known and expected to be accurate and cover all release sources at the site.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Data are from Slovenia, an OECD country.
	Metric 3:	Applicability	High	Data are for textile finishing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Medium	Data are greater than 10 years old but no more than 20 years old.
	Metric 5:	Sample Size	Medium	Sample distribution characterized by limited statistics (means, standard deviations, confidence intervals, ranges) but discrete samples not provided and distribution not fully characterized.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Uncertainty is addressed in the methodology of the report. Variability is addressed by sampling three types of fabrics.
Overall Quality Determination			High	

Study Citation:	Wal, V.d., J. F. (1982). Formaldehyde measurements in Dutch houses, schools and offices in the years 1977-1980. Atmospheric Environment 16(10):2471-2478.		
HERO ID:	26999		
Conditions of Use:	Compressed Wood Product Manufacturing		
EXTRACTION			
Parameter	Data		
Life cycle description:	Used as building material in homes, schools and offices		
Process description:	On pg. 1; "In most cases chipboard (particle board), a common building construction material in the Netherlands, is made of ground wood and urea formaldehyde glue"		
Number of sites:	59 building were tested (see Table 4 for building types)		
EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	Data are from The Netherlands, an OECD country.
	Metric 3: Applicability	High	The report is for use in composite wood products, an occupational scenario within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5: Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination		Medium	

Study Citation:	Wallingford, K. M., Elliot, L. J., McAuley, D. B. (1988). Health Hazard Evaluation Report HETA 82-354-1897, Kemper-Tappan, Richmond, Indiana, May 1988.			
HERO ID:	8139239			
Conditions of Use:	Adhesive and sealant chemicals in wood product manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	formaldehyde manufacture-> resin manufacture->particleboard manufacture-> **cabinet manufacture**-> installation-> consumer use (household use). [De-veloped based on report]			
Process description:	The cabinet manufacturing process begins with cutting veneered particle board sheets and natural grain wood (from the raw material storage area) to the desired size for use as cabinet components. These components are then further worked in the millroom as necessary using power planers, groovers, notchers, sanders, and drills in preparation for primary assembly. In the primary assembly operation, the cabinet cases and their corresponding doors and drawer fronts are assembled separately using wood glue and industrial staplers. These sub-assemblies are then sent to the finishing department where there are two separate finishing lines; one for cabinet cases, the other for doors and drawer fronts . In the finishing operation, the exterior natural grain wood surfaces are sprayed in spray booths with: a stain, a sealer, and a glossy top coat . Some of the doors and drawer fronts are sprayed with a stain which is then handwiped. The sub-assemblies are dried in gas-fired ovens after the application of each spray finish. The finished sub-assemblies are then moved to the final assembly department where the doors, drawers and accessory hardware are attached to the cabinet case. The completed cabinets are then boxed and sent to the warehouse for storage prior to shipment. (5/30)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality methods from frequently-used sources (NIOSH HHE).
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the U.S.
	Metric 3:	Applicability	High	Data are for adhesives and sealant chemicals in wood product manufacturing, am in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		High		

Study Citation:	Wan, H., Wang, X.M., Barry, A., Shen, J. (2014). Recycling wood composite panels: Characterizing recycled materials. BioResources 9(4):7554-7565.			
HERO ID:	3072990			
Conditions of Use:	Recycling			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	(USA 2013) Consumption of 2.87 billion square feet of particleboard and 2.66 billion square feet of medium density fiberboard. In 2014 the consumption of PB and MDF panels will increase by 5.8% and 13.7%, respectively			
Life cycle description:	the wood composite industry in the USAand Canadais reluctant to use more than 15% of recycled or downgraded UF resin bonded panel materialsin manufacturing, for example, PBpanels			
Process description:	The procedure of steam explosion of recycled wood composite materials can be described as follows: 1) a mechanical feeder (a feeder hopper) supplies recycled materials to a pressurized vessel with a reciprocating piston in such a manner that the pressure difference can be maintained on a continuous basis. The feeder hopper is equipped with a water sprinkler system that supplies water to the material prior to its entry into the reactor vessel. The stainless steel pressure vessel measures 0.6 m in diameter and about 7 m in length with a screw conveyor running at 34 rpm through its interior. In this experiment, a certain amount of tap water was added such that the final steam-exploded recycled materials would reach moisture content around 65%. 2) As the material is fed in the vessel, saturated steam at a maximum temperature of 235 C is applied simultaneously to the vessel. The screw conveyor carries the materials through the reactor at a designated rate and mixes and shreds the materials into smaller sized particles. 3) Once the steam treatment time is reached, an electronic valve can be used to quickly open and close the pressurized vessel to allow the material to move to a material collection cyclone. The pressure difference between the vessel and the atmosphere creates an explosion effect and further breaks the materials down into fibers. The steam explosion treatment time and temperatures used are presented in Table 2 - MDF time: 0.8 minutes, 227 C; PB time: 0.8 minutes, 227 C. Process used in study were sampled of 1000 g of downgraded PB or the same amount of MDF were impregnated with the same amount of 05% BTCA and 0.5% NaH2PO2 water solution under a vacuum (700 mmHg) for 10 min and then autoclaved using a Medalist 200 at 113 C for 20 min. So the retention of the solution of treated panels was 100%. Prep of hammermilled particles, 1-1/2 inch wide PB strips were cut from 1-1/2 inch thick recycled PB panels and proken down into particles by a Blue Streak hammermill of 25 HP at 1765 rpm, without screening. It took approximately 45 s to break down 10 PB strips about 30 inches long.			
Chemical concentration:	MDF panels - 12% Urea formaldehyde (UF) on face of panel, 10% on core layers; PB - 10% UF on face, 8% on core layers.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Source is peer reviewed so likely high quality data.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data is a combined study between US and Canada
	Metric 3:	Applicability	High	The data are for an occupational scenario (commercial use of building/construction materials – wood and engineered wood) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	Data is less than 10 years old (2015)
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Clear but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	Variability in recycling processes is discussed; uncertainty is discussed as they test different approaches.
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Study Citation:	Wan, H., Wang, X.M., Barry, A., Shen, J. (2014). Recycling wood composite panels: Characterizing recycled materials. BioResources 9(4):7554-7565.		
HERO ID:	3072990		
Conditions of Use:	Recycling		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Wang, H., Li, H., Lv, M., Zhou, D., Bai, L., Du, L., Xue, X., Lin, P., Qiu, S. (2015). Associations between occupation exposure to Formaldehyde and semen quality, a primary study. Scientific Reports 5:15874.			
HERO ID:	3421098			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	46 billion lbs annually produced worldwide. In 2007 China’s FA output reached 12,000 kt.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Medium	The assessment or report uses high quality data and/or techniques or sound methods that are not from a frequently used source and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	The data are from a non-OECD country.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Medium	

Study Citation:	Wang, H.X., Zhou, D.X., Zheng, L.R., Zhang, J., Huo, Y.W., Tian, H., Han, S.P., Zhang, J., Zhao, W.B. (2012). Effects of paternal occupation exposure to formaldehyde on reproductive outcomes. Journal of Occupational and Environmental Medicine 54(5):518-524.			
HERO ID:	1070240			
Conditions of Use:	Multiple			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	In 2004, China surpassed the United States as the largest FA producer and consumer in the world. China’s actual FA output was 12,000 kt (kilotons) in 2007, about 4000 times the amount five decades earlier.			
Life cycle description:	Formaldehyde (FA) is used in resins, construction, wood processing, furniture, textiles, carpeting, hospitals, laboratories, and chemical industry.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	High	Report uses high quality data.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from a non-OECD country.	
	Metric 3: Applicability	High	Report is for an occupational scenario within the scope of the risk evaluation.	
	Metric 4: Temporal Representativeness	Medium	Data is more than 10 years old.	
	Metric 5: Sample Size	Low	Distribution of samples is characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Report clearly documents its data sources.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Low	Report does not address variability or uncertainty.	
Overall Quality Determination		Medium		

Study Citation:	Wang, W.L., Gardner, D.J., Baumann, M.G. (2002). Volatile organic compound emissions during hot-pressing of southern pine particleboard: Panel size effects and trade-off between press time and temperature. Forest Products Journal 52(4):24-30.			
HERO ID:	2886898			
Conditions of Use:	Compressed Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Process description:	The wood adhesive was sprayed onto the particle furnish in a drum blender by using a compressed air spray head. After blending, the furnish was hand felted into a 400- by 400-mm (16- by 16-in.) or 305- by 305-mm (12- by 12-in.) or a 610- by 610-mm(24- by 24-in.) deckle box. The mat was then pressed in the hot-press maintained at the desired temperature. Pressing time and temperature varied: 3-6 min, 160-188oC			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Unclear if data is peer reviewed but appears to contain high quality data.	
Domain 2: Representativeness	Metric 2: Geographic Scope	High	Data is for US.	
	Metric 3: Applicability	High	Data is for use of formaldehyde containing wood adhesives.	
	Metric 4: Temporal Representativeness	Medium	Data is from 2002, over 10 years old.	
	Metric 5: Sample Size	N/A	qualitative	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Addresses variability by looking at different adhesives/resins. Does not address uncertainty.	
Overall Quality Determination		High		

Study Citation:	Washko, R., Burkhart, J., Piacitelli, C. (1998). Health hazard evaluation report 96–0093–2685, Microfibres Inc. Pawtucket, Rhode Island, April 1998.
HERO ID:	8024157
Conditions of Use:	Incorporation into an article - Finishing agents in textiles

EXTRACTION

Parameter	Data
Process description:	The flocked upholstery fabric manufactured by Microfibres consists of three basic components: a backing fabric, adhesive, and cut nylon fibers. A complex process brings these three basic components together into a final product. In recent years, only nylon flock has been used at the Microfibres plant, but both nylon and polyester flock is produced. All polyester flock produced at the plant is bagged for shipment to other plants. To produce flock, nylon (or polyester) “tow”—a loose rope of thin continuous nylon (or polyester) fibers—is dyed and coated with a finish before being cut, dried, screened, and bagged as flock. The flock is later deposited on cotton–polyester fabric backing coated with an acrylic latex adhesive by a process using an electrostatic field to align the falling flock fibers. After heat–curing of the adhesive, the flocked fabric may be subjected to finishing, mechanical embossing, and/or water–based ink–screen printing. A number of different departments perform specific tasks in producing the final product. Dye House Department At the Continuous Dyer, bulk “tow” (which arrives in boxes or on spools) is dipped in a dye bath, fixed with steam, and placed damp in large boxes for temporary holding. At the Recycle Area, located elsewhere in the plant, workers from the Dye House Department wash and dye waste flock from this and other Microfibres plants. Raycote Department “Tow” received from the Dye House Department is rinsed in a hot water bath, dipped in a finishing bath (containing tannic acid, an ammonium ether of potato starch, and a fatty alcohol derivative), and cut into flock by machines called rotary precision cutters (RPCs). The flock is then dried, screened, and stored in large bags for future use in this and other flocking plants. Compounding Department In the Compounding Department, acrylic latex adhesives are mixed. In addition, a fabric protector (Scotchgard®) and softening compounds are also prepared for use in finishing processes. Compounding Department workers deliver the prepared compounds to the areas of use and remove waste adhesive and empty containers. Coating Department The Coating Department consists of two roll–to–roll coating ranges (Ranges 1 and 2), two embossing ranges, and a printing range. (Note: when the term “Range” is used in this report without specifying the particular type, it refers to the coating range.) At each coating range, polyester/cotton fabric backing is coated with adhesive. The backing enters the flocking module located in a temperature– and humidity–controlled flocking room. Flock is manually dumped into hoppers and a desiccant powder may be added and mixed in to control moisture content and prevent clumping. In the module (an enclosed unit where flock is applied), the flock–desiccant mixture is dispersed above the adhesive–coated backing in an electrostatic field that aligns the falling flock fibers so they embed in the adhesive at an angle more or less perpendicular to the backing. Upon exiting the flocking room, the fabric is passed through a gas–fired curing oven, sprayed with either a fabric protector or a softening compound, returned through the oven, inspected, and taken up onto a roll. The fabric can then be sent to be processed at an embossing range or at a printing range that utilizes water–based inks, or can be sent directly to shipping. Between process runs that differ with respect to flock texture (e.g., length and/or diameter) or color, the affected Range must be cleaned of residual flock prior to starting the new run. A “blow–down” involves the use of compressed air to clear loose flock from the flocking module, and from the flocking room walls, floor, and other equipment. Workers conducting blow–downs begin this process on the module and blow out any loose flock in or on the module, then blow the flock from one side of the room to the other, and finally bag the loose flock for disposal. The frequency of blow–downs varies with the production schedule. On occasion, it may be necessary to perform several blow–downs per shift. Other Departments Shipping Department personnel utilize forklifts to retrieve finished rolls of fabric from production areas and bring them to the loading area where they are placed in trucks for shipment. In addition to short–term storage space in the plant, an off–site warehouse is located in a nearby town. Maintenance Department workers maintain equipment throughout the facility. Office personnel are located within offices in the production building, as well as in a separate building nearby.
Number of sites:	1

EVALUATION

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The report is for an occupational scenario (textiles) within the scope of the risk evaluation.

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Study Citation:	Washko, R., Burkhart, J., Piacitelli, C. (1998). Health hazard evaluation report 96–0093–2685, Microfibres Inc. Pawtucket, Rhode Island, April 1998.				
HERO ID:	8024157				
Conditions of Use:	Incorporation into an article - Finishing agents in textiles				
			EVALUATION		
Domain		Metric	Rating	Comments	
	Metric 4:	Temporal Representativeness	Low	1996 - more than 20 years old	
	Metric 5:	Sample Size	N/A	qualitative information provided	
Domain 3: Accessibility/ Clarity					
	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.	
Domain 4: Variability and Uncertainty					
	Metric 7:	Metadata Completeness	N/A	qualitative information provided	
Overall Quality Determination			High		

Study Citation:	Westberg, H. B., Seldén, A. I., Bellander, T. (2001). Exposure to chemical agents in Swedish aluminum foundries and aluminum remelting plants—a comprehensive survey. Applied Occupational and Environmental Hygiene 16(1):66-77.			
HERO ID:	1989125			
Conditions of Use:	Use of metal products			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	In Sweden, about 90,000 tons of aluminum were produced in 1997 during scrap smelting, of which, 31,000 tons were aluminum and magnesia castings. Associated emissions of chemical agents (such as formaldehyde) from cores and molds have also increased correspondingly.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	OECD country
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	data is more than 20 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	report clearly documents its data sources
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Westberg, H., Löfstedt, H., Seldén, A., Lilja, B.G., Nayström, P. (2005). Exposure to low molecular weight isocyanates and formaldehyde in foundries using hot box core binders. Annals of Occupational Hygiene 49(8):719-725.				
HERO ID:	5943728				
Conditions of Use:	Binder in Metal Manufacturing (Foundries)				
EXTRACTION					
Parameter	Data				
Process description:	The brass foundries were producing armatures for households, and the grey iron foundry spare parts for the automobile industry. During core production, both manual and enclosed automaticcore machines were used, and during die-casting manually operated as well as enclosed robots were used.				
Throughput:	The grey iron foundry was large, producing some 75 000 ton per year, in contrast to the smaller brass foundries producing between 500 and 1000 ton per year.				
Chemical concentration:	The binder in use at all foundries was based on a carbamide–formaldehyde resin(<1% formaldehyde)				
EVALUATION					
Domain	Metric	Rating		Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data	
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S	
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation	
	Metric 4:	Temporal Representativeness	Medium	report is generally more than 10 years but no more than 20 years old	
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted	
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.	
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted	
Overall Quality Determination			High		

Study Citation:	Weynes, C. (1981). Sterilising with steam and formaldehyde. Sterile World 3(3):9-10.			
HERO ID:	6121060			
Conditions of Use:	Laboratory chemicals (sterilization of respiratory equipment)			
EXTRACTION				
Parameter	Data			
Process description:	Low temperature steam plus formaldehyde (LTSF). The temperature of the load must not exceed around 72°C; there must be even penetration of the load; the load must retain at most a very low and preferably an undetectable concentration of formaldehyde or its polymers; the atmosphere at the steriliser door and drains must at no time exceed 2 parts per million. Optimum sterilising conditions will be achieved if all surfaces of the load are in continuous contact with monomeric formaldehyde evenly mixed with dry saturated steam. It seems desirable to minimise the production of condense and to remove it as soon as it forms. The STERILISING stage consists of 40-60 steam/formalin pulses between 50-250 TORR with 0.2ml formalin/cu. ft.lpulse. This period takes between 40-60 minutes and varies with the load size. Removal of formaldehyde and its polymers can only effectively bc achieved by steam pulses or chemical neutralization followed by air pulses. DRYING is achieved by about five air/vacuum pulses between 50-760 TORR.			
Chemical concentration:	Formaldehyde alone requires concentrations of over 1000 mg/litre to be sporicidal. With both steam and formaldehyde, concentrations as low as 3 mg/litre are effective at killing spores. Where many continuous pulses are used the amounts of formalin inlroduced can be as low as 0.2ml per cubic foot sterilizer space per pulse.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Medium	The data are from an OECD country other than the U.S., and locality-specific factors (e.g., potential differences in regulatory occupational exposure or emission limits, industry/ process technologies) may impact exposures or releases relative to the U.S.	
	Metric 3: Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation	
	Metric 4: Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.	
	Metric 5: Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Low	Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.	
Overall Quality Determination		Low		

Study Citation:	White, G. L., Keogh, J. P. (1978). Hazard Evaluation and Technical Assistance Report No. TA-78-33, William T. Burnett Company, Baltimore, Maryland.
HERO ID:	1317282
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product

EXTRACTION	
Parameter	Data
Process description:	Bush StreetThere is one urethane foaming line. The front of the line with the foam head is called the 'Bridge' and the end of the line is designated as the 'lower end.' Chemicals are stored in an area below the bridge in tanks and drums. Batches of chemical additives (surfactants, fire resistant, blowing agents, dyes, catalysts, etc.) are mixed together in the 'activation room' by an activator and assistant, (compounders), and pumped to the bridge, in a closed system, to combine with toluene diisocyanate (TOI) and a polyester resin. All the ingredients mix and flow through thefoamer head onto a plastic-coated paper conveyor system which is controlled by the foamer operator who maintains the rate and density of foam application. The foam reacts, exothermically, as the process flows towards the lower end. The conveyor system is partially enclosed and is ventilated. As the reacting foam solidifies (polymerizes), into flat slabs, it passes a series of heat lamps which can be used to facilitate skin formation for certain batches ofproduct. At the lower end the paper is removed, ('paper take off'), and the solid polyurethane moves onto a roller system which transports it to a cutting process, ('saw'). The continuous band saw is operated by a 'cutter' who adjusts the machine to achieve specified lengths of foam and also labels each piece as it is cut. The cut pieces are then removed from the roller conveyor and stacked, by color, for ambient curing. Cured foam slabs are cut to desired thicknesses by the 'duplex' operation and then are restacked forshipment. Some of the polyurethane is processed on-site for specialty products such as gaskets, shoulder pads, and hair curlers. Overall, the foaming process is a batch operation.JessupThere is one urethane foam process line similar to that at Bush street. The chemical additives are mixed in the activation room, pumped to the Bridge foaming/pouring head where the mixture combines with TOI and resin, and is metered through the pouring head onto a conveyor covered with a continuously fed plastic coated paper. The paper in this process however is slowly curled up on the sides so that the reacting foam becomes cylindrical in shape upon solidification (polymerization). The reacting foam proceeds along the partially enclosed, exhaust-ventilated, conveying system, through the 'paper take off' station and onto a roller system leading to the cutting station. As the urethane cylinder is cut to specified lengths, it is labeled and stacked, in the 'backroom' for a four hour minimum ambient cure. The urethane cylinders are placed on a core borer which bores a hole through the cylinder's horizontal center (core) and the cylinder is mounted onto a machine which peels it into sheets of specified thickness and length. (Longer sheets can be made by heat-sealing two peeled cylinder ends together.) The peeling room is called the 'main room'. rewinds the cut sheets into a cylinder which is placed into a polyethylene bag, which is then compressed either by vacuum or mechanically, wrapped, taped, weighed and readied for shipment. Excess scraps of urethane are fed into a shredder which feeds a baler, via a roof cyclone. The baled urethane scraps are loaded by a fork lift truck into railroad cars for shipment.
Number of sites:	2

EVALUATION			
Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	High	NIOSH study
Domain 2: Representativeness	Metric 2: Geographic Scope	High	US
	Metric 3: Applicability	High	The report is for an occupational scenario (urethane foam production) within the scope of the risk evaluation.
	Metric 4: Temporal Representativeness	Low	1978 - more than 20 years old
	Metric 5: Sample Size	N/A	This report provided qualitative information
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	High	Information provided was derived from NIOSH site visit.

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Study Citation:	White, G. L., Keogh, J. P. (1978). Hazard Evaluation and Technical Assistance Report No. TA-78-33, William T. Burnett Company, Baltimore, Maryland.		
HERO ID:	1317282		
Conditions of Use:	Incorporation into a formulation, mixture, or reaction product		
Domain	Metric	EVALUATION	
		Rating	Comments
Domain 4: Variability and Uncertainty			
	Metric 7: Metadata Completeness	N/A	This report provided qualitative information
Overall Quality Determination		High	

Study Citation:	White, G. L., Schwartz, E. (1979). Health Hazard Evaluation Determination, Report No. HEE 79-41-594, Stout Sportswear, Queens Long Island City, New York.			
HERO ID:	3970612			
Conditions of Use:	Fabric, textile, and leather products not covered elsewhere; Photographic supplies			
EXTRACTION				
Parameter	Data			
Process description:	”The process evaluated involved pattern making for women’s sportswear for size 38-50... When a garment sample is received a pattern is developed to the particular specifications and thebasic slope blocks. A draft pattern is made and a single garment is cut out, sewn, pressed and fit-tested on a live model. Appropriate corrections/ modifications are made until the right fit is obtained. Then from the basic pattern the other size patterns can be made. Multiple pattern sets can then be made on a 'lay table'. Here the patterns are laid out over a plastic sheet and 'run' paper is laid over it. The run paper contains a chemical which is light sensitive so when the lay table lights are turned on for a prescribed time the patterns’ outline is photo copied onto the run paper. The run paper is then 'developed'/copied on a photomaker machine for the master copies. The photomaker machine uses a solution calledSuper Diazol which is composed of primarily ammonium hydroxide. ... After copies of the patterns are made they can be laid out on long cutting tables, over laid with material (up to 100 layers depending on fabric density) and the patterns cut out. Cutting is performed with reciprocating electric cutters, both straight and disc. There are three cutting tables, one lay out phototable, one pattern table, and one automatic sizing table. The cut material is shipped to sewing facilities . ” (2-3/10)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses process information directly provided by the site and source is from frequently used sources (NIOSH)
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States
	Metric 3:	Applicability	Medium	The report is for an occupational scenario within the scope of the risk evaluation, however the report does not indicate that formaldehyde is used or present at the site.
	Metric 4:	Temporal Representativeness	Low	more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Report clearly documents sources but not fully transparent on basis for formaldehyde sampling.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			Medium	

Study Citation:	Whitmyre, G. K., Driver, J. H., Ginevan, M. E., Tardiff, R. G., Baker, S. R. (1992). Human exposure assessment I: understanding the uncertainties. Toxicology and Industrial Health 8(5):297-320.			
HERO ID:	4635			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Process description:	From the storage area, material is moved to the staging area where it is pulled out of its protective bag and allowed to sit for at least a half day before cutting. In the cutting department, the fabric is taken to either automatic spreading machines or to tables on which the fabric is hand-laid to match stripes. Occasionally, solvent-based adhesives are used to glue the pattern pieces in place. A band saw or straight knife is used to cut fabric and a rotary saw is sometimes used to cut elastic pieces. The cut pieces go to the bundling area where they are sorted into buckets (20 to 50 pieces depending on the garment to be made). Tote carts are used to transport the buckets to the sewing area. The sewing department makes the clothing; a variety of machines are used, including three-thread, single-needle, multi-needle, flat-bed hemmer, pocket setter, tacker, labels, button-holer, snap, and needle-nose. The machines used vary, depending on the garment being produced. To reduce the size of needle marks in the fabric, asolution of silicone lubricant, fabric softener, and water is used on the material. The completed garments are taken to the finishing department, where the garment is inspected for stitch quality, loose threads, matching stripes, spots, and stains. There are two spotting stations, used to remove stains from the garments, located adjacent to the sewing department. These spotting stations are used as needed. Spot removers containing trichlorethylene and perchloroethylene, and a rust stain remover containing hydrogen fluoride (8%) are used. There are local exhaust controls at each station. A heat press is used occasionally for fusible pella fabric. Some employees in this area use Johnson & Johnson Germ filter masks as protection from organic vapors and dust. After inspection, the garments are folded and packed to ship to the customer.			
Number of sites:	1			
Chemical concentration:	FabricsInterlock (berry red) 110 ug/gLycra (charcoal) NDFlat Back Rib (Copenhagen) 920 ug/gInterlock (ivory maple leaf) 120 ug/gInterlock (red) 57 ug/gFleece (gray) 89 ug/gRib (navy) 160 ug/gLycra (berry flora) 33 ug/gJersey (banana) 68 ug/gStripe (red and ivory 2x2) 160 ug/gJersey (gray) 47 ug/g			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	NIOSH study - AATCC test method 112-1993
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (Garment fabrication) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1996 - more than 20 years old.
	Metric 5:	Sample Size	High	Results from individual textile formaldehyde contents samples were provided which could be used to develop statistics. Uncertainty was not discussed but assumed that it was addressed by NIOSH in the AATCC test method used.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	High	Results from individual textile formaldehyde contents samples were provided which could be used to assess variability between fabrics. Uncertainty was not discussed but assumed that it was addressed by NIOSH in the AATCC test method used.

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Study Citation:	Whitmyre, G. K., Driver, J. H., Ginevan, M. E., Tardiff, R. G., Baker, S. R. (1992). Human exposure assessment I: understanding the uncertainties. Toxicology and Industrial Health 8(5):297-320.		
HERO ID:	4635		
Conditions of Use:	Use of fabric, textile and leather products		
Domain	Metric	EVALUATION Rating	Comments
Overall Quality Determination		High	

Study Citation:	Wicks, Z. W., Jr, Jones, F. N. (2013). Coatings.			
HERO ID:	6301611			
Conditions of Use:	Processing-Incorporation into a formula-Painting and coating manufacture			
EXTRACTION				
Parameter	Data			
Process description:	Film Formation by Coalescence of Polymer Particles. Hydroxy-functional latexes can be formulated with melamine–formaldehyde (MF) resins or a water-dispersible polyisocyanate for wood and maintenance coatings.Amino Resins. MF resins are made by reacting melamine (1,3,5-triazine-2,4,6-triamine) [108-78-1] and formaldehyde [50-00-0] followed by etherification of the methylol groups using an alcohol. There are two major classes of MF resins: Class I MF resins are made using excess formaldehyde, and a high fraction of the methylol groups are etherified with alcohol. Commercial resins are mixtures of compounds, most having a single melamine unit with a large fraction of the amine groups substituted with two alkoxyethyl groups. The resins also contain oligomers having two or more triazine rings coupled with methylene ether groups and possibly with methylene groups. Various alcohols can be used. The largest volume class I resins contain a high proportion of hexamethoxymethylmelamine (HMMM) (N,N0,N00-hexamethoxymelamine). Class II MF resins are made using a lower ratio of formaldehyde to melamine, and a significant fraction of the nitrogens have one alkoxyethyl group and a hydrogen. An example of one compound present is N,N0,N00-trimethoxymethylmelamine (TMMM). Class II resins have a larger fraction of oligomers.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources (Kirk-Othmer) and are generally accepted by the scientific community, and associated information does not indicate flaws or quality issues.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report captures operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Williams, T.M., Levine, R.J., Blunden, P.B. (1984). Exposure of embalmers to formaldehyde and other chemicals. American Industrial Hygiene Association Journal 45(3):172-176.			
HERO ID:	1317520			
Conditions of Use:	Embalming			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemical substances in products not described by other codes: embalmers			
Process description:	Incision is made in the femoral artery and vein, through which embalming fluid are infused and blood is drained. A trocar is inserted to puncture the internal organs and aspirate fluids form the thoracic and abdominal cavities. to embalm the viscera a bottle of embalming fluid containing a more concentrated solution of formaldehyde is attached by hose to the trocar, and the contents are instilled into the thorax and abdomen. The small abdominal puncture wound resulting form the insertion of the trocar is closed by means of a screw-in plastic button. Accumulated embalming fluid is removed by suction. The walls of the skull, thorax and abdomen are cauterized an sealed with hardening compounds and saw dust like material. Plastic bag containing the viscera is placed in the abdominal and thoracic cavities and the body is closed up.			
Number of sites:	7			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data and/or techniques or sound methods that are from frequently used sources
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	Medium	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	The study was derived from data collected in 1980, before the most recent PEL (1992) and more than 20 years old.
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Willigen, A.H., Stolz, E., Joost, T.v. (1987). Sensitization to phenol formaldehyde resin in rubber glue. Contact Dermatitis 16(5):291-292.			
HERO ID:	1314621			
Conditions of Use:	Rubber Product Manufacturing			
EXTRACTION				
Parameter	Data			
Life cycle description:	Chemosil 211 is widely used m the rubber industry as a rubber metal adhesive.			
Chemical concentration:	Chemosil 211 pure (containing 8% phenol formaldehyde polymers)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently-used sources.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	Data are from the Netherlands, an OECD country.
	Metric 3:	Applicability	High	Data are for an additive in rubber product manufacturing, an in-scope occupational scenario.
	Metric 4:	Temporal Representativeness	Low	Report is based on data greater than 20 years old and industry conditions that are expected to be outdated. (1987)
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	Variability and uncertainty are not addressed.
Overall Quality Determination			Medium	

Study Citation:	Wills, F. K. (1983). Fumigants and sanitation: update on formaldehyde. Poultry digest 42(499):452.			
HERO ID:	6016950			
Conditions of Use:	Manufacturing of formaldehyde			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	7.5 billion pounds/yr			
Life cycle description:	Half is used for adhesives for particleboard, fiberboard, and plywood. It is widely used in the paper, textile, and plastics industries.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Uninformative	Assessment or report does not document its data sources, assessment methods, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Uninformative		

General Engineering Assessment

Study Citation:	Wills, F. K. (1983). Fumigants and sanitation: update on formaldehyde. Poultry digest 42(499):452.			
HERO ID:	6016950			
Conditions of Use:	Disinfectant at hatchery			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Formalin is a 37 per cent water solution of formaldehyde. Ten per cent formalin is being sprayed in chicken houses between flocks as part of a clean-up and disinfection program.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	The data, data sources, and/or techniques or methods used in the assessment or report are not specified.
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario for non-TSCA uses not within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	The report is more than 20 years old. The report captures operations, equipment, and worker activities that are expected to be outdated.
	Metric 5:	Sample Size	Low	Distribution of samples is qualitative or characterized by no statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	Assessment or report does not document its datasources, assessment methods, and assumptions. Assessment or report provides results, but the underlying methods, data sources, and assumptions are not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination			Low	

Study Citation:	Wolkoff, P., Schneider, T., Kildesø, J., Degerth, R., Jaroszewski, M., Schunk, H. (1998). Risk in cleaning: chemical and physical exposure. Science of the Total Environment 215(1-2):135-156.			
HERO ID:	1314113			
Conditions of Use:	Use of Cleaning and Furniture Care Products			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Formaldehyde is one of the active components in disinfectants, where the concentration of the active compound range is 0.1 – 10 % w/w.			
EVALUATION				
Domain	Metric	Rating		Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	data are from an OECD country other than the U.S.
	Metric 3:	Applicability	High	report is for an occupational scenario within the scope of the risk evaluation
	Metric 4:	Temporal Representativeness	Low	report is more than 20 years old
	Metric 5:	Sample Size	Low	characterized by no statistics
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Low	data sources not identified
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	report does not discuss uncertainties
Overall Quality Determination		Medium		

Study Citation:	Wooster, G., Martinez, C., Bowser, P., O’Hara, D. (2005). Human health risks associated with formalin treatments used in aquaculture: Initial study. North American Journal of Aquaculture 67(2):111-113.			
HERO ID:	1986873			
Conditions of Use:	”Use in agriculture, forestry, fishing, and hunting”			
EXTRACTION				
Parameter	Data			
Process description:	Routine treatment concentrations of formalin range from 15 to 200 mg/ L for the control of protozoal parasites and monogenes of fish and shrimp, and up to 2,000 mg/L for the control of fungi on fish eggs.			
Chemical concentration:	The U.S. Food and Drug Administration (FDA) currently approves three commercial formalin products for use in U.S. food fish aquaculture as parasiticides and fungicides. The three products have the same formulation of about 37% formaldehyde.			
Comments:	The article implies that this is an FDA regulated use			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US data
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	data is less than 10 years
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination		High		

Study Citation:	Xu, W., Stewart, E. J. (2016). A comparison of engineering controls for formaldehyde exposure during grossing activities in health care anatomic pathology laboratories. Journal of Occupational and Environmental Hygiene 13(7):529-537.			
HERO ID:	5936295			
Conditions of Use:	lab chemical (pathology labs)			
EXTRACTION				
Parameter		Data		
Process description:		In health care anatomic pathology laboratories, the process of gross examination of anatomic pathology specimens is usually performed after the tissue has been in full contact with a 10% neutral buffered formalin solution (3.7% formaldehyde) for several hours to days. During grossing, the pathologist or pathology assistant removes the tissue sample from containers of the formalin solution, examines and sections the portion of interest from the tissue mass, then places it into plastic cassettes. The cassettes are placed into trays of formalin while grossing continues. At the conclusion of the grossing session, the cassettes are processed into paraffin blocks, which are then sliced into extremely thin ribbons, adhered to glass slides, stained, and covered for microscopic analysis by a pathologist (pg 2-3)		
Chemical concentration:		37% formaldehyde in formalin (pg 2)		
EVALUATION				
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.
Domain 2: Representativeness		Metric 2: Geographic Scope	High	Data are from the U.S.
		Metric 3: Applicability	High	Data are for lab chemical, an in-scope occupation scenario.
		Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old.
		Metric 5: Sample Size	N/A	process description/concentration data
Domain 3: Accessibility/ Clarity		Metric 6: Metadata Completeness	High	All data sources, methods, results, and assumptions are clearly documented.
Domain 4: Variability and Uncertainty		Metric 7: Metadata Completeness	N/A	process description/concentration data
Overall Quality Determination			High	

Study Citation: Yager, J.W., Cohn, K.L., Spear, R.C., Fisher, J.M., Morse, L. (1986). Sister-chromatid exchanges in lymphocytes of anatomy students exposed to formaldehyde-embalming solution. Mutation Research 174(2):135-139.	
HERO ID:	626642
Conditions of Use:	Embalming
EXTRACTION	
Parameter	Data
Number of sites:	1
Chemical concentration:	embalming fluid 37% formaldehyde
EVALUATION	
Domain	Metric
Domain 1: Reliability	
Metric 1:	Methodology
	High
	The sampling collection method correlates well (0.97) with the NIOSH impinger method. Analysis using the NIOSH standard chromotropic acid method. Back-up filters were analyzed separately to check for break-through.
Domain 2: Representativeness	
Metric 2:	Geographic Scope
Metric 3:	Applicability
	High
	US
Metric 4:	Temporal Representativeness
	Medium
	The data are for an occupational scenario that is similar to an occupational scenario within the scope of the risk evaluation
Metric 5:	Sample Size
	Low
	Provided data may represent outdated operations, equipment, and activities compared to current operations, equipment, and worker activities. The data were published in 1986, before the most recent PEL (1992) and more than 20 years old.
	High
	Statistical distribution of samples is fully characterized including weekly values, averages and ranges.
Domain 3: Accessibility/ Clarity	
Metric 6:	Metadata Completeness
	High
	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions
Domain 4: Variability and Uncertainty	
Metric 7:	Metadata Completeness
	High
	The report addresses variability and uncertainty in the results. Uncertainty is well characterized
Overall Quality Determination	
High	

Study Citation:	Younesi-Kordkheili, H., Pizzi, A., Niyatzade, G. (2016). Reduction of formaldehyde emission from particleboard by phenolated kraft lignin. Journal of Adhesion 92(6):485-497.			
HERO ID:	5953822			
Conditions of Use:	Incorporation into article- Wood Product Manufacturing			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Formalin - 37% formaldehyde solution. Content of free formaldehyde in urea-formaldehyde (UF), UF modified by lignin (LUF), and UF modified by phenolated lignin (PLUF) ranged between 0.22% and 0.4%.			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	Low	data are from a non-OECD country
	Metric 3:	Applicability	High	Data can be used in general for concentration in UF resins which would be applicable for multiple occupational scenarios.
	Metric 4:	Temporal Representativeness	High	report is generally no more than 10 years old
	Metric 5:	Sample Size	N/A	N/A - This metric is not applicable to the data being extracted
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Report clearly documents results but not fully transparent
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	N/A - This metric is not applicable to the data being extracted
Overall Quality Determination			High	

Study Citation:	Zengin, A.C., Crudu, M., Maier, S.S., Deselnicu, V., Albu, L., Gulumser, G., Bitlisli, B.O., Basaran, B., Mutlu, M.M. (2012). Eco-leather: Chromium-free leather production using titanium, oligomeric melamine-formaldehyde resin, and resorcinol tanning agents and the properties of the resulting leathers. Ekoloji Dergisi 21(82):17-25.			
HERO ID:	1972579			
Conditions of Use:	Use of fabric, textile and leather products			
EXTRACTION				
Parameter	Data			
Process description:	The pickled sheep skins were processed according to Table 2 and the recipes were differed during the pickling process by the addition of pretanning agents according to the experimental design of the tanning process. These recipes are given in Tables 3, 4, 5, 6, and 7.			
Chemical concentration:	Leather after tanning: max 16.21 (ppm)			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1: Methodology	Medium	Report uses high quality data that are not from frequently-used sources and there are no known quality issues.	
Domain 2: Representativeness	Metric 2: Geographic Scope	Low	Data are from Romania, a non-OECD country.	
	Metric 3: Applicability	High	Data are for fabric, textile and leather products not covered elsewhere, an in-scope occupational scenario.	
	Metric 4: Temporal Representativeness	High	Report is based on current industry conditions and data no more than 10 years old. (2012)	
	Metric 5: Sample Size	Medium	Sample distribution characterized by limited statistics (mean) but discrete samples not provided and distribution not fully characterized.	
Domain 3: Accessibility/ Clarity	Metric 6: Metadata Completeness	Medium	Methods, results, and assumptions are clearly documented, but underlying data sources are not fully transparent.	
Domain 4: Variability and Uncertainty	Metric 7: Metadata Completeness	Medium	Variability addressed by testing multiple leather preparations but uncertainty is not addressed.	
Overall Quality Determination		Medium		

Study Citation:	Zey, J. N., Todd, W. F. (1987). Health Hazard Evaluation Report HETA 85-308-1829, Kardon Industries, St. Paris, Ohio, September 1987.			
HERO ID:	4038955			
Conditions of Use:	Thermal decomposition product- Packaging			
EXTRACTION				
Parameter	Data			
Process description:	The structure of the cans is three plies of paperboard, along with an inner liner and an outside label. these five plies are held together by a water-soluble glue. After the five plies are joined, an in-line process will cut the tube (cans) to a predetermined length and the tube continues to flow, uninterrupted down the production line. Depending o the inner liner used as dictated by customer specifications, a lubricant is applied (mineral spirits or mineral oil) to release the liner from the winding and/or cutting mandrel. the cans are then automatically seamed, placed a metal top with a plastic spout on the composite can. these are then packed in corrugated cartons to ship to the customer. the metal tops mentioned above converted in the St. Paris Plant on punch presses. operations.Hand WaxAn application of was is sprayed by a machine in the back, open end of the composite can. This is done so that when the customers insert a closed device after the composite can is filled at their facility it reduces air and moisture penetration. Approximately 10% of the composite cans produced have eth was added. This manufacturing process was not a full-time production operations. the longest continuous mode of this process was 6 weeks 24 hours a day five days a work week.Auto WaxThis is a second generation of the hand waxer. The auto waxer increased production by 20 times the amount realized on the hand waxer. All materials are consistent with the hand wax operations. Composite cans are automatically fed from the production lines to the auto was operation. Two duplex spray heads operate simultaneously - spraying wax into the open end of the composite cans. Th e wax is preheated in a drum and then hand carried in open buckets to two melt tanks on the auto wax machine. mineral oil is used to cut the wax.CompounderThis machine places a strip of compound material around the outer and inner circumferences of the caulk top (metal). This is required by some customers in order to prevent air or moisture from penetrating through the base of the plastic spout off the metal as it is joined to the composite can. This equipment may be scheduled one or two days, eight hours/shift, per week.Line 2This is where paperboard plies , together with the inner liner and label are joined.			
Number of sites:	2			
EVALUATION				
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Report uses high quality data from frequently used source, NIOSH study
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	US
	Metric 3:	Applicability	High	The report is for an occupational scenario (cardboard tube manufacture) within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Low	1986- more than 20 years old
	Metric 5:	Sample Size	N/A	qualitative information provided
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Information provided was derived from NIOSH site visit.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	N/A	qualitative information provided
Overall Quality Determination			High	

Study Citation:	Zhang, L., Steinmaus, C., Eastmond, D.A., Xin, X.K., Smith, M.T. (2009). Formaldehyde exposure and leukemia: A new meta-analysis and potential mechanisms. Mutation Research: Reviews in Mutation Research 681(2-3):150-168.			
HERO ID:	626661			
Conditions of Use:	Manufacture			
EXTRACTION				
Parameter	Data			
Production, import, or use volume:	global production 46 billion pounds US production 11 billion pounds. Commercially, formaldehyde is manufactured as an aqueous solution called formalin, usually containing 37% by weight of dissolved formaldehyde. It is commonly used as a tissue preservative or as a bactericide in embalming fluid and medical laboratories. Formaldehyde is primarily used in the production of phenol- or urea-formaldehyde resins, plastics and chemical intermediates. Such resins are commonly used in everyday products as previously stated above. Formaldehyde is also widely used in molding compounds, glass wool and rock wool insulation, decorative laminates and textile treatments.			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	The assessment or report uses high quality data
Domain 2: Representativeness	Metric 2:	Geographic Scope	High	The data are from the United States and are representative of the industry being evaluated.
	Metric 3:	Applicability	High	The report is for an occupational scenario within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	Medium	Operations, equipment, and worker activities are expected to be reasonably representative of current conditions. The monitoring data were collected (report published 2009) after the most recent PEL (1992) establishment and is more than 10 but less than 20 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics. It is unclear if analysis is representative.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	Medium	Assessment or report clearly documents results, methods, and assumptions. Data sources are generally described but not fully transparent.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Low	The report does not address variability or uncertainty.
Overall Quality Determination		Medium		

Study Citation:	Łebkowska, M., Narożniak-Rutkowska, A., Pajor, E. (2013). Effect of a static magnetic field of 7 mT on formaldehyde biodegradation in industrial wastewater from urea-formaldehyde resin production by activated sludge. Bioresource Technology 132:78-83.			
HERO ID:	3001786			
Conditions of Use:	Disposal			
EXTRACTION				
Parameter	Data			
Chemical concentration:	Wastewater from urea-formaldehyde resin production can contain up to 4000 mg/L of FA but can be even higher according to other studies: highest literature value reported is 13,000 mg/L. Wastewater obtained for this study also had 13000 mg/L but the wastewater was diluted to achieve different FA concentrations of 30, 60, 120, 450, 550, 700, 1100 and 1600 mg/L			
EVALUATION				
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Methodology	High	Sound method (Polish Standard PN-C-04593:1971)
Domain 2: Representativeness	Metric 2:	Geographic Scope	Medium	Poland, an OECD country
	Metric 3:	Applicability	High	The report is for an occupational scenario, disposal, within the scope of the risk evaluation.
	Metric 4:	Temporal Representativeness	High	The report is expected to capture operations, equipment, and worker activities expected to be representative of current conditions. The report is generally no more than 10 years old.
	Metric 5:	Sample Size	Medium	Distribution of samples is characterized by a range with uncertain statistics.
Domain 3: Accessibility/ Clarity	Metric 6:	Metadata Completeness	High	Assessment or report clearly documents its data sources, assessment methods, results, and assumptions.
Domain 4: Variability and Uncertainty	Metric 7:	Metadata Completeness	Medium	The report provides only limited discussion of the variability and uncertainty in the results.
Overall Quality Determination			High	