An Alternatives Assessment for Use of Methylene Chloride

(EPA Docket EPA-HQ-OPPT-2020-0465, RIN 2070-AK70)

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Disclaimer

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ABBREVIATIONS AND ACRONYMS

1-BP	1-Bromopropane
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	Bioaccumulation factor
BCF	Bioconcentration factor
BMD	Benchmark dose
CalEPA	California Environmental Protection Agency
CASRN	Chemical Abstracts Service Registry Number
CDC	Centers for Disease Control and Prevention
COC	Concentration(s) of Concern
COU	Condition(s) of use
DfE	Design for the Environment (historical program)
ECHA	European Chemicals Agency
EPA	U.S. Environmental Protection Agency
GHS	Globally Harmonized System
GWP	Global Warming Potential
HCM	Hazard Comparison Module
HPV	High production volume
IPCC	Intergovernmental Panel on Climate Change
IRIS	Integrated Risk Information System
LC_{50}	Lethal concentration of 50% test organisms
LD_{50}	Lethal dose of 50% test organisms
LOAEC	Lowest observed adverse effect concentration
LOAEL	Lowest observed adverse effect level
MC	Methylene chloride (also known as dichloromethane [DCM])
MOA	Mode of action
NIOSH	National Institute for Occupational Safety and Health
NMP	n-Methylpyrrolidone (also known as n-methyl-2-pyrrolidone)
NOAEL	No observed adverse effect level
NTP	National Toxicology Program
ODP	Ozone depletion potential
OCSPP	Office of Chemical Safety and Pollution Prevention
OECD	Organisation for Economic Cooperation and Development
OPP	Office of Pesticide Programs
OPPT	Office of Pollution Prevention and Toxics
OSHA	Occupational Safety and Health Administration
POD	Point(s) of departure
PBPK	Physiological based pharmacokinetic modeling and simulation
PCE	Perchloroethylene, also known as tetrachloroethylene
QSAR	Quantitative structure-activity relationship
RQ	Risk quotient
SDS	Safety data sheet(s) (previously known as material safety data sheets [MSDS])
TRACI	Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts
TCE	Trichloroethylene
TSCA	Toxic Substances Control Act
UVCB	Unknown or variable composition, complex reaction products or biological materials
WHO	World Health Organization
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

EPA is undertaking proposed rulemaking under section 6(a) of the Toxic Substances Control Act (TSCA) for methylene chloride after completing a TSCA section 6(b) risk evaluation and determining that the chemical substance presents unreasonable risk of injury to health under the conditions of use (COU). This report was developed consistent with the statutory requirements of TSCA section 6(c)(2)(C) "Consideration of Alternatives" in support of the section 6(a) rulemaking in docket EPA-HQ-OPPT-2020-0465 in regulations.gov (RIN 2070-AK70).

EPA's methodology for this analysis is described in detail in this report. As an overview, each of the COUs of methylene chloride proposed to be prohibited or substantially restricted was mapped to 16 product categories for further analysis. EPA then identified products within those product categories that do not contain methylene chloride and are known to be reasonably available to achieve similar functions as methylene chloride-containing products. All chemical ingredients of those products, including chemical ingredients performing the same or similar functions as methylene chloride, were then screened to identify reasonably available hazard information. This search of reasonably available information resulted in the identification of several hundred substitute products across the product categories that do not contain methylene chloride. As part of this search of reasonably available information, EPA also determined that there do not appear to be reasonably available alternative chemicals or products for several conditions of use based on reasonably available information.

Specifically, EPA screened all product ingredients for toxicological and environmental endpoints using the Hazard Comparison Module (HCM). The HCM aggregates data from authoritative sources, quantitative structure-activity relationship (QSAR) modeling, and other screening tools to present a high-level assessment of fate properties and human health and environmental hazard endpoints. It generally used historical peer-reviewed, hazard-based Design for the Environment (DfE) criteria where hazard data are converted into scores of low, medium, high, or very high for comparability. In addition, the ingredients were compared to established lists of global warming potential (GWP) and ozone depletion potential (ODP) chemicals to identify which ingredients were included on the lists. Finally, Occupational Safety and Health Administration (OSHA) flammability categories were calculated for the individual ingredients to inform feasibility considerations given certain stakeholder concerns about more flammable alternatives to methylene chloride.

The identification of chemical product alternatives and the results of the ingredients screening form the basis for considering whether various alternatives benefit human health or the environment compared to the use of methylene chloride. These screening results are presented in hazard tables coded using the DfE criteria, with ratings assigned from Low to High or Very High across 17 hazard endpoints as well as persistence and bioaccumulation potential. The results section is organized by product category and summarizes the screening analysis tables, providing both descriptions of the toxicological and environmental endpoints for the product ingredients and highlighting those that perform similar functions as methylene chloride. Dozens of solvents were identified, and varying levels of hazard screening data are reasonably available for these solvents. This report considers a broad range of available products and chemical substances that are available for methylene chloride-containing products, enabling EPA to analyze whether there are feasible alternatives that are beneficial to health or the environment relative to methylene chloride. These chemicals reflect a diverse set of ratings for human health and environmental hazard endpoints and have varying degrees of flammability. In addition, some of these solvents have potential for either global warming or ozone depletion.

Importantly, this document does not make recommendations of products that should be used in place of methylene chloride; rather, its purpose is to present a representative list of alternative products and

chemical ingredients and their hazard relative to methylene chloride to ensure that the screening results for potential alternatives are considered as part of regulations under TSCA section 6(a) for methylene chloride.

1 BACKGROUND AND PURPOSE

EPA issued the TSCA risk evaluation for methylene chloride (also known as dichloromethane or DCM, CASRN 75-09-2) in June 2020 (U.S. EPA, 2020), and subsequently determined that methylene chloride, as a whole chemical substance, presents an unreasonable risk of injury to health when evaluated under its COUs (U.S. EPA, 2022). No unreasonable risks to the environment were identified from any COUs of methylene chloride. The analyses presented in TSCA risk evaluations consider the weight of the scientific evidence as the result of systematic review and involve application of expert scientific judgement (U.S. EPA, 2018). Based on these analyses, the risk evaluation determined that potential health effects associated with methylene chloride exposure include effects on the central nervous system, liver, immune system, as well as irritation/burns, and cancer.

EPA has produced this Alternatives Assessment for Use of Methylene Chloride to support rulemaking under TSCA section 6(a) in docket EPA-HQ-OPPT-2020-0465 in regulations.gov (RIN 2070-AK70). TSCA section 6(c)(2)(C) states the following:

> Based on the information published under subparagraph (A), in deciding whether to prohibit or restrict in a manner that substantially prevents a specific condition of use of a chemical substance or mixture, and in setting an appropriate transition period for such action, the Administrator shall consider, to the extent practicable, whether technically and economically feasible alternatives that benefit health or the environment, compared to the use so proposed to be prohibited or restricted, will be reasonably available as a substitute when the proposed prohibition or other restriction takes effect.

This analysis compares the hazard endpoints and fate characteristics of methylene chloride (the subject of this TSCA section 6(a) risk management proposed rulemaking) to chemical ingredients in alternative products known to be reasonably available. Consideration of whether there are technically and economically feasible alternatives, when compared with methylene chloride for the uses proposed to be prohibited or restricted, is discussed in the Economic Analysis of the Proposed Regulation of Methylene Chloride Under TSCA Section 6(a). This alternatives analysis primarily focuses on commercial and consumer uses of methylene chloride. As described in more detail in Section 2.1, several of the processing and industrial uses of methylene chloride appear to have no known alternatives based on reasonably available information. As a result, alternatives were not assessed for these conditions of use.

EPA has focused this alternatives assessment on alternative chemical ingredients performing the same or similar functions as methylene chloride in products for consumer or commercial/industrial use. In most cases, EPA did not find it practicable to consider alternative processes that may be reasonably available as a substitute for processes involving methylene chloride when the proposed prohibitions or restrictions would take effect. This is due to considerable uncertainties about alternative processes that may be reasonably available, and the limited time to conduct research on alternative processes in light of the statutory timeframe for completing the TSCA section 6(a) risk management rule for methylene chloride, the difficulty of ascertaining whether any alternative processes may be technically and economically feasible, the challenges of comparing the benefits of alternative processes to the benefits of the methylene chloride-containing processes, and other relevant considerations,

Although the alternatives to methylene chloride presented in this document is not intended to be an exhaustive list of every alternative product or chemical, it presents (1) a representative list of reasonably available alternatives for consideration by EPA, to the extent practicable and based on reasonably available information, to form a snapshot of the current market; and (2) where practicable, to enable EPA to compare the human health hazards, environmental hazards, potential persistence, and bioaccumulative properties of each chemical for each product in each product category. This document is limited to hazard comparisons; it does not compare potential risks between methylene chloride and alternatives as there are not exposure estimations or discussions of exposure potential presented for the alternatives.

This report does not make recommendations for or against a specific alternative. Its purpose is to characterize the landscape of potential chemical alternatives in order to ensure that the alternatives that benefit health or the environment of potential alternatives are considered as part of regulations under TSCA section 6(a) for methylene chloride.

2 IDENTIFYING PRODUCT ALTERNATIVES

2.1 Methylene Chloride Conditions of Use and Product Categories

For this analysis, EPA principally identified and assessed alternatives to methylene chloride in products relevant to several commercial and consumer uses proposed to be prohibited or significantly restricted. In assessing the scenario in which there is market adoption of these alternative commercial and consumer products that do not contain methylene chloride, the earlier and later life cycle stages are no longer relevant to the assessment: these conditions of use (COUs) for methylene chloride are dependent on continued use in the commercial and consumer life cycle stages. As such, this alternatives assessment excludes manufacturing, repackaging, distribution in commerce, disposal, and recycling. The COUs included in this assessment are listed in Table 5-1 with a crosswalk to the 16 product categories used in this assessment. Because of a lack of reasonably available information, this analysis did not assess alternatives for every individual COU EPA is proposing to prohibit or significantly restrict; the COUs and reasons for exclusion from this analysis are listed in Appendix D.

2.2 Alternative Products and Product Ingredients

For each product category, EPA researched methylene chloride-based products and products containing alternative chemical ingredients available for sale in the United States to identify a representation of the types of products available for consideration, to the extent practicable and based on reasonably available information and prepare a comparison between methylene chloride-based products and alternatives. To this end, EPA performed Internet searches, reviewed published market research, and used the expertise of industry experts to find examples of methylene chloride-based products and alternative product formulations. Specifically, EPA undertook a web-based search of products advertised by function (*e.g.*, paint removal) to identify safety data sheets or material safety data sheets (collectively, SDS) that identify product ingredients by chemical name and/or CASRN.

SDS for alternative products were collected to identify chemical ingredients listed by the manufacturers for each product category. Alternative and baseline products typically contained multiple ingredients. Products that identified less than 60 percent of the total content (*i.e.*, approximately half the mass of the product is unknown) were removed from consideration due to poor characterization and not analyzed further.

For use as a reactant, specifically in triacetate film production, EPA investigated industrial processes using alternate chemicals that could be substituted without fundamentally changing the process. In addition, alternative processes were investigated to produce the same product that do not require the use of methylene chloride.

Within each product category, EPA compiled the chemical ingredients for each product to compare the baseline and alternative products. This allowed EPA to consider trends, such as whether chemicals were frequently found in each product or if they were more variable and present in only small amounts. The formulations described in the MSDS or SDS are listed in Appendix A for all available ingredients. In addition, the range of concentrations listed for methylene chloride identified among the recently available products is also shown. Note that inherent errors in the original SDS, including inconsistencies between the CASRNs and chemical names, may carry through in Appendix A; the listed CASRN was used for screening in this assessment in the event of a discrepancy.

To further facilitate the comparison of the baseline and alternative products, the most likely function of each chemical in a product was identified. Methylene chloride is a solvent, which means it can dissolve other substances. This attribute can be used in a variety of ways, depending on the product. For instance, solvents can be used to dissolve and remove adhesives, paints, or other coatings. Solvents may also be used to create homogeneous mixtures or otherwise change a product to make it perform its role better. For example, solvents may be used to minimize clogs in spray nozzles or promote quick drying of inks and paints.

The chemical properties and common uses of each ingredient listed in an alternative product were researched to identify the function the chemical performed as part of the product. This allowed a more appropriate comparison of the hazard profiles where methylene chloride could be compared to chemicals that behave in a similar manner during product use. For example, methylene chloride can be compared to other chemicals that function in a product as a solvent rather than chemicals that perform a different function, such as surfactants, which decrease surface tension. In some cases, the alternative product may function without the use of a solvent as an ingredient.

2.3 Non-chemical Alternatives

Several of the functions of chemical products containing methylene chloride can also be accomplished by non-chemical means, such as mechanical or thermal methods (*e.g.*, sanding, media blasting, heat guns). Where any of these alternative processes have been identified for a product use, they are described qualitatively in the corresponding results section.

For methylene chloride, non-chemical alternatives are noted briefly under the product categories of paint and coating removal (Section 5.9) and other adhesive removal (Sections 5.1, 5.5, and 5.8).

3 DATA SOURCES AND ASSESSMENT METHODOLOGY

This section describes the data sources used to screen identified chemical alternatives and explains key methodological differences from the TSCA risk evaluations or other work products from the Office of Pollution Prevention and Toxics (OPPT) for context. For this analysis, EPA used publicly available tools and data that could rapidly screen hundreds of chemicals using existing methods and authoritative sources across a broad range of health and environmental endpoints. This is a more high-level, semi-automated assessment than the in-depth analysis for risk evaluations under TSCA section 6(b). EPA

surveyed chemicals across each use by examining the HCM results for each endpoint for the key ingredients identified in the alternative products.

3.1 Hazard Comparison Module for Chemical Alternatives

After the alternative chemical ingredients for products in each product category were identified, EPA used the Hazard Comparison Module (HCM),[1] which is part of a broader set of cheminformatics proof-of-concept modules, to rapidly screen the ingredients. The HCM compiles and uses data generated within EPA and sourced from public databases, literature, and QSAR predictions. The HCM outputs support chemical read-across for each alternative chemical ingredient. The original data were gathered from GHS (Globally Harmonized System) hazard codes/categories, presence on hazardous chemical lists, and quantitative experimental toxicity values. HCM outputs describe the human health effects, environmental hazard to aquatic organisms, and the environmental fate properties of each chemical available in the referenced sources (Williams et al., 2017); (Vegosen and Martin, 2020); (Lowe and Williams, 2021); (Williams et al., 2021). Data disseminated via the HCM are compiled from multiple authoritative sources, outlined in Table 3-1 and Table 3-2.

In the HCM, to fill data gaps where there are no records from authoritative or screening level sources, predicted toxicity values from WebTEST[2] are included (Martin et al., 2019). Where possible, EPA's Toxicity Estimation Software Tool (T.E.S.T.) predicts toxicity values and physical properties of chemicals using QSAR models based on hierarchical clustering, single model, group contribution, nearest neighbor, and consensus methods (Vegosen and Martin, 2020).

Once the information is compiled by the HCM, the HCM rates each hazard and fate parameter according to EPA's historical DfE Program Alternatives Assessment Criteria for Hazard Evaluation Version 2.0, August 2011, described in further detail in Section 4.[3] Although there are many assessment methods and tools that are available for defining and comparing the hazards associated with chemicals, EPA has selected the peer-reviewed, hazard-based DfE Alternatives Assessments criteria that were also used in support of risk management actions for TSCA chemicals. Hazard information is converted into scores of Low, Medium, High, or Very High (L, M, H, or VH, respectively) based on a modified version of the DfE criteria (see Table 4-2). The final scores assigned are based on the "trumping method" that selects the highest score from the most authoritative source as the integrated score (Vegosen and Martin, 2020).

The data presented in this Alternatives Assessment represents the output from the HCM, which is a dynamic resource subject to periodic updates. The data in these tables reflect data last updated in October 2021.

[1] Previous versions of the HCM have been referred to as the Hazard Comparison Dashboard. HCM is part of the ChemInformatics modules and is publicly accessible at https://www.epa.gov/chemical-research/cheminformatics

[2] WebTEST is a web-services based application hosted within NCCT's CompTox Chemicals Dashboard. WebTEST can estimate toxicity values and physical properties through the web browser or directly through the web via web-services and is publicly accessible at https://cfpub.epa.gov/si/si_public_record_Report.cfm?Lab=NRMRL&dirEntryId=344752.

[3] These 2011 criteria are historical criteria from the DfE Alternatives Assessments and are not part of the current DfE product certification program that is now administered jointly with OPP and focuses solely on antimicrobial products under the Federal Insecticide, Fungicide, and Rodenticide Act. For further information see https://www.epa.gov/pesticide-labels/design-environment-dfe-certification-information-registrants.

Table 3-1. Data Sources Consulted for the Hazard Analysis Sorted by Authority Level (from Vegosen and Martin, 2020)

Authoritative
• European Chemicals Agency (ECHA) Classification Labeling and Packaging (CLP) • EPA mid-Atlantic Region Human Health Risk-Based Concentrations • Germany Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area • World Health Organization International Agency for Research on Cancer (IARC) Monographs on the Evaluation of Carcinogenic Risks to Humans • Integrated Risk Information System (IRIS) • US National Institute for Occupational Safety and Health (NIOSH) list of potential occupational carcinogens; • California Office of Environmental Health Hazard Assessment Proposition 65 List • EU European Chemicals Agency (ECHA) Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) Candidate List of Substances of Very High Concern for Authorization • US Department of Health and Human Services National Toxicology Program Report on Carcinogens
Screening
• Safe Work Australia Hazardous Chemical Information System (HCIS) • Canada CNESST Workplace Hazardous Materials Information System (WHMIS) • ChemIDplus • Environment and Climate Change Canada Domestic Substance List (DSL) • Health Canada Priority Substances Lists (2006) (Carcinogenicity) • Health Canada Priority Substances Lists (2006) (Reproductive Toxicity) • National Institute of Technology and Evaluation (NITE) of Japan GHS Classification Results • Department of Occupational Safety and Health Ministry of Human Resources • Malaysia Industry Code of Practice on Chemicals Classification and Hazard Communication • New Zealand Environmental Protection Authority • Chemsec Substitute It Now (SIN) List • The Endocrine Disruption Exchange (TEDX) List of Potential Endocrine Disruptors • US EPA Toxicity Estimation Software Tool (T.E.S.T.); Experimental toxicity values • US EPA Toxicity Values (ToxVal) database, v8 • US EPA TSCA Work Plan for Chemical Assessments: 2014 Update University of Maryland (UMD) List of Acute Toxins, Teratogens, Carcinogens, or Mutagens
QSAR model
• US EPA Toxicity Estimation Software Tool (T.E.S.T.) Predicted toxicity values • Ministry of Environment and Food of Denmark Advisory List for Self-Classification of Dangerous Substances. Predicted GHS categories

Table 3-2. Reference Information for Data Sources Consulted for the Hazard Analysis, described further in (Vegosen and Martin, 2020)

Data Source
Safe Work Australia Hazardous Chemical Information System (HCIS)
Canada CNESST Workplace Hazardous Materials Information System (WHMIS)
U.S. National Library of Medicine ChemID*plus*
Ministry of Environment and Food of Denmark Advisory List for Self-Classification of Dangerous Substances
Environment and Climate Change Canada Domestic Substances List (DSL)
European Chemicals Agency (ECHA) Classification Labeling and Packaging (CLP) Annex VI
EPA mid-Atlantic Region Human Health Risk-Based Concentrations
Germany Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area (MAK Commission)
Health Canada Priority Substances Lists (2006) (Carcinogenicity)
Health Canada Priority Substances Lists (2006) (Reproductive Toxicity)
World Health Organization International Agency for Research on Cancer (IARC) Monographs on the Evaluation of Carcinogenic Risks to Humans
Integrated Risk Information System (IRIS) (via DSSTOX)
National Institute of Technology and Evaluation (NITE) of Japan GHS Classification Results
Department of Occupational Safety and Health Ministry of Human Resources Malaysia Industry Code of Practice on Chemicals Classification and Hazard Communication
New Zealand Environmental Protection Authority Chemical classification and information database (CCID)
US National Institute for Occupational Safety and Health (NIOSH) list of potential occupational carcinogens
California Office of Environmental Health Hazard Assessment Proposition 65 List
EU European Chemicals Agency (ECHA) Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) Candidate List of Substances of Very High Concern for Authorization
US Department of Health and Human Services National Toxicology Program Report on Carcinogens
ChemSec Substitute It Now (SIN) List
The Endocrine Disruption Exchange (TEDX) List of Potential Endocrine Disruptors
US EPA Toxicity Estimation Software Tool (T.E.S.T.) Experimental
US EPA Toxicity Estimation Software Tool (T.E.S.T.) Predicted
US EPA Toxicity Values (ToxVal) database, v8;
US EPA Toxic Substances Control Act (TSCA) Work Plan for Chemical Assessments: 2014 Update

Data Source
University of Maryland (UMD) List of Acute Toxins, Teratogens, Carcinogens, or Mutagens

An explanation of how the DfE Alternatives Assessment Criteria were modified within the HCM, as well as a discussion of how scores were determined in specific cases where multiple hazard scores were identified across multiple authoritative sources, is outlined in (Vegosen and Martin, 2020).

3.2 HCM and TSCA Risk Evaluation Methods Comparisons

EPA's assessment provides information on alternatives for consideration during risk management and regulatory development in accordance with TSCA section 6(c)(2)(C). Therefore, the screening methods in this document differ from the more comprehensive methods used for risk evaluations under TSCA section 6(b). Generally, for the risk evaluations, EPA applied a robust systematic review process to reasonably available information for relevant scientific disciplines, including human health hazard, environmental hazard, exposure, environmental fate, engineering, and physical-chemical properties. These data were then screened for relevance and overall quality following the approaches outlined in the *Application of Systematic Review in TSCA Risk Evaluations* (U.S. EPA, 2018). In contrast, the hazard ratings presented in this document for ingredients in product alternatives for methylene chloride were largely derived from a series of searchable databases and predictive modeling approaches that are automatically searched and ranked hierarchically according to the methodology of the HCM (Vegosen and Martin, 2020). Conclusions of the TSCA risk evaluations are not yet available for use as a source in the HCM. However, given that certain chemicals that EPA has recently evaluated also appear as ingredients in the product alternatives for methylene chloride, select hazard ratings for perchloroethylene (PCE), trichloroethylene (TCE), and 1-bromopropane (1-BP) were added to this analysis to better reflect the endpoints described in their respective TSCA risk evaluations and are noted in the ratings provided in Appendix A.

3.2.1 Human Health Hazard

The human health hazard ratings in the HCM are based on a modified version of DfE criteria. These criteria have been used to consider hazard for all Alternatives Assessments conducted by DfE since 2011. In this assessment, a hazard rating was based on the exposure route with the highest hazard designation from the most authoritative source. Ratings applied ranged from "Very High" to "Very Low," noting that ratings for target organ effects, cancer, genotoxicity, sensitization, and irritation are on different scales and are not directly comparable.

In TSCA risk evaluations, point(s) of departure (POD) values (*e.g.,* no observed adverse effect level/lowest observed adverse effect level) [NOAEL/LOAEL], Human Equivalent Dose [HED]/Human Equivalent Concentration [HEC], benchmark dose [BMD]) are determined for each specific toxicity endpoint. In lieu of hazard ratings like those used in DfE, TSCA risk evaluations present hazard identification conclusions and dose-response analyses based on information resulting from a systematic review process and data integration procedures using a weight of the scientific evidence approach.

3.2.2 Environmental Hazard

The environmental hazard ratings in the HCM are based on DfE criteria for aquatic toxicity for fish and pelagic invertebrates only. Hazard designations for aquatic toxicity from acute and chronic exposures are described numerically in Table 4-2.

The TSCA risk evaluations provide available hazard values for specific endpoints (*e.g.*, LC_{50}, no observed effect concentration [NOEC]) for each trophic level of aquatic species—including aquatic vertebrates (*e.g.*, fish and amphibians), invertebrates (*e.g.*, pelagic and benthic invertebrates), and plants (*e.g.*, algae and vascular plants). However, in the TSCA risk evaluations these values are used in a risk context, integrating exposure and concentration estimates especially for ecotoxicological considerations. In lieu of hazard designations, environmental hazard values in TSCA risk evaluations are weighed for quality and relevance and integrated into Concentrations of Concern (COC) that are representative of the species in the available data.

3.2.3 Persistence and Bioaccumulation Fate Parameters

The fate scores for persistence and bioaccumulation potential of substances in the HCM used in this assessment are based on the DfE Alternatives Assessment criteria. Conversely, TSCA section 6 risk evaluations, as well as other parts of OPPT's program under TSCA section 5, use different criteria to score persistence and bioaccumulation potential. Both sets of criteria are based on Agency guidelines and best practices, not statutory or regulatory requirements, with the DfE criteria providing a higher level of precision. A short discussion of the scientific basis of, and distinction between the two scoring practices, is included below.

The goal of DfE was to create a spectrum of ratings criteria to differentiate among chemicals. The Arnot & Gobas (2006) data showed that a significant percentage of subject chemicals had bioconcentration/ accumulation factors (BCF/BAF) values below 1,000, making further differentiation desirable. After publication of the draft criteria, DfE discussed this issue with several technical experts within and outside of EPA who supported the use of a threshold at 100, an order of magnitude below the moderate range threshold of 1,000 as a useful means of differentiating among chemicals. A similar approach was taken for persistence criteria. The use of "Very Low" criteria and lowering the half-life threshold for chemicals with "Moderate" persistence (16 to 60 days vs. 60 to 180 days in the New and Existing Chemicals program) allowed further differentiation among readily biodegradable chemicals and chemicals with half-lives of less than 60 days.

Therefore, the TSCA persistence criteria and the DfE criteria have differing precision for the metrics for ratings, with the DfE metrics being considered more granular (see Table 3-3). Under DfE, persistence categorization was divided into five categories based on environmental degradation half-lives for both biodegradation and abiotic degradation. Half-life in air was not intended to be used in determining persistence in the DfE criteria.[4] Under OPPT's TSCA New and Existing Chemicals programs, chemicals are similarly assigned persistence ratings based on environmental half-lives, however, only three categories are used, which do not align with the DfE criteria (*e.g.*, the OPPT "High" is the same as the DfE "Very High").

Table 3-3. Comparison of TSCA Persistence Criteria

DfE Persistence Criteria (Water, Soil, Sediment)				
Very Low	**Low**	**Moderate**	**High**	**Very High**

[4] The HCM uses screening data and ratings from Environment and Climate Change Canada's Domestic Substance List (DSL). Environment and Climate Change Canada does rate "High" persistence based on atmospheric half-life. This distinction is not apparent where DSL screening data have been used to inform the final persistence rating and may inflate ratings as compared to a strict read of the DfE criteria. For example, persistence of acetone, benzene, butane, ethanol, ethylbenzene, isopropanol, methanol, methyl acetate, propane, and toluene would otherwise be rated no higher than "Low" in the HCM if the DSL values based on persistence in air were excluded.

DfE Persistence Criteria (Water, Soil, Sediment)				
Readily biodegradable Passes 10-day Window criteria	Half-life <16 days Readily biodegradable	Half-life 16 to 60 days	Half-life 60 to 180 days	Half-life >180 days
TSCA new and existing chemicals persistence criteria (water, soil, sediment)				
Low			**Moderate**	**High**
Half-life <60 days			Half-life 60 to 180 days	Half-life >180 days
TSCA new and existing chemicals persistence criteria (air)				
Not Persistent			**Persistent**	
<2 days			≥2 days	

Similarly, the TSCA bioaccumulation criteria and the DfE criteria ratings have differing rating thresholds. Under DfE, bioaccumulation ratings are divided into four categories based on measured bioconcentration or bioaccumulation factors (see Table 3-4 below). Where measured BCF or BAF values are not available, measured octanol/water (Kow) or octanol/air (Koa) partition coefficient values are used. If no related values are available, estimated Kow and Koa values and lastly estimated BAFs may be used.

Under OPPT's TSCA programs, chemicals are assigned bioaccumulation ratings based on measured or estimated BCF/BAF values, however, three categories are used. The BCF ranges designated as "Very High" using DfE Criteria are classified as "High" under the TSCA criteria, see Table 3-4 below. The BCF ranges designated as "High" using DfE Criteria are classified as "Moderate" under the TSCA criteria. The BCF ranges designated as "Moderate" or "Low" using DfE Criteria are classified as "Low" under the TSCA criteria.

Table 3-4. Comparison of TSCA Bioaccumulation Criteria

DfE Bioconcentration Potential Criteria			
Low	**Moderate**	**High**	**Very High**
BCF/BAF <100 Kow <100 OR Koa <100,000	BCF/BAF 100 to <1,000	BCF/BAF 1,000 to 5,000	BCF/BAF >5000
TSCA new and existing chemicals bioconcentration potential criteria			
Low		**Moderate**	**High**
< 1,000		1,000 to 5,000	>5,000

3.3 Additional Assessment Sources

In addition to human health effects, environmental hazard to aquatic organisms, and environmental fate properties, EPA identified several chemical characteristics relevant to consideration of potential impact to health and the environment for screening and comparison to methylene chloride. The data sources and methodology for identifying these additional characteristics are described below.

3.3.1 Global Warming Potential and Ozone Depletion Potential

EPA queried the Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts (TRACI), an environmental impact assessment tool, to obtain information on the global warming potential (GWP) and ozone depletion potential (ODP) of a chemical (Bare, 2011). The chemicals were searched using their CASRNs. The latest version of TRACI 2.1 database was used for determining the GWPs and ODPs.

The GWP for each chemical, measured as kg CO_2eq/kg substance, indicate the potency of greenhouse gases relative to CO_2. TRACI provides GWPs with 100-year time horizons as per the guidelines of the United Nations Framework Convention on Climate Change (UNFCCC). TRACI contains GWPs sourced from a hierarchy of internationally accepted resources, including the Intergovernmental Panel on Climate Change (IPCC) assessment reports (IPCC, 1996) and (IPCC, 2001). In addition to GWPs, TRACI provided ODPs for the chemicals from recent sources (WMO, 2003). The ODPs, expressed as kg CFC-11 eq/kg substance), are an internationally recognized metric proposed by the World Meteorological Organization (WMO) to indicate the expected contribution of a substance to the breakdown of the ozone layer.

3.3.2 Physical Hazard Warnings

Flammability of a chemical depends on its flash point, which in turn depends on the boiling point and vapor pressure of the liquid. EPA queried the EPA CompTox Chemicals Dashboard using the Batch Search feature and CASRNs to find flash point and boiling point data (U.S. EPA, 2021). The CompTox Chemicals Dashboard, supported by the EPA Chemical Safety for Sustainability Research Program, compiles information from U.S. federal, state, and international data sources. Using the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) definition of flammable liquid (a liquid having a flash point of no more than 93°C [199.4°F]), EPA used boiling point and flash point data to identify for each alternative chemical that OSHA flammable liquid category applied.

OSHA divides flammable liquids into the following four categories (29 CFR § 1910.106(a)(19)):

- Category 1 flammable liquids have flash point <23 °C (73.4 °F) and initial boiling point ≤35 °C (95 °F);
- Category 2 flammable liquids have flash point <23°C (73.4 °F) and initial boiling point >35 °C (95 °F);
- Category 3 flammable liquids have flash point ≥23°C (73.4 °F) and ≤60 °C (140 °F); and
- Category 4 flammable liquids have flash point >60°C (140 °F) and ≤93 °C (199.4 °F).

Only flammable liquids were identified based on properties downloaded from CompTox Chemicals Dashboard.

4 HAZARD ENDPOINTS AND FATE PARAMETERS

The hazard profile for each chemical contains endpoint-specific summary statements (see Table 4-2). These summary statements provide a hazard designation for each of the endpoints in Table 4-1, as well

as the type of data (experimental or estimated) and the rationale. The endpoint summaries may also include explanatory comments, a discussion of confounding factors or an indication of the confidence in the data to help put the results in perspective.

4.1 Definition of Each Endpoint Screened against Criteria

EPA screened each ingredient using the HCM which directly compares experimental or estimated data to the Design for the Environment (DfE) Alternatives Assessment Criteria for Hazard Evaluation (U.S. EPA, 2011) for human health hazard, environmental hazard, and environmental fate endpoints. Table 4-1 provides brief definitions of these endpoints.

Table 4-1. Definitions of Toxicological and Environmental Endpoints for Hazard Assessment

Endpoint Category	Endpoint	Definition
Human Health Effects	Acute Mammalian Toxicity	Adverse effects occurring following oral or dermal administration of a single dose of a substance, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours.
	Carcinogenicity	Capability of a substance to increase the incidence of malignant neoplasms, reduce their latency, or increase their severity or multiplicity.
	Mutagenicity/Genotoxicity	Mutagenicity: The ability of an agent to induce permanent, transmissible changes in the amount, chemical properties, or structure of the genetic material. These changes may involve a single gene or gene segment, a block of genes, parts of chromosomes, or whole chromosomes. Mutagenicity differs from genotoxicity in that the change in the former case is transmissible to subsequent cell generations. Genotoxicity: The ability of an agent or process to alter the structure, information content, or segregation of DNA, including those which cause DNA damage by interfering with normal replication process, or which in a non-physiological manner (temporarily) alter its replication.
	Reproductive Toxicity	The occurrence of biologically adverse effects on the reproductive systems of females or males that may result from exposure to environmental agents. The toxicity may be expressed as alterations to the female or male reproductive organs, the related endocrine system, or pregnancy outcomes. The manifestation of such toxicity may include, but is not limited to: adverse effects on onset of puberty, gamete production and transport, reproductive cycle normality, sexual behavior, fertility, gestation, parturition, lactation, developmental toxicity, premature reproductive senescence or modifications in other functions that were dependent on the integrity of the reproductive systems
	Developmental Toxicity	Adverse effects in the developing organism that may result from exposure prior to conception (either parent), during prenatal development, or postnatally to the time of sexual maturation. Adverse developmental effects may be detected at any point in the lifespan of the organism. The major manifestations of developmental toxicity include: (1) death of the developing organism, (2) structural abnormality, (3) altered growth, and (4) functional deficiency.
	Neurotoxicity	An adverse change in the structure or function of the central and/or peripheral nervous system following exposure to a chemical, physical, or biological agent.
	Repeated Dose Toxicity	Adverse effects (immediate or delayed) that impair normal physiological function (reversible and irreversible) of specific target organs or biological systems following repeated exposure to a chemical substance by any route relevant to

Endpoint Category	Endpoint	Definition
Human Health Effects		humans. Adverse effects include biologically significant changes in body and organ weights, changes that affect the function or morphology of tissues and organs (gross and microscopic), mortality, and changes in biochemistry, urinalysis, and hematology parameters that are relevant for human health; may also include immunological and neurological effects.
	Respiratory Sensitization	Hypersensitivity of the airways following inhalation of a substance.
	Skin Sensitization	A cell-mediated or antibody-mediated allergic response characterized by the presence of inflammation that may result in cell death, following an initial induction exposure to the same chemical substance, *i.e.*, skin allergy.
	Eye Irritation/Corrosivity	Irritation or corrosion to the eye following the application of a test substance.
	Dermal Irritation/Corrosion	Dermal irritation - reversible damage to the skin following the application of a test substance for up to 4 hours. Dermal corrosion - irreversible damage to the skin namely, visible necrosis through the epidermis and into the dermis following the application of a test substance for up to 4 hours.
Environmental Toxicity[a]	Aquatic Toxicity (Acute)	The property of a substance to be injurious to an organism in a short-term (days), aquatic exposure to that substance.
	Aquatic Toxicity (Chronic)	The property of a substance to cause adverse effects to aquatic organisms during aquatic exposures which were determined in relation to the life cycle of the organism.
Environmental Fate	Environmental Persistence	The length of time the chemical exists in the environment, expressed as a half-life, before it is destroyed (*i.e.*, transformed) by natural or chemical processes. For alternative assessments, the amount of time for complete assimilation (ultimate removal) is preferred over the initial step in the transformation (primary removal).
	Bioaccumulation	The process in which a chemical substance is absorbed in an organism by all routes of exposure as occurs in the natural environment (*e.g.*, dietary and ambient environment sources). Bioaccumulation is the net result of competing processes of chemical uptake into the organism at the respiratory surface and from the diet and chemical elimination from the organism including respiratory exchange, fecal egestion, metabolic biotransformation of the parent compound, and growth dilution.

[a] Environmental toxicity refers to adverse effects observed in living organisms that typically inhabit the wild; the assessment is focused on effects in three groups of surrogate aquatic organisms (freshwater fish, invertebrates, and algae).

4.2 Ratings Criteria

Table 4-2 summarizes the DfE criteria that EPA used to interpret the data from the hazard profiles of the ingredients of the identified products in Appendix A. These criteria have been used to consider hazard for all Alternatives Assessments conducted by DfE since 2011; they underwent Agency-wide review and public comment and were finalized in 2011 (U.S. EPA, 2011).

In this analysis, hazard designation was based on the exposure route with the highest hazard designation, rather than for each human health endpoint for each route of exposure. Data may have been available for some or all relevant routes of exposure. Based on the DfE criteria, ratings were applied in a color-coded form ranging from very high to very low. Where multiple data sources were available, the HCM applies a "trumping method" that selects the highest score from the most authoritative source as the integrated score. EPA notes that most endpoints did not have criteria for all ratings. In many cases, hazard information was not reasonably available specific endpoints or fate properties, or the reasonably available data were determined to be conflicting or indeterminate. In those cases, the criteria are either left blank, or are given a rating of I for indeterminate.

The criteria in the final tables are shown below:

VH - Very High	H - High	M - Medium	L - Low	I - Inconclusive	No Data

The details of these criteria are summarized in Table 4-2 and in the DfE full criteria document, Design for the Environment (DfE) Program Alternatives Assessment Criteria for Hazard Evaluation Version 2.0, August 2011. Further explanation of how these criteria were used within the HCM, as well as a discussion of how scores were determined in specific cases where multiple hazard scores were identified across multiple authoritative sources, is outlined in (Vegosen and Martin, 2020).

Table 4-2. Criteria Used to Assign Hazard Designations from the Alternatives Assessment[a]

Endpoint	Very High	High	Moderate	Low	Very Low
Human Health Effects					
Acute mammalian toxicity					
Oral median lethal dose (LD_{50}) (mg/kg)	≤50	>50–300	>300–2,000	>2,000	–
Dermal LD_{50} (mg/kg)	≤200	>200–1,000	>1,000–2,000	>2,000	–
Inhalation median lethal concentration (LC_{50}) – vapor/gas (mg/L)	≤2	>2–10	>10–20	>20	–
Inhalation LC50 –- dust/mist/fume (mg/L)	≤0.5	>0.5–1.0	>1–5	>5	–
Carcinogenicity					
Carcinogenicity	*Known or presumed human carcinogen* Equivalent to Globally Harmonized System of Classification and Labeling of Chemicals (GHS) Categories 1A and 1B	*Suspected human carcinogen* Equivalent to GHS Category 2	*Limited or marginal evidence of carcinogenicity in animals* *and inadequate evidence in humans*	*Negative studies or robust mechanism-based Structure Activity Relationship (SAR)* As described above	–
Mutagenicity/genotoxicity					
Germ cell mutagenicity	GHS Category 1A or 1B: Substances known to induce heritable mutations or to be regarded as if they	GHS Category 2: Substances which cause concern for humans owing to the possibility that they may induce heritable	Evidence of mutagenicity supported by positive results in *in vitro* OR *in vivo* somatic	Negative for chromosomal aberrations and gene mutations, or no structural alerts.	–

Endpoint	Very High	High	Moderate	Low	Very Low
	induce heritable mutations in the germ cells of humans	mutations in the germ cells of humans OR Evidence of mutagenicity supported by positive results in *in vitro* AND *in vivo* somatic cells and/or germ cells of humans or animals	cells of humans or animals		
Mutagenicity and genotoxicity in somatic cells	Evidence of mutagenicity supported by positive results in *in vitro* AND *in vivo* somatic cells and/or germ cells of humans or animals	Mutagenicity and genotoxicity in somatic cells	Evidence of mutagenicity supported by positive results in *in vitro* AND *in vivo* somatic cells and/or germ cells of humans or animals	Negative for chromosomal aberrations and gene mutations, or no structural alerts.	--
Reproductive toxicity					
Oral (mg/kg/day)	–	<50	50–250	>250–1,000	>1,000
Dermal (mg/kg/day)	–	<100	100–500	>500–2,000	>2,000
Inhalation - vapor, gas (mg/L/day)	–	<1	1–2.5	>2.5–20	>20
Inhalation - dust/mist/fume (mg/L/day)	–	<0.1	0.1–0.5	>0.5–5	>5
Oral (mg/kg/day)	–	<50	50–250	>250–1,000	>1,000
Developmental toxicity					
Oral (mg/kg/day)	–	<50	50–250	>250–1,000	>1,000

Endpoint	Very High	High	Moderate	Low	Very Low
Dermal (mg/kg/day)	–	<100	100–500	>500–2,000	>2,000
Inhalation – vapor, gas (mg/L/day)	–	<1	1–2.5	>2.5-20	>20
Inhalation – dust/mist/fume (mg/L/day)	–	<0.1	0.1–0.5	>0.5-5	>5
Neurotoxicity					
Oral (mg/kg/day)	–	<10	10–100	>100	–
Dermal (mg/kg/day)	–	<20	20–200	>200	–
Inhalation – vapor, gas (mg/L/day)	–	<0.2	0.2–1.0	>1.0	–
Inhalation – dust/mist/fume (mg/L/day)	–	<0.02	0.02–0.2	>0.2	–
Repeated-dose toxicity					
Oral (mg/kg/day)	–	<10	10–100	>100	–
Dermal (mg/kg/day)	–	<20	20–200	>200	–
Inhalation – vapor, gas (mg/L/day)	–	<0.2	0.2–1.0	>1.0	–
Inhalation – dust/mist/fume (mg/L/day)	–	<0.02	0.02–0.2	>0.2	–
Sensitization					
Skin sensitization	–	High frequency of sensitization in humans and/or high potency in animals (GHS Category 1A)	Low to moderate frequency of sensitization in human and/or low to moderate	Adequate data available and not GHS Category 1A or 1B	–

Endpoint	Very High	High	Moderate	Low	Very Low
			potency in animals (GHS Category 1B)		
Respiratory sensitization	–	Occurrence in humans or evidence of sensitization in humans based on animal or other tests (equivalent to GHS Category 1A and 1B)	Limited evidence including the presence of structural alerts	Adequate data available indicating lack of respiratory sensitization	–
Irritation/corrosivity					
Eye irritation/corrosivity	Irritation persists for >21 days or corrosive	Clearing in 8–21 days, severely irritating	Clearing in ≤7 days, moderately irritating	Clearing in <24 hours, mildly irritating	Not irritating
Skin irritation/corrosivity	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation at 72 hours	Not irritating
Endocrine activity					
Endocrine activity	–	Positive for estrogenic activity either	–	Negative for estrogenic activity	–
Environmental Toxicity and Fate					
Aquatic toxicity					
Acute aquatic toxicity – LC_{50} or half maximal effective concentration (EC_{50}) (mg/L)	<1.0	1–10	>10–100	>100 or No Effects at Saturation (NES)	–
Chronic aquatic toxicity – lowest observed effect concentration (LOEC) or chronic value (ChV) (mg/L)	<0.1	0.1–1	>1–10	>10 or NES	–

Endpoint	Very High	High	Moderate	Low	Very Low
Environmental persistence					
Persistence in water, soil, or sediment	Half-life >180 days or recalcitrant	Half-life of 60–180 days	Half-life <60 but ≥16 days	Half-life <16 days OR passes Ready Biodegradability test not including the 10-day window. No degradation products of concern.	Passes Ready Biodegradability test with 10-day window. No degradation products of concern.
Persistence in air (half-life days)	*For this endpoint, High/Moderate/Low etc. characterizations will not apply. A qualitative assessment of available data will be prepared.*				
Bioaccumulation					
Bioconcentration Factor (BCF)/ Bioaccumulation Factor (BAF)	>5,000	5,000–1,000	<1,000–100	<100	–
Log BCF/BAF	>3.7	3.7–3	<3-2	<2	–

[a] Very High or Very Low designations (if an option for a given endpoint in Table 4-2) were assigned only when there were experimental data located for the chemical under evaluation. In addition, the experimental data must have been collected from a well conducted study specifically designed to evaluate the endpoint under review. If the endpoint was estimated using experimental data from a close structural analog, by professional judgment, or from a computerized model, then the next-level designation was assigned (*e.g.*, use of data from a structural analog that would yield a designation of very high would result in a designation of high for the chemical in review). One exception is for the estimated persistence of polymers with an average molecular weight (MW) >1,000 Daltons, which may result in a "Very High" designation.

5 RESULTS OF CHEMICAL ALTERNATIVE SCREENING

Methylene chloride has a long history of use as a solvent. However, in many product categories numerous products with alternative chemical ingredients exist. As described in Section 3.1, EPA mapped COUs from the risk evaluation to product categories for the purpose of identifying chemical alternatives; this crosswalk is provided in Table 5-1. Across all the following products and their applicable conditions of use, several hundred products, representing feasibility for use, were identified that did not contain methylene chloride. For each of the listed product categories, EPA screened the ingredients in the identified products for their potential benefit to health or the environment compared to methylene chloride. Results of this screening are provided in detailed tables in Appendix A; high-level summaries with supplementary references describing chemical or non-chemical alternatives for products in that product category are provided in the text below.

EPA reviewed four types of information as part of the consideration, to the extent practicable and based on reasonably available information, of whether technically and economically feasible alternatives that benefit health or the environment will be reasonably available. First, EPA considered the number of identified products per product category without methylene chloride and the number of unique ingredients that perform the same or similar functions as methylene chloride in that product. For these key ingredients, EPA prioritized sources based on their authority, as defined by the HCM, in considering the information reasonably available for evaluating the associated endpoints: "authoritative" sources were prioritized over "screening" sources, which were, in turn, prioritized over "QSAR model" sources. EPA surveyed the human health and environmental hazard ratings themselves, including the proportion of "High" and "Very High" scores across endpoints. Finally, EPA noted any additional characteristics of the key ingredients, which may include having a combination of persistence and bioaccumulation potential, listed as having either ozone depletion or global warming potential, or calculated to have a high flammability rating. High-level summaries of these considerations are described for each product category in the subsections that follow.

Table 5-1. Crosswalk between Product Categories and TSCA Conditions of Use for Screening

Product Category	Conditions of Use from TSCA Risk Evaluation for Methylene Chloride
Adhesive remover	Consumer use in adhesives and caulk removers Industrial and commercial use in adhesive and calk removers
Adhesives	Consumer use in adhesives and sealants Consumer use in arts, crafts, and hobby material glue Industrial and commercial use in adhesives, sealants, and calks
Anti-spatter	Consumer use in an anti-spatter welding aerosol Industrial and commercial use as anti-spatter welding aerosol
Caulk	Consumer use in adhesives and sealants Consumer use in arts, crafts, and hobby materials glue Industrial and commercial use in adhesives, sealants, and caulks
Floor adhesive remover	Consumer use in adhesive and caulk removers Industrial and commercial use in adhesive and caulk removers Industrial and commercial use in carbon remover, wood floor cleaner, and brush cleaner

Product Category	Conditions of Use from TSCA Risk Evaluation for Methylene Chloride
General aerosol degreaser	Consumer use as solvent in aerosol degreasers/cleaners Industrial and commercial use as solvent for aerosol spray degreaser/cleaner Industrial and commercial use in aerosol degreasers and cleaners Industrial and commercial use in metal aerosol degreasers. Consumer use in automotive care products (degreasers) Consumer use in carbon removers and other brush cleaners Consumer use in metal degreasers Industrial and commercial use for electrical equipment, appliance, and component manufacturing Industrial and commercial use in automotive care products (degreasers) Industrial and commercial use in automotive care products (interior car care) Industrial and commercial use in carbon remover, wood floor cleaner, and brush cleaner
Degreaser, other	Consumer use in automotive care products (degreasers) Consumer use in carbon removers and other brush cleaners Consumer use in metal degreasers Industrial and commercial use for electrical equipment, appliance, and component manufacturing Industrial and commercial use in automotive care products (degreasers) Industrial and commercial use in automotive care products (interior car care) Industrial and commercial use in carbon remover, wood floor cleaner, and brush cleaner Industrial and commercial use for plastic and rubber products manufacturing (equipment cleaning) Industrial and commercial use for oil and gas drilling, extraction, and support activities (equipment cleaning) Industrial and commercial use in metal non-aerosol degreasers Industrial and commercial use in non-aerosol degreasers and cleaners Industrial and commercial use in spot removers for apparel and textiles Consumer use as solvent in aerosol degreasers/cleaners Industrial and commercial use as solvent for aerosol spray degreaser/cleaner Industrial and commercial use as solvent for cold cleaning Industrial and commercial use in aerosol degreasers and cleaners
Mastic adhesive remover	Consumer use in adhesive and caulk removers and industrial Commercial use in adhesive and caulk removers
Paint and coating remover	Industrial and commercial use in paint and coating removers Consumer use in brush cleaners for paints and coatings
Sealant	Consumer use in adhesives and sealants Consumer use in arts, crafts, and hobby materials glue Industrial and commercial use in adhesives, sealants, and caulks
Tape, label, and sticker remover	Consumer use in adhesive and caulk removers Industrial and commercial use in adhesive and caulk removers

Product Category	Conditions of Use from TSCA Risk Evaluation for Methylene Chloride
Vapor degreasing and cold cleaning	Industrial and commercial use as solvent for batch vapor degreasing Industrial and commercial use as solvent for in-line vapor degreasing Industrial and commercial use as solvent for cold cleaning
Cold pipe insulation	Industrial and commercial use in cold pipe insulations Consumer use in cold pipe insulation
Lubricants and greases	Industrial and commercial use in liquid lubricants and greases Industrial and commercial use in spray lubricants and greases Consumer use in lubricants and greases
Lithographic plate cleaner	Industrial and commercial use in lithographic printing plate cleaner
Cellulose triacetate film production	Industrial and commercial use in cellulose triacetate film production

The sections that follow include analyses of the alternative products identified for each product category and the list of unique alternative chemicals found in those products. Although the alternative products presented in this section are not intended to be an exhaustive list of every alternative product or chemical, they present a representative list of reasonably available alternatives for consideration by EPA. Many identified products have formulations that do not include solvents or other chemicals that function like methylene chloride. However, for each product category, the most common direct chemical alternatives for methylene chloride are highlighted and described further. These include solvents or other chemicals that perform a similar function to that of methylene chloride in the product, such as surfactants or degreasers. Where practicable, the three most commonly occurring functional alternatives to methylene chloride in each product category were reviewed in greater detail. In some cases, approximately two to four functional alternatives were reviewed, if doing so provided a more accurate overview of the alternatives for that category. Note that frequently used chemicals that act as propellants, fragrances, or other functions that do not serve the same or similar functions to methylene chloride were not included in this more detailed review.

Dozens of solvents and other chemicals that perform a similar function as methylene chloride in the alternative products were specifically identified and screened using the HCM. These include five solvents that have undergone TSCA section 6 evaluations and are the subject of ongoing risk management efforts; they are noted below and throughout Section 5. Varying levels of hazard screening data are reasonably available for the dozens of identified alternative solvents; many have authoritative sources documenting their hazard ratings. These chemical substances represent a diverse set of ratings for human health and environmental hazard endpoints and have varying degrees of flammability. In addition, some of these solvents have potential for either global warming or ozone depletion. Specific alternative chemicals that were identified and screened using the HCM include, but are not limited to following:

- 1,1,1,2-Tetraflurorethane
- 1,4-Dioxane (subject to risk management under TSCA section 6)
- 1-Bromopropane (subject to risk management under TSCA section 6)
- 1-Hexadecene
- 1-Propoxy-2-propanol

- 1-Tetradecene
- 2-Methyl butyl acetate
- 2-Methyl-2-propanol
- 2-Propanol
- Acetic acid
- Acetone
- Benzene, 1,2,4-trimethyl-
- Benzyl alcohol
- Chloroform
- Cumene
- Decafluoropentane
- Diethylene glycol ethyl ether
- Diethylene glycol monobutyl ether
- Dimethyl carbonate
- Dipropylene glycol methyl ether
- Ethanol
- Ethyl benzene
- Ethylene glycol
- Ethylene glycol monobutyl ether
- Formic acid
- Glycerin
- Heptane
- Hexane
- Methanol
- Methyl ethyl ketone
- N-methylpyrrolidone (subject to risk management under TSCA section 6)
- Oleic acid
- Parachlorobenzotrifluoride
- Perchloroethylene (subject to risk management under TSCA section 6)
- Propylene glycol butyl ether
- Toluene
- Trans-1,2- dichloroethylene
- Trichloroethylene (subject to risk management under TSCA section 6)

In addition, several chemical ingredients could not be profiled because their chemical names and CASRNs are not specific to a unique chemical structure for screening using the HMC. Instead, their chemical names and CASRNs often referred to mixtures or compositions of multiple chemicals, which are incompatible with HCM analysis. Specific examples that were commonly identified in the product ingredient lists include various chain length isoalkanes, categories of hydrocarbons, and other types or synonyms for petroleum distillates. In these cases, the chemical names instead refer to a chemical category, group, or class of chemicals, many of which are substances of unknown or variable composition (U.S. EPA, 2015).[5] A few of these generic chemicals are of particular note for this Alternatives Analysis:

[5] UVCBs are substances that do not have a static or well-defined composition; they are variable substances rather than being a single chemical or discrete mixture of several specific chemicals present in a known ratio. They include, for example, mixtures of similar chemical compounds with differing carbon chain lengths, such as hydrotreated light distillate. The

- Methyl soyate, which has been identified as a readily biodegradable alternative solvent, is a mixture of long chain fatty acid methyl esters for which limited safety data is available. It has been considered to have lower toxicity and environmental impact than chlorinated solvents (Wildes, 2002).
- Cresols are ortho- para- and meta-substituted isomers under a generic chemical name, which each have distinct but similar physical and chemical properties. Tri-isomeric cresol is known to have toxicological risk by inhalation and dermal routes and these isomers are identified as possible carcinogens (ASTDR, 2008).
- Xylene is a generic name for ortho-, para- and meta-substituted isomers. Xylene also falls under the broader category of aromatic hydrocarbon solvent on this list. Xylene isomers all have relatively low flash points and high flammability, as well as known health effects in acute exposures (ASTDR, 2007).
- Oil-based formulations, including various petroleum distillates and naphthenic ingredients, were also prevalent in the following analyses, and represent a range of organic chemicals of various characteristics.

Generally, the physical and chemical properties of the chemicals within these groups differ such that the group are not screened using HCM. However, some of these chemical groups include chemicals that are identified more specifically and profiled elsewhere in this document, such as hexane, which also falls under the broader category of alkanes.

5.1 Category: Adhesive Remover

This product category includes two COUs from the methylene chloride TSCA risk evaluation:

1. consumer use in adhesives and caulk removers, and
2. industrial and commercial use in adhesive and calk removers.

EPA identified 29 total alternative products in this product category. Five of the products contained n-methylpyrrolidone (also known as n-methyl-2-pyrrolidone or NMP) and none contained PCE, TCE, and 1-BP. With the removal of any products containing any of the other TSCA risk evaluation solvents, a total of 24 products remained. In addition, mechanical or thermal methods *(e.g.*, sanding, media blasting, heat guns) may also be non-chemical alternatives to using products containing methylene chloride for adhesive removers.

In the 29 alternative products, EPA found 47 unique chemicals with associated CASRNs. Of the 47 chemicals, no hazard information is reasonably available for 19 chemicals. Of the 28 chemicals for which hazard screening data are reasonably available, approximately 68 percent have at least 1 authoritative source. None of the 28 chemicals have an identified ODP, though one has an identified GWP. Additionally, 21 chemicals are flammable, with 3 chemicals as Category 1, 7 chemicals as Category 2, 6 chemicals as Category 3, and 5 chemicals as Category 4.

Among the aforementioned 28 unique chemicals in the 29 identified products, 17 were categorized as solvents or cleaner/solvents, or degreasers. Other ingredients in adhesive removal include cleaner, paint thinner, and surfactant, which comprise another three chemicals. The remaining eight chemicals are distributed as follows: base oil formulation (1), dispersant (1), fragrance (1), plasticizer (1), and propellant (4).

different carbon chain lengths and structures result in the individual chemicals within the group having varying physical and chemical properties, which, while they often follow a general trend, can cover a wide range.

Of the products identified, several contain ingredients with either a lower hazard screening rating than methylene chloride for certain endpoints, or no reasonably available hazard information, although some ingredients present higher hazard screening ratings than methylene chloride. As an example, of the 23 solvents identified, 19 of the chemicals have a lower hazard rating, or no available information, for genotoxicity/mutagenicity than methylene chloride, whose genotoxicity mutagenicity is categorized as "Very High." Based on a preliminary review of the hazard screening results presented by the 28 unique chemicals in the 29 identified products, 16 solvents have either no "Very High" hazard ratings, or no reasonably available hazard information, and one solvent has no "High" rating across any of the hazard endpoints. Of the nine solvents with no "Very High" hazard rating, four are not flammable.

For chemicals or formulations in the adhesive remover product category, acetone, dipropylene glycol methyl ether, and NMP are the most common alternative solvents identified in the products. The hazard screening data for dipropylene glycol methyl ether is unavailable in the EPA Hazard Comparison Module. Acetone has two "Very High" hazard ratings—one for acute mammalian dermal route, which is higher than the rating for methylene chloride, and one for genotoxicity/mutagenicity, which is the same as the rating for methylene chloride. NMP has the same or lower hazard ratings for 13 of the hazard categories when compared to methylene chloride and has no "Very High" hazard ratings. However, NMP has higher hazard ratings than methylene chloride for reproductive human health effects and systemic repeat exposure. Acetone and NMP are also flammable.

5.2 Category: Adhesive

This product category includes three COUs from the methylene chloride TSCA risk evaluation:

1. Consumer use in adhesives and sealants;
2. Consumer use in arts, crafts, and hobby materials glue; and
3. Industrial and commercial use in adhesives, sealants, and caulks.

EPA identified 162 total alternative products in this product category. Additionally, 26 of the products contained PCE, 12 contained TCE, 5 included 1-BP, and 1 included NMP. With the removal of any products containing methylene chloride or any of the other TSCA risk evaluation solvents, there were 125 products.

In the 162 products without methylene chloride, EPA found 158 unique chemicals with associated CASRNs. Of the 158 chemicals, no hazard information is reasonably available for 54 chemicals. Of the remaining 104 chemicals for which hazard screening data are reasonably available, approximately 65 percent of the chemicals have at least one authoritative source. None of the 104 chemicals have an identified ODP, though 4 of the chemicals have an identified GWP. Additionally, 64 chemicals are flammable, with 8 chemicals as Category 1, 23 chemicals as Category 2, 19 chemicals as Category 3, and 14 chemicals as Category 4.

Among the aforementioned 104 unique chemicals in the 162 identified products, 33 were categorized as solvents, cleaner/solvents, dry-side spotting agent/solvent (1), and solvent/propellant. The remaining 71 chemicals were distributed as follows: abrasive (1), accelerator (1), adhesion promoter (7), antioxidant (3), base oil formulation (1), binding agent (2), blending component (1), bonding agent (2), carrier (1), catalyst (1), catalyst/curing agent (1), cleaner (1), corrosion resistance (1), coupling agent (2), cross-linking agent (6), curing agent (5), detergent (1), dispersion resin (1), drying agent (1), film-forming agent (2), friction and wear protection (1), initiator (1), monomer (2), part of formulation (1), phenolic resins (1), pigment (1), plasticizer (3), polymerization inhibitor (1), primer (2), produce polyurethane resins (2), propellant (9), reinforcement (1), reinforcing agent (3), surface property modifier (1), and thickener (1).

Of the products identified, several contain ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, while some ingredients present higher hazards than methylene chloride. As an example, of the 33 solvents and cleaners identified, 24 of the chemicals have a lower hazard rating for genotoxicity/mutagenicity than methylene chloride, whose genotoxicity mutagenicity is categorized as "Very High." Based on a preliminary review of the hazard screening results presented by the 104 unique chemicals in the 162 identified products, 18 solvents have no "Very High" ratings across any of the hazard endpoints and one solvent has no "High" ratings across any of the hazard endpoints. Of the 18 solvents with no "Very High" hazard rating, all are flammable.

For chemicals or formulations in the adhesive product category, acetone, toluene, and hexane are the most common alternative solvents identified in the products. Acetone has two "Very High" hazard ratings for acute mammalian dermal, which is higher than the rating for methylene chloride, and for genotoxicity/mutagenicity, which is the same as the rating for methylene chloride. Toluene also has two "Very High" hazard ratings. The first is for acute mammalian dermal route, which is higher than the hazard rating for methylene chloride. The second is for genotoxicity mutagenicity, which is the same as the hazard rating for methylene chloride. None of the hexane hazard ratings are categorized as "Very High," although several categories have "High" hazard ratings. Additionally, acetone, toluene, and hexane are all flammable.

5.3 Category: Anti-Spatter

This product category includes two COUs from the methylene chloride TSCA risk evaluation:

1. Consumer use in an anti-spatter welding aerosol, and
2. Industrial and commercial use as anti-spatter welding aerosol.

EPA identified 51 total alternative products in this product category. Additionally, two of the products contained PCE and none contained TCE, 1-BP, or NMP. With the removal of any products containing methylene chloride or PCE, there were 49 products.

In the 51 products without methylene chloride, EPA found 45 unique chemicals with associated CASRNs. Of the 45 chemicals, no hazard information is reasonably available for 18 chemicals. Of the remaining 27 chemicals for which hazard screening data are reasonably available, approximately 70 percent of the chemicals have at least 1 authoritative source. None of the 27 chemicals have an identified ODP, although 1 of the chemicals has an identified GWP. Additionally, 12 chemicals are flammable, with 4 chemicals as Category 1, 3 chemicals as Category 2, 1 chemical as Category 3, and 4 chemicals as Category 4.

Among the aforementioned 27 unique chemicals in the 51 identified products, 6 are categorized as solvents, cleaner/solvent, or lubricant/solvent—acetone, glycerin, methyl ethyl ketone, oleic acid, PCE, and propylene glycol butyl ether. Additionally, hazard screening data are not reasonably available for an additional three solvents because they are chemical groups (C12–C14 isoalkanes, polyethylene glycol) or are obscure (c.i. solvent orange 54). Other ingredients in anti-spatter include cleaner and surfactants, which comprise another four chemicals. The remaining 17 chemicals are distributed as follows: abrasive (1), accelerator (1), antifreeze (1), blending component (1), carrier (1), corrosion inhibitor (1), dispersing agent (1), friction and wear protection (1), pigment (2), preservative (3), propellant (3), and sequestering agent (1).

Of the products identified, several contain ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, although some ingredients present higher hazards than

methylene chloride. As an example, of the six solvents identified, three have a lower hazard screening rating for genotoxicity mutagenicity than methylene chloride, whose genotoxicity mutagenicity is categorized as "Very High." Based on a preliminary review of the screening results presented by the 27 unique chemicals in the 51 identified products, 2 solvents have no "Very High" ratings across any of the hazard endpoints, although both have "High" ratings for some of the hazard endpoints. Of the two solvents with no "Very High" hazard rating, one is not flammable.

For chemicals or formulations in the anti-spatter product category, acetone, oleic acid, and methyl ethyl ketone are the most common alternative solvents found in the products. EPA identified an additional six chemicals as potential alternatives—castor oil, ethanol, ethylene glycol, naphtha (petroleum), white mineral oil, and xylene—and expanded screening to include m-xylene, o-xylene, and p-xylene more specifically because xylene is sufficiently generic not to have screening data included. Acetone has two "Very High" hazard ratings. The first is for the acute mammalian dermal category, which is higher than the hazard rating of methylene chloride. Acetone and methyl ethyl ketone both have "Very High" ratings for genotoxicity mutagenicity. Oleic acid has no "Very High" hazard screening ratings and has the same or lower hazard rating for all categories when compared to methylene chloride. Oleic acid is also the only one of these solvents that is not flammable. Ethanol has "Very High" hazard ratings for acute mammalian oral and inhalation toxicity, and carcinogenicity, and has a Category 2 flammability rating.

5.4 Category: Caulk

This product category includes three COUs from the methylene chloride TSCA risk evaluation:

1. Consumer use in adhesives and sealants;
2. Consumer use in arts, crafts, and hobby materials glue; and
3. Industrial and commercial use in adhesives, sealants, and caulks.

EPA identified 19 total alternative products in this product category. One of the products contained PCE, leaving 18 products without any of the TSCA risk evaluation solvents.

Of these 19 products without methylene chloride, EPA found 32 unique chemicals with associated CASRNs. For chemicals or formulations in the caulk product category, calcium carbonate, crystalline quartz silica, and titanium dioxide are the most commonly used chemicals. Solvents play a more limited role in caulks, as compared to the other product categories, and most of the chemicals in caulk have other uses including drying agents, filler, hardener and reinforcing agents.

Methylene chloride may be both a solvent and a blending agent within caulk. Of the 32 chemicals, there are three solvents, toluene, ethylene glycol, and PCE. All three of these solvents have at least one authoritative source, at least one "Very High" rating for one of the endpoints, and are also flammable. Various forms of petroleum distillates, including "stoddard solvent," are potentially used as blending agents. Because these ingredients represent broader categories of chemicals, hazard screening is not available for them.

5.5 Category: Floor Adhesive Remover

This product category includes three COUs from the methylene chloride TSCA risk evaluation:

1. Consumer use in adhesive and caulk removers;
2. Industrial and commercial use in adhesive and caulk removers; and
3. Industrial and commercial use in carbon remover, wood floor cleaner, and brush cleaner.

EPA identified five total alternative products in this product category. Mechanical or thermal methods (*i.e.*, sanding, media blasting, heat guns) may also be a non-chemical alternative to using products containing methylene chloride for floor adhesive removers.

In the five products indicated earlier, EPA found four unique chemicals with associated CASRNs. Of the four chemicals, no hazard information is reasonably available for one chemical. Of the remaining three chemicals for which hazard screening data are reasonably available, all have at least one authoritative source. None of the chemicals have an identified ODP or GWP. Additionally, two of these chemicals are flammable, with one chemical as Category 3, and one chemical as Category 4.

Among the aforementioned three unique chemicals in the five identified products, one is categorized as a degreaser. The other chemicals were an accelerator and a coupling agent.

Of the products identified, several contain ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, although some ingredients present higher hazards than methylene chloride. As an example, the degreaser has the same hazard rating for genotoxicity/mutagenicity as methylene chloride, whose genotoxicity mutagenicity is categorized as "Very High."

Of the five products identified, diethylene glycol monobutyl ether was the most commonly occurring chemical and is also a solvent. In addition, benzyl alcohol is a degreaser. The remaining chemicals include alcohol ethoxylate, a surfactant. No hazard screening rating is reasonably available for alcohol ethoxylate. Diethylene glycol monobutyl ether has the same or lower hazard rating than methylene chloride for every hazard category except systemic repeat exposure. It does not have an identified ODP or GWP and is not flammable. Although most hazard ratings for benzyl alcohol are the same or lower than those of methylene chloride, it has some hazard ratings that are higher than those of methylene chloride, such as reproductive and chronic aquatic. Benzyl alcohol has a flammability rating of Category 4.

5.6 Category: General Aerosol Degreaser

This product category includes 11 COUs from the methylene chloride TSCA risk evaluation:

1. Consumer use as solvent in aerosol degreasers/cleaners;
2. Industrial and commercial use as solvent for aerosol spray degreaser/cleaner;
3. Industrial and commercial use in aerosol degreasers and cleaners;
4. Industrial and commercial use in metal aerosol degreasers;
5. Consumer use in automotive care products (degreasers);
6. Consumer use in carbon removers and other brush cleaners;
7. Consumer use in metal degreasers;
8. Industrial and commercial use for electrical equipment, appliance, and component manufacturing;
9. Industrial and commercial use in automotive care products (degreasers);
10. Industrial and commercial use in automotive care products (interior car care); and
11. Industrial and commercial use in carbon remover, wood floor cleaner, and brush cleaner.

EPA identified 105 total alternative products in this product category. Additionally, 6 of the products contained PCE, 17 contained TCE, 14 contained 1-BP, and 1 contained NMP. With the removal of any products containing any TSCA risk evaluation solvents (1-BP, PCE, TCE, and NMP), there were 69 products.

Of the 105 products indicated earlier, EPA found 93 unique chemicals with associated CASRNs. Of the 93 chemicals, no hazard information is reasonably available for 35 chemicals. Of the 58 chemicals for which hazard screening data are reasonably available, approximately 70 percent of the chemicals have at least one authoritative source. None of the 58 chemicals have an identified ODP, though 4 of the chemicals have an identified GWP. Additionally, 48 chemicals are flammable, with 6 chemicals as Category 1, 20 chemicals as Category 2, 15 chemicals as Category 3, and 8 chemicals as Category 4.

Among the aforementioned 58 unique chemicals in the 105 identified products, 32 were categorized as a solvent, cleaner/solvent, dry-side spotting agent/solvent, or solvent/propellant. Other ingredients in general aerosol degreaser include cleaner, cleaner/fragrance, emulsifier, and surfactant, which comprise another 6 chemicals. The remaining 22 chemicals are distributed as follows: accelerator (1), adhesion promoter (1), base oil formulation (2), buffering agent (1), carrier (1), caustic agent (1), chelating agent (1), corrosion inhibitor (1), coupling agent (1), fragrance (3), pH adjuster (1), plasticizer (1), produce polyurethane foams (1), propellant (4), solubilizer (1), and stabilizer (1).

Of the products identified, several contain ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, while some ingredients present higher hazards than methylene chloride. As an example, of the 32 solvents identified, 25 of the chemicals have a lower hazard rating for genotoxicity mutagenicity than methylene chloride, whose genotoxicity mutagenicity is categorized as "Very High." Based on a preliminary review of the hazard screening results presented by the 60 unique chemicals in the 105 identified products, it was found that 15 solvents have no "Very High" ratings across any of the hazard endpoints, though all 15 chemicals have "High" ratings in some of the hazard endpoints. Of the 15 solvents with no "Very High" hazard rating, 1 is not flammable.

For chemicals or formulations in the general aerosol degreaser product category, acetone, TCE, and hydrotreated light distillates (petroleum) are the most common alternative solvents identified; however, an additional 17 solvents were identified across the 105 products in this category. The hazard screening data for hydrotreated light distillates (petroleum) is unavailable because this represents a category of chemicals. Both acetone and TCE are solvents with at least two "Very High" hazard ratings. For acetone, the "Very High" hazard ratings are for genotoxicity mutagenicity and acute dermal effects. TCE has three "Very High" hazard ratings for carcinogenicity, genotoxicity mutagenicity, and chronic aquatic. Both of these chemicals are flammable.

5.7 Category: Degreasers, Other

This category combines products identified from six subcategories as the products may be used interchangeably: auto parts degreaser, electronic degreaser, engine degreaser, liquid auto parts degreaser, liquid general degreaser, and liquid industrial degreaser. This product category includes 16 COUs from the methylene chloride TSCA risk evaluation:

1. Consumer use in automotive care products (degreasers);
2. Consumer use in carbon removers and other brush cleaners;
3. Consumer use in metal degreasers;
4. Industrial and commercial use for electrical equipment, appliance, and component manufacturing;
5. Industrial and commercial use in automotive care products (degreasers);
6. Industrial and commercial use in automotive care products (interior car care);
7. Industrial and commercial use in carbon remover, wood floor cleaner, and brush cleaner;

8. Industrial and commercial use for plastic and rubber products manufacturing (equipment cleaning);
9. Industrial and commercial use for oil and gas drilling, extraction, and support activities (equipment cleaning);
10. Industrial and commercial use in metal non-aerosol degreasers;
11. Industrial and commercial use in non-aerosol degreasers and cleaners;
12. Industrial and commercial use in spot removers for apparel and textiles;
13. Consumer use as solvent in aerosol degreasers/cleaners;
14. Industrial and commercial use as solvent for aerosol spray degreaser/cleaner;
15. Industrial and commercial use as solvent for cold cleaning; and
16. Industrial and commercial use in aerosol degreasers and cleaners.

5.7.1 Subcategory: Auto Parts Degreaser

EPA identified 19 total alternative products in this product category. Additionally, three of the products contained PCE, one contained TCE, two contained 1-BP, and none contained NMP. With the removal of any products containing 1-BP, PCE, and TCE, there were 14 products.

In the 19 products, EPA found 47 unique chemicals with associated CASRNs. Of the 47 chemicals, no hazard information is reasonably available for 14 chemicals. Of the 33 chemicals for which hazard screening data are reasonably available, approximately 72 percent of the chemicals have at least one authoritative source. None of the 33 chemicals have an identified ODP though 1 of the chemicals has an identified GWP. Additionally, 28 chemicals are flammable, with 3 chemicals as Category 1, 9 chemicals as Category 2, 9 chemicals as Category 3, and 7 chemicals as Category 4.

Among the aforementioned 33 unique chemicals in the 19 identified products, 18 were categorized as solvents, cleaner/solvents, and dry side spotting agent/solvent. Other ingredients in auto parts degreaser include two cleaners and one degreaser. The remaining 12 chemicals are distributed as follows: antifreeze (1), buffering agent (1), coupling agent (1), dispersing agent (1), fragrance (1), hardener (1), plasticizer (1), produce polyurethane foams (1), propellant (3), and sequestering agent (1).

Of the products identified, several contained ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, although some ingredients presented higher hazards than methylene chloride. As an example, of the 18 solvents identified, 11 of the chemicals have a lower hazard rating for genotoxicity/mutagenicity than methylene chloride, whose genotoxicity/mutagenicity is categorized as “Very High.” Based on a preliminary review of the screening results presented by the 33 unique chemicals in the 19 identified products, 6 solvents have no “Very High” ratings in any of the hazard endpoints, although all 6 chemicals have “High” ratings for some of the hazard endpoints. Of the six solvents with no “Very High” hazard rating, all are flammable.

For chemicals or formulations in the auto parts degreaser product category, acetone, toluene, and heptane are the most common alternative solvents. Based on the hazard screening profiles for acetone and toluene, these chemicals have at least one “Very High” hazard rating and multiple “High” ratings for different categories. Acetone has “Very High” hazard ratings for acute dermal effects and genotoxicity mutagenicity, while toluene has “Very High” hazard ratings for acute inhalation effects and genotoxicity mutagenicity Heptane has no “Very High” hazard ratings, though it has several “High” ratings. Additionally, all three of these solvents are flammable.

5.7.2 Subcategory: Electronic Degreaser

EPA identified 29 total alternative products in this product category. Additionally, one of the products contained TCE, eight contained 1-BP, and none contained PCE and NMP. With the removal of any products 1-BP and TCE, there were 20 products.

In the 29 products, EPA found 51 unique chemicals with associated CASRNs. Of the 51 chemicals, no hazard screening information is reasonably available for 9 chemicals. Of the 42 chemicals for which hazard screening data are reasonably available, approximately 50 percent of the chemicals had at least 1 authoritative source. Additionally, none of the remaining 38 chemicals have an identified ODP, although four of the chemicals have an identified GWP. Additionally, 38 chemicals are flammable, with 6 chemicals as Category 1, 26 chemicals as Category 2, and 6 chemicals as Category 3.

Among the aforementioned 42 unique chemicals in the 29 identified products, 30 were categorized as solvents, cleaner/solvent, dry-side spotting agent/solvent, or solvent/propellants. The only other ingredient in the electronic degreaser product category are cleaners, which comprise another two chemicals. The remaining 10 chemicals are distributed as follows: carrier (1), fragrance, (1), chemical producing polyurethane foams (1), propellant (5), rinsing agent (1), and stabilizer (1).

Of the products identified, several contain ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, although some ingredients present higher hazards than methylene chloride. As an example, of the 30 solvents identified, 24 of the chemicals have a lower hazard screening rating for genotoxicity mutagenicity than methylene chloride, whose genotoxicity mutagenicity is categorized as "Very High." Based on a preliminary review of the screening results presented by the 42 unique chemicals in the 29 identified products, 14 solvents have no "Very High" hazard ratings in any of the endpoints, and only 1 has no "High" hazard rating in any of the endpoints. Of the 14 solvents with no "Very High" hazard rating, 1 is not flammable.

For chemicals or formulations in the electronic degreaser product category, 1,1,1,2-tetrafluoroethane, 2-propanol, and 1-BP are the most commonly seen alternative solvents identified. Unlike 1-BP that has a "Very High" hazard screening rating for inhalation, carcinogenicity, and genotoxicity mutagenicity, the other two solvents do not have any "Very High" hazard screening ratings. However, all three of these chemicals have "High" ratings for some of the hazard endpoints. All three chemicals are flammable.

5.7.3 Subcategory: Engine Degreaser

EPA identified 14 total alternative products in this product category. The identified products did not contain any of the TSCA risk evaluation solvents.

Of the 14 products, EPA found 40 unique chemicals with associated CASRNs. Of the 40 chemicals, no hazard screening information is reasonably available for 23 chemicals. Of the remaining 17 chemicals for which hazard screening data are reasonably available, approximately 82 percent of the chemicals have at least 1 authoritative source. None of the 17 chemicals have an identified ODP, although 1 of the chemicals has an identified GWP. Additionally, 11 chemicals are flammable, with 3 chemicals as Category 1, 2 chemicals as Category 2, 3 chemicals as Category 3, and 3 chemicals as Category 4.

Among the aforementioned 17 unique chemicals in the 14 identified products, 5 were categorized as solvents or cleaner/solvents—acetone; benzene, 1,2,4-trimethyl-; diethylene glycol ethyl ether; diethylene glycol monobutyl ether; and ethylene glycol monobutyl ether. Additionally, hazard screening data are not available for an additional six solvents because they are chemical groups – alkanes, C10–C20, branched and linear; aromatic petroleum distillates; diesel fuel no. 2; fuel oil, no. 2; and glycol

ether(s) (unspecified). Other ingredients in engine degreaser included caustic agent, cleaner, and surfactant, which comprise another three chemicals. The remaining nine chemicals were distributed as follows: break-down oil, grease, and water softener (1), builder (1), carrier (1), coupling agent (1), fragrance (1), hardener (1), and propellant (3).

Of the products identified, several contained ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, although some ingredients presented higher hazards than methylene chloride. As an example, of the five solvents identified, two of the chemicals have a lower hazard rating for genotoxicity mutagenicity than methylene chloride, whose genotoxicity/mutagenicity is categorized as "Very High." Based on a preliminary review of the hazard screening results presented by the 17 unique chemicals in the 14 identified products, 2 solvents have no "Very High" hazard screening ratings in any of the endpoints, although they have "High" ratings for some of the hazard endpoints. Of the five solvents, four are flammable and one is non-flammable.

For chemicals or formulations in the engine degreaser product category, ethylene glycol monobutyl ether, hydrotreated light distillates (petroleum), and kerosene were the most common, which serve similar functions as methylene chloride. EPA identified an additional nine potential alternative solvents, including ethanol, ethyl benzene, four base oil formulations; alcohols, C12–C16, ethoxylated; distillates (petroleum), hydrodesulfurized middle; and xylene. EPA expanded screening to include m-xylene, o-xylene, and p-xylene more specifically since xylene is sufficiently generic not to have screening data. Of the three most common chemicals, hazard screening data are reasonably available only for ethylene glycol monobutyl ether, whose carcinogenicity is less than that of methylene chloride, whose hazard rating is "Very High." However, the hazard screening rating for genotoxicity/mutagenicity is the same as that of methylene chloride. This solvent is also flammable.

5.7.4 Subcategory: Liquid Auto Parts Degreaser

EPA identified 15 total alternative products in this product category. Additionally, two contained PCE, two contained 1-BP, and none contained TCE and NMP. With the removal of any products containing methylene chloride, 1-BP, and PCE, this number decreased to 11 products.

In the 15 products without methylene chloride, EPA found 30 unique chemicals with associated CASRNs. Of the 30 chemicals, no hazard information is reasonably available for 13 chemicals. Of the 16 chemicals for which hazard screening data are reasonably available, approximately 75 percent have at least 1 authoritative source. None of the 16 chemicals have an identified ODP or GWP. Additionally, 11 chemicals are flammable, with 3 chemicals as Category 2, 8 chemicals as Category 3, and 1 as Category 4.

Among the aforementioned 16 unique chemicals in the 15 identified products, 7 were categorized as solvents and cleaners. The other 9 chemicals are distributed as follows: adhesion promoter (2), base oil formulation (1), buffering agent/water softener (1), fragrance (1), paint thinner (1), and sequestering agent (1).

Of the products identified, several contained ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, while some ingredients presented higher hazards than methylene chloride. As an example, of the seven solvents and cleaners identified, four of the chemicals have a lower hazard rating for genotoxicity mutagenicity than methylene chloride, whose genotoxicity/mutagenicity is categorized as "Very High." Based on a preliminary review of the hazard screening results presented by the 16 unique chemicals in the 15 identified products, 2 solvents have no

"Very High" hazard ratings in any of the endpoints—although both have "High" ratings for some of the hazard endpoints. Both of the solvents with no "Very High" hazard rating are flammable.

For chemicals or formulations in the engine degreaser product category, 1-BP, PCE, 2-methyl-2-propanol, and dipropylene glycol methyl ether were the most common alternative solvents identified. No hazard screening data are reasonably available for dipropylene glycol methyl ether. Of the remaining three chemicals, 1-BP has a "Very High" hazard screening rating for inhalation, carcinogenicity, and genotoxicity/mutagenicity, and PCE has a "Very High" hazard screening rating for carcinogenicity. The final solvent, 2-methyl-2-propanol, does not have any "Very High" hazard screening ratings. However, all three of these chemicals have "High" ratings for some of the hazard endpoints and all three are also flammable.

5.7.5 Subcategory: Liquid General Degreaser

EPA identified 22 total alternative products in this product category.

In the 22 products, EPA found 33 unique chemicals with associated CASRNs. Of the 33 chemicals, no hazard screening information was reasonably available for 16 chemicals. Of the remaining 17 chemicals for which hazard screening data are reasonably available, approximately 76 percent of the chemicals had at least 1 authoritative source. None of the 17 chemicals have an identified ODP or GWP. Additionally, five chemicals are flammable, with one chemical as Category 2, three chemicals as Category 3, and one chemical as Category 4.

Among the aforementioned 17 unique chemicals in the 22 identified products, 3 were categorized as solvents or solvent/buffering agents. Other ingredients in liquid general degreaser included caustic agent, chemical to breakdown oil and grease and water softener, cleaner/fragrance, emulsifier, and surfactant, which comprise another six chemicals. The remaining eight chemicals were distributed as follows: accelerator (1), base oil formulation (1), buffering agent (1), chelating agent (3), fragrance (1), and pH adjuster (1).

Of the products identified, several contained ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, although some ingredients presented higher hazards than methylene chloride. As an example, of the three solvents identified, one chemical has a lower hazard rating for genotoxicity mutagenicity than methylene chloride, whose genotoxicity mutagenicity is categorized as "Very High." Based on a preliminary review of the screening results presented by the 17 unique chemicals in the 22 identified products, 1 solvent has no "Very High" hazard screening rating in any of the endpoints, though it has "High" ratings for some of the hazard endpoints. The solvent with no "Very High" hazard rating is flammable.

For chemicals or formulations in the liquid general degreaser product category, hydrotreated light distillates (petroleum), alcohol ethoxylate, ethylene glycol monobutyl ether, and sodium metasilicate are the most common alternative chemicals. The hazard screening data for hydrotreated light distillates and alcohol ethoxylate are unavailable. The remaining two chemicals have at least one "Very High" hazard rating and multiple "High" ratings for different categories. Ethylene glycol monobutyl ether is flammable while sodium metasilicate is not.

5.7.6 Subcategory: Liquid Industrial Degreaser

EPA identified 59 total alternative products in this product category. Two of the products contained PCE, two contained TCE, three contained 1-BP, and none contained NMP. With the removal of any products containing methylene chloride, 1-BP, PCE, and TCE, this number decreases to 54 products.

Of the 59 products without methylene chloride, EPA found 76 unique chemicals with associated CASRNs. Of the 76 chemicals, no hazard information was reasonably available for 28 chemicals. Of the remaining 48 chemicals for which hazard screening data are reasonably available, approximately 70 percent of the chemicals had at least 1 authoritative source. None of the remaining 48 chemicals have an identified ODP, although 1 of the chemicals has an identified GWP. Additionally, 28 chemicals are flammable, with 2 chemicals as Category 1, 6 chemicals as Category 2, 16 chemicals as Category 3, and 4 chemicals as Category 4.

Among the aforementioned 48 unique chemicals in the 59 identified products, 21 were categorized as solvents, solvent/buffering agents, dry-side spotting agent/solvent, and cleaner/solvent. Other ingredients in liquid industrial degreaser include chemicals used for breaking down oil and grease and water softener, caustic agent, cleaner, cleaner/fragrance, emulsifier, and surfactant, which comprise another 10 chemicals. The remaining 17 chemicals are distributed as follows: accelerator (1), buffering agent/water softener (1), chelating agent (3), coupling agent (1), dispersing agent (1), fragrance (3), paint thinner (1), pH adjuster (3), produce polyurethane foams (1), sequestering agent (1), and water softener/pH adjuster/ emulsification agent (1).

Of the products identified, several contained ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, while some ingredients presented higher hazards than methylene chloride. As an example, of the 21 solvents identified, 12 of the chemicals have a lower hazard rating for genotoxicity mutagenicity than methylene chloride, whose genotoxicity mutagenicity is categorized as "Very High." Based on a preliminary review of the hazard screening results presented by the 48 unique chemicals in the 59 identified products, 8 solvents, and solvent/cleaner have no "Very High" hazard ratings in any of the endpoints, although all 8 chemicals have "High" ratings for some of the hazard endpoints. Of the eight solvents with no "Very High" hazard rating, one is not flammable.

For chemicals or formulations in this product category, ethylene glycol monobutyl ether, alcohol ethoxylate, and sodium metasilicate are the most commonly seen alternative chemicals. Hazard screening data are not reasonably available for alcohol ethoxylate. The remaining two chemicals have at least one "Very High" hazard rating and multiple "High" ratings for different categories. Ethylene glycol monobutyl ether is flammable while sodium metasilicate is not.

5.8 Category: Mastic Adhesive Remover

This product category includes two COUs from the methylene chloride TSCA risk evaluation:

1. Consumer use in adhesive and caulk removers and industrial; and
2. Commercial use in adhesive and caulk removers.

EPA identified 13 total alternative products in this product category.

In the 13 products, EPA found 12 unique chemicals with associated CASRNs. Of the 12 chemicals, no hazard screening information is reasonably available for 7 chemicals. Of the remaining five chemicals for which hazard screening data are reasonably available, all had at least one authoritative source. None of the chemicals have an identified ODP or GWP. Additionally, four chemicals are flammable, with two chemicals as Category 3, and two chemicals as Category 4.

Among the aforementioned 5 unique chemicals in the 13 identified products, 2 were categorized as a solvent. The other ingredients in mastic adhesive remover include a degreaser, an accelerator, and a fragrance.

Of the products identified, several contain ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, although some ingredients present higher hazards than methylene chloride. As an example, the solvent with available hazard screening data has the same hazard screening rating for genotoxicity mutagenicity as methylene chloride, whose genotoxicity mutagenicity is categorized as "Very High." The solvent is also flammable.

Of the 13 products identified, 11 contain diethylene glycol monobutyl ether. Nine of those products also include hydrotreated light distillates (petroleum), and four contain an aromatic petroleum distillate. Both petroleum distillates are active agents, although hazard screening ratings are not reasonably available for either. Diethylene glycol monobutyl ether has the same or lower hazard rating than methylene chloride for every hazard category except systemic repeat exposure. It does not have an identified ODP or GWP and is not flammable.

5.9 Category: Paint and Coating Remover

Products identified within this category included two COUs from the methylene chloride TSCA risk evaluation (see Table 5-1):

1. Industrial and commercial use in paint and coating removers; and
2. Consumer use in brush cleaners for paints and coatings.

EPA identified 65 total alternative products in this product category. As described in the associated Methylene Chloride Economic Analysis, these alternative products may not meet the specific use for some furniture refinishing uses. Mechanical or thermal methods (*e.g.*,, sanding, media blasting, heat guns) may also be non-chemical alternatives to using products containing methylene chloride for paint and coating removers.

In the 65 products without methylene chloride, EPA found 66 unique chemicals, excluding any chemicals listed only with generic names or without a CASRN. Of the 66 chemicals, hazard screening information is not reasonably available for 19 chemicals. Of the remaining 47 chemicals for which hazard screening data are reasonably available, approximately 74 percent of the chemicals had at least one authoritative source. None of the 47 chemicals have an identified ODP or GWP. Additionally, 33 chemicals are flammable, with 3 chemicals as Category 1, 6 chemicals as Category 2, 12 chemicals as Category 3, and 12 chemicals as Category 4.

Among the aforementioned 47 unique chemicals in the 65 identified products, 21 were categorized as solvents or cleaner/solvents. Other ingredients in paint or coating removal include cleaners, emulsifiers, paint thinner, and surfactants, which comprise another eight chemicals. The remaining 18 chemicals were distributed as follows: accelerator (2), activator (1), antioxidant (1), caustic agent (1), coupling agent (1), degreaser (1), friction and wear protection (1), fragrance (1), pH adjuster (4), plasticizer (1), produce polyurethane resins (1), propellant (2), and rheology modifier (1).

Of the products identified, several contained ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, while some ingredients presented higher hazards than methylene chloride. As an example, of the 21 solvents and cleaners identified, 15 of the chemicals have a lower hazard rating for genotoxicity mutagenicity than methylene chloride, whose genotoxicity mutagenicity is categorized as "Very High." Based on a preliminary review of the hazard screening results presented by the 47 unique chemicals in the 65 identified products, it was found that 11 solvents have no "Very High" hazard ratings in any of the endpoints, and 1 solvent has no "High" hazard rating

in any of the endpoints. Of the 21 solvents with no "Very High" hazard rating, 2 chemicals are not flammable.

For chemicals or formulations in the paint and coating remover product category, alcohol ethoxylate, dimethyl carbonate, benzyl alcohol, and methanol are the most common chemicals that perform a similar function as methylene chloride. The hazard screening data for alcohol ethoxylate is not reasonably available. Though no authoritative source is reasonably available for dimethyl carbonate, benzyl alcohol, and methanol have at least one authoritative source available and all three are flammable. Dimethyl carbonate does not have any "Very High" hazard ratings and only one "High" rating for environmental persistence. Methanol and benzyl alcohol both have one "Very High" hazard rating for genotoxicity mutagenicity. Methanol has 12 "High" hazard ratings for other endpoints, while benzyl alcohol has 6 "High" hazard ratings.

Other assessments of alternatives to methylene chloride for paint and coating removers include the government-funded reports from California (Morris, 2006) and the Army Research Lab ARL (2016) as well as reports from the Toxic Use Reduction Institute (TURI) (TURI, 2017) and (TURI, 2020) and BizNGO (BizNgo, 2015). The Army Research Lab and TURI conducted technical performance testing on available formulations with lower hazard profiles, including measures of flammability. Broadly speaking, these assessments concluded that there were available paint and coating removers that performed well and rated lower on their organization's hazard assessments.

5.10 Category: Sealant

This product category includes three COUs from the methylene chloride TSCA risk evaluation:

1. Consumer use in adhesives and sealants;
2. Consumer use in arts, crafts, and hobby materials glue; and
3. Industrial and commercial use in adhesives, sealants, and caulks.

EPA identified 60 total alternative products in this product category. Additionally, 16 of the products contained PCE, 1 contained NMP, and none contained TCE and 1-BP. With the removal of any products containing methylene chloride, PCE, and NMP, there were 43 products.

In the 60 products without methylene chloride, EPA found 73 unique chemicals with associated CASRNs. Of the 73 chemicals, no hazard information is reasonably available for 27 chemicals. Of the 46 chemicals for which hazard screening data are reasonably available, approximately 60 percent of the chemicals had at least 1 authoritative source. None of these 46 chemicals have an identified ODP or GWP. Additionally, 28 chemicals are flammable, with 5 chemicals as Category 2, 10 chemicals as Category 3, and 13 chemicals as Category 4.

Among the aforementioned 46 unique chemicals in the 60 identified products, 11 were categorized as solvents. Other ingredients in sealants include adhesion promoter, binding agent, coupling agent, cross-linking agent, hardener, and reinforcing agent, which comprise another 18 chemicals. The remaining 17 chemicals are distributed as follows: abrasive (1), antifreeze (1), base oil formulation (1), cleaner (1), corrosion resistance (1), curing agent (4), drying agent (2), friction and wear protection (1), paint thinner (1), stabilizer (2), surface property modifier (1), and surfactant (1).

Of the products identified, several contained ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, while some ingredients presented higher hazards than methylene chloride. As an example, of the 11 solvents identified, 9 of the chemicals have a lower hazard rating for genotoxicity/mutagenicity than methylene chloride, whose genotoxicity/mutagenicity is

categorized as "Very High." Based on a preliminary review of the screening results presented by the 46 unique chemicals in the 60 identified products, it was found that 6 solvents have no "Very High" hazard ratings in any of the endpoints, although all 6 of these chemicals have "High" ratings for some of the hazard endpoints. Of the 11 solvents with no "Very High" hazard rating, all are flammable.

For chemicals or formulations in the sealant product category, solvents naphtha, 1,2,4-trimethylbenzene, and cumene are the most commonly occurring. Hazard screening data for the solvent naphtha are not reasonably available. The solvent 1,2,4-trimethylbenzene has no "Very High" hazard ratings and has four "High" hazard ratings for genotoxicity/mutagenicity. While cumene has a lower hazard rating in three categories than methylene chloride, it has a higher hazard rating in three other categories. Cumene and 1,2,3-trimethylbenzene also have a higher flammability rating of Category 3, as opposed to Category 2 for methylene chloride.

5.11 Category: Tape, Label, and Sticker Remover

This product category includes two COUs from the methylene chloride TSCA risk evaluation:

1. Consumer use in adhesive and caulk removers; and
2. Industrial and commercial use in adhesive and caulk removers.

EPA identified eight total alternative products in this product category.

In the eight products, EPA found 17 unique chemicals with associated CASRNs. Of the 17 chemicals, no hazard information is reasonably available for 5 chemicals. Of the 12 chemicals for which hazard screening data are reasonably available, approximately 67 percent of the chemicals have at least 1 authoritative source. None of the 12 chemicals have an identified ODP or GWP. Additionally, eight chemicals are flammable, with two chemicals in each of the flammability categories.

Among the aforementioned 12 unique chemicals in the 8 identified products, 5 were categorized as a solvent or cleaner/solvent—1-propoxy-2-propanol, acetone, ethylene glycol monobutyl ether, diethyl glycol monobutyl ether, and oleic acid. The other ingredients in tape, label, and sticker remover were hydrotreated light distillates (petroleum) and methylal, a degreaser and a cleaner, respectively. The remaining five chemicals included chelating agent (1), fragrance (1), pH adjuster (1), and propellant (2).

Of the products identified, several contained ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, although some ingredients presented higher hazards than methylene chloride. As an example, of the five solvents and cleaners identified, three of the chemicals have a lower hazard rating for genotoxicity/mutagenicity than methylene chloride, whose genotoxicity mutagenicity is categorized as "Very High." Based on a preliminary review of the hazard screening data for the 12 unique chemicals in the eight identified products, three solvents have no "Very High" hazard ratings in any of the endpoints, though all of these solvents have a "High" ratings for some of the hazard endpoints. Of the three solvents with no "Very High" hazard rating, one is not flammable.

For chemicals or formulations in the tape, label, and sticker remover category, hydrotreated light distillates (petroleum), and methylal are the most commonly occurring chemicals. In addition, naphtha (petroleum) is a base oil formulation and benzyl alcohol is a degreaser. However, no hazard screening data are reasonably available for hydrotreated light distillates (petroleum) or naphtha (petroleum). Methylal has a single "Very High" hazard rating for genotoxicity/mutagenicity and three "High" hazard ratings for skin and eye irritation and persistence. Methylal is also flammable, with a Category 2 rating. Although most hazard ratings for benzyl alcohol are the same or lower than those for methylene

chloride, it has some hazard ratings that are higher than those of methylene chloride, such as reproductive and chronic aquatic. Benzyl alcohol has a flammability rating of Category 4.

5.12 Category: Vapor Degreasing Solution & Vapor Degreasing

This product category includes three COUs from the methylene chloride TSCA risk evaluation:

1. Industrial and commercial use as solvent for batch vapor degreasing;
2. Industrial and commercial use as solvent for in-line vapor degreasing; and
3. Industrial and commercial use as solvent for cold cleaning.

EPA identified 68 total alternative products in this product category. One of these products contained PCE, one contained TCE, four contained 1-BP, and two contained NMP. With the removal of any products containing 1-BP, PCE, NMP, and TCE, there were 60 products.

In the 68 products, EPA found 71 unique chemicals with associated CASRNs. Of the 71 chemicals, no hazard information is reasonably available for 13 chemicals. Of the remaining 58 chemicals for which hazard screening data are reasonably available, approximately 65 percent of the chemicals had at least 1 authoritative source. Three of these 58 chemicals have an identified ODP and 8 have an identified GWP. Additionally, 42 chemicals are flammable, with 5 chemicals as Category 1, 20 chemicals as Category 2, 9 chemicals as Category 3, and 8 chemicals as Category 4.

Among the aforementioned 58 unique chemicals in the 68 identified products, 36 were categorized as solvents, solvent/buffering agent, solvent/propellant, dry-side spotting agent/solvent, or cleaner/solvents. Other ingredients in vapor degreasing products include cleaners (3), emulsifiers (1), surfactants (2), and water softener/emulsifiers (1), which comprise another 7 chemicals. The remaining 15 chemicals are distributed as follows: accelerator (1), adhesion promoter (2), base oil formulation (1), buffer (1), carrier (1), caustic agent (1), chelating agent (1), fragrance (1), pH adjuster (2), produce polyurethane foam (1), propellant (1), rheology modifier (1), and rinsing agent (1).

Of the products identified, several contained ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, although some ingredients presented higher hazards than methylene chloride. As an example, of the 36 solvents and cleaners identified, 24 of the chemicals have a lower hazard rating for genotoxicity mutagenicity than methylene chloride, whose genotoxicity mutagenicity is categorized as “Very High.” Based on a preliminary review of the hazard screening results presented by the 58 unique chemicals in the 68 identified products, 12 solvents have no “Very High” ratings across any of the hazard endpoints and 1 solvent has no “High” hazard rating in any of the endpoints. Of the 12 solvents with no “Very High” hazard rating, all are flammable.

For chemicals or formulations in the vapor degreasing product category, the following were the most commonly occurring chemicals, 1,2-trans-dichloroethylene, methanol, decafluoropentane, and 1-BP.

1,2-trans-dichloroethylene has the same or a lower hazard rating in all categories than methylene chloride, and the same flammability rating. Methanol has a higher hazard rating than methylene chloride in four categories and a flammability rating of Category 1, as opposed to Category 2 for methylene chloride. Although decafluoropentane has lower hazard ratings in three categories than methylene chloride, it has higher hazard ratings in two categories, including a “Very High” rating for persistence. Decafluoropentane has a flammability rating of Category 1 and an identified GWP. 1-BP has a “Very High” hazard screening rating for inhalation, carcinogenicity, and genotoxicity/mutagenicity and a flammability rating of Category 2.

5.13 Category: Cold Pipe Insulation

This product category includes two COUs from the methylene chloride TSCA risk evaluation:

1. Industrial and commercial use in cold pipe insulations; and
2. Consumer use in cold pipe insulation.

EPA identified eight total alternative products in this product category. Four of these products contained TCE, and none contained PCE, 1-BP, and NMP. With the removal of any products containing methylene chloride or TCE, there were four products.

In the 8 products without methylene chloride, EPA found 15 unique chemicals with associated CASRNs. Of the 15 chemicals, no hazard information is reasonably available for 5 chemicals. Of the 10 chemicals for which hazard screening data are reasonably available, 40 percent of the chemicals had at least 1 authoritative source. None of the 10 chemicals have an identified ODP or GWP. Additionally, six chemicals are flammable, with two chemicals as Category 1, one chemical as Category 2, and three chemicals as Category 3.

Among the aforementioned 10 unique chemicals in the 8 identified products, 3 were categorized as solvents and dry-side spotting agents/solvent. Another agent active in cold pipe insulation spray is thermal insulation. The remaining six chemicals are distributed as follows: corrosion resistance (1), moisture absorbent (1), friction and wear protection (1), produce polyurethane foams (1), and propellant (2).

Of the products identified, several contain ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, although some ingredients present higher hazards than methylene chloride. As an example, of the three solvents identified, one of the chemicals has a lower hazard rating for genotoxicity/mutagenicity than methylene chloride, whose genotoxicity/mutagenicity is categorized as “Very High.” Based on a preliminary review of the hazard screening results presented by the 10 unique chemicals in the 8 identified products, all of the solvents have “Very High” ratings for some of the hazard endpoints. All three solvents are flammable.

Methylene chloride may be functionally replaced by other solvents in the cold pipe insulation product category, however multiple products have been formulated containing neither. In this category, the solvents toluene and TCE appear in multiple products and parachlorobenzotrifluoride appears in one product. Toluene has two “Very High” hazard ratings. The first is for acute mammalian dermal, which is higher than the hazard rating for methylene chloride. The second “Very High” hazard rating is for genotoxicity mutagenicity, which is the same as the hazard rating for methylene chloride and TCE. TCE also has “Very High” hazard ratings for carcinogenicity and chronic aquatic. All three of these solvents have flammability ratings of Category 3.

5.14 Category: Lubricants and Greases

This product category includes three COUs from the methylene chloride TSCA risk evaluation:

1. Industrial and commercial use in liquid lubricants and greases;
2. Industrial and commercial use in spray lubricants and greases; and
3. Consumer use in lubricants and greases

EPA identified 32 total alternative products in this product category. Of that, 18 of the products contained PCE, six contained TCE, and none contained 1-BP and NMP. With the removal of any products containing methylene chloride, PCE, or TCE, there were 13 products.

Of the 32 products without methylene chloride, EPA found 58 unique chemicals with associated CASRNs. Of the 58 chemicals, no hazard information is reasonably available for 31 chemicals. Of the 27 chemicals for which hazard screening data are reasonably available, approximately 55 percent of the chemicals had at least 1 authoritative source. None of the 27 chemicals have an identified ODP, although 1 of the chemicals has an identified GWP. Additionally, 17 chemicals are flammable, with 2 chemicals as Category 1, 6 chemicals as Category 2, 7 chemicals as Category 3, and 2 chemicals as Category 4.

Among the aforementioned 27 unique chemicals in the 32 identified products, 14 were categorized as solvents, cleaner/solvents, and dry-side spotting agent/solvent. Additionally, hazard screening data is not available for an additional four solvents because they are chemical groups (C9–C11 isoalkanes, lubricating greases as a complex combination of hydrocarbons having carbon numbers predominantly in the range of C12–C50, isobutanol), or are obscure (dipropylene glycol methyl ether). Other ingredients in the lubricant category include base oil formulation and friction and wear protection that comprise another 4 chemicals. The remaining nine chemicals are distributed as follows: adhesion promoter (1), blending component (1), dispersing agent (1), detergent (1), dispersant (1), solubilizer (1), and propellant (3).

Of the products identified, several contained ingredients with a lower hazard screening rating than methylene chloride for certain endpoints, although some ingredients presented higher hazards than methylene chloride. As an example, of the 14 solvents identified, 9 of the solvents had a lower hazard rating for genotoxicity mutagenicity than methylene chloride, whose genotoxicity/mutagenicity is categorized as "Very High." Based on a preliminary review of the screening results presented by the 27 unique chemicals in the 32 identified products, it was found that seven solvents have no "Very High" hazard ratings in any of the endpoints, although all 7 of these solvents have "High" ratings for some of the hazard endpoints. Of the seven solvents with no "Very High" hazard rating, six are flammable (four with a Category 2 rating, and two with a Category 3 rating) and one is non-flammable.

For chemicals or formulations in the lubricant product category, PCE, hydrotreated light distillates (petroleum), and TCE are the most common chemicals that perform a similar function as methylene chloride. EPA identified an additional 20 base oil formulations—including 1-hexadecene, 1-tetradecene, nine petroleum/paraffinic distillates and oils, six naphtha or naphthenic solvents, kerosene, light aliphatic hydrocarbon solvent, and white mineral oil—as potential alternative solvents. Furthermore, 2-methyl butyl acetate, a solubilizer, and xylene, a lubricant, are also potential alternative solvents. EPA expanded screening to include m-xylene, o-xylene, and p-xylene more specifically because xylene is sufficiently generic not to have screening data. PCE and TCE have "Very High" hazard screening ratings for carcinogenicity, which is the same as the hazard rating for methylene chloride. TCE also has "Very High" hazard ratings for genotoxicity mutagenicity and chronic aquatic. Both of these solvents have flammability ratings of Category 3. 1-Hexadecene and 1-tetradecene have hazard screening ratings lower, the same, or higher compared to methylene chloride, and both are non-flammable. However, 2-methyl butyl acetate has hazard screening ratings lower or the same compared to methylene chloride. No hazard screening data are reasonably available for xylene and the remaining base oil formulations.

5.15 Category: Cellulose Triacetate Film Production

This product category includes industrial and commercial use in cellulose triacetate film production where methylene chloride is used as a reactant. EPA identified five alternative chemicals in this category (acetic acid, chloroform, cresols, 1,4-dioxane, and formic acid) and expanded screening to include m-cresol, o-cresol, and p-cresol more specifically because cresols are sufficiently generic not to have screening data available. As these chemicals would be directly substituted as a reactant in a process,

neither product names nor percent in the formulation was reasonably available for analysis for this product category. Only 1,4-dioxane is also a TSCA risk evaluation solvent.

Of these chemicals, only the generic cresols do not have hazard screening data reasonably available. Of the remaining seven chemicals, none has an identified ODP, though chloroform has an identified GWP. Additionally, three of the non-cresol chemicals are flammable, with one chemical as Category 2 and two chemicals as Category 3.

Several identified chemicals in this category have a lower hazard screening rating than methylene chloride for certain endpoints, although some ingredients present higher hazards than methylene chloride. As an example, chloroform has a lower hazard rating for genotoxicity/mutagenicity than methylene chloride, whose genotoxicity/mutagenicity is categorized as "Very High." Based on a preliminary review of the hazard screening results, all these chemicals have "Very High" ratings for some of the hazard endpoints.

5.16 Category: Lithographic Plate Cleaner

Products within this category were identified from the EPA's DfE Cleaner Technologies Substitute Assessment (U.S. EPA, 1997) that is provided with this assessment as Appendix C. This DfE analysis covers the COU of industrial and commercial lithographic printing plate cleaning formulations for blanket washes and identified 56 alternative chemicals used in wash formulations. The TSCA risk evaluation solvent, NMP, was also included as part of this chemical list.

Of the 56 chemicals identified in the blanket wash formulations, 25 chemicals have hazard screening data reasonably available using the HCM. EPA provides this screening data in Appendix A, Table A.16 as an update to the more in-depth DfE analysis provided in Appendix C. Approximately 60 percent of these 25 chemicals have at least 1 authoritative source. None of the 25 chemicals have an identified ODP or GWP. Additionally, 14 chemicals are flammable, with 5 chemicals as Category 3 and 9 chemicals as Category 4. Based on a high-level review of the updated hazard screening results, several identified chemicals in this category have a lower hazard screening rating than methylene chloride for certain endpoints, while some ingredients present higher hazards than methylene chloride.

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