Dicyclohexyl Phthalate:
Technical Report on Production and Trade

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About this Technical Report

On August 23, 2019, the U.S. Environmental Protection Agency (EPA) released what it describes as "reasonably available information" about dicyclohexyl phthalate (DCHP) and requested comments about the chemical's conditions of use. DCHP is one of twenty proposed high-priority substances for evaluation under the Toxic Substances and Control Act.

In response to EPA's call for further information, this Technical Report provides an overview of the manufacturing, processing, importation, distribution into commerce, and disposal of this chemical. It also provides an accounting of DCHP waste transfers and releases from these conditions of use.

Most of the information in the following Technical Report is not in EPA's August 2019 information document. Specifically, EPA did not:

- Name the identities of importers, processors, distributors, or disposers of DCHP.
- Consider the most common condition of use for DCHP, as a part of the coating of cellulose food wrap.
- Consider evidence for the migration of DCHP from this wrap into foods.
- Discuss the release of toxic chemicals, including cyclohexanol, phthalic anhydride, and toluene, from the manufacturing and combustion of DCHP, including packaging containing this chemical.

The following technical report is based on public information, including company literature and filings; state and federal agency data, especially from the EPA, Centers for Disease Control, and U.S. Customs and Border Protection; and overseas government agencies.

Note: Pounds are used for consistency with EPA's most common units of measure.

A. Identifying information

Chemical Name: Dicyclohexyl phthalate
CAS RN : 84-61-7
EPA Docket: EPA-HQ-OPPT-2018-0504

Synonyms:

- 1, dicyclohexyl ester
- 1,2-Benzenedicarboxylic acid, 1,2-dicyclohexyl ester
- 1,2-BENZENEDICARBOXYLIC ACID, DICYCLOHEXYL ESTER
- cyclohexyl 2-(cyclohexyloxycarbonyl)benzoate
- DCHP
- Diclohexyl 1,2-benzenedicarboxylate
- Dicyclohexyl benzene-1,2-dicarboxylate
- Dicyclohexyl phthalate
- Dicyclohexylphthalate
- Phthalic acid dicyclohexyl
- Phthalic Acid Dicyclohexyl Ester
- Phthalic acid, bis-cyclohexyl ester

Trade Names:

- Morflex 150 (active, made by Morflex Chemicals / Vertellus Holdings)
- Unimoll 66 and Unimoll 66 M (made by Lanxess)
- Uniplex 250, Uniplex 250M, Uniplex 250L (Lanxess)
- Ergoplast FDC (sold by Parchem)
- Howflex CP (obsolete)

B. Manufacturing

According to Ullman's Encyclopedia of Industrial Chemistry, dicyclohexyl phthalate (DCHP) is, "prepared from the reaction of phthalic anhydride with cyclohexanol in an inert solvent like toluene at about 130 deg C."[1]

DCHP is a relatively low-volume phthalate. According to EPA's Chemical Data Report (CDR) information, the "National Aggregate Production Volume" (that is, imports plus domestically manufactured DCHP) was between 500,000 and 1,000,000 pounds of DCHP each year between 2011 and 2015. This is less than 0.03% of all phthalates produced or imported in the U.S. (over 470 million pounds per year according to EPA in 2012).[2]

Decades ago, this phthalate was more widely produced, peaking at over 12 million pounds in the 1970s. Current production levels are comparable to those in 1942, when duPont was making approximately "480,000 pounds per year for their own use," according to a Monsanto

company memo.[3] By 1958, another Monsanto company memo said the market for dicyclohexyl phthalate was “as high as 5,000,000 pounds per year... probably captive with duPont.”[4] In 1963, four companies produced a combined 6.5 million pounds (Monsanto, DuPont, FMC, and Allied Chemical).[5] In 1972, there were three manufacturers (FMC Corp., Monsanto, and Pfizer).[6] “The 1977 TSCA inventory listed four companies which manufactured DCHP with a total production volume of 12,200,000 pounds,” according to a Consumer Products Safety Commission (CPSC) report. From 1986 to 1994, production dropped below 10 million pounds, and has been under 1 million pounds since 1996.[7]

By 1992, only two companies produced DCHP, both located in Greensboro, North Carolina: Unitex Chemical (now Lanxess), and Reilly Industries (now Morflex Chemicals, a subsidiary of Vertllus Holdings/Wind Point Partners).[8]

EPA requires companies that manufacture or import over 25,000 pounds of a subject chemical in a calendar year to report this information in quadrennial Chemical Data Reports. To date, there have been CDR filings in 2012 and 2016. CDR reports, available in EPA’s ChemView database,[9] can provide information that is vital for identifying conditions of use, such as the volumes manufactured or processed and industries that are involved. EPA routinely withholds this information from the public when reporting companies claim it to be confidential business information.

1. U.S. Manufacturers

In 2019, Lanxess and Morflex continue to produce DCHP in the U.S.

a. Lanxess Corp. (Greensboro, North Carolina)

Lanxess acquired its Greensboro chemical plant from Unitex in 2010. At the time, Lanxess publicized this plant’s portfolio of phthalate-free plasticizers[10]; however, CDR and other reporting shows this plant continues to produce and/or export DCHP plasticizers.

Lanxess sells DCHP under the trade names Unimoll 66 and Uniplex 250. It reported manufacturing 112,900 pounds of the chemical in 2010, and exporting 14,850 pounds in 2012, and 280,111 pounds in 2016. For other years, this information is withheld. U.S. Customs records confirm that Lanxess ships Uniplex 250 worldwide. Destinations since 2016 include Australia, China, Germany, Japan, and Poland (over 584,000 pounds total).[11]

Uniplex 250 is used in “food wrappers, food and pharmaceutical labels, and other applications requiring delayed heat activation adhesion,” says a Lanxess “Product Safety Assessment” published in December 2017.[12]

Lanxess updated a technical data sheet for Unimoll 66 in July 2019. It states the chemical is used in, “nitrocellulose coatings for cellulose film and aluminum foil.”[13] Unlike Uniplex 250, Unimoll 66 does not appear to be marketed as a food-grade plasticizer.

b. Morflex Chemicals / Vertellus Performance Materials (Greensboro, North Carolina)

This plant opened in Greensboro in 1927 under the name Morton Chemical Company. Pfizer acquired it in 1957. It was employee-owned from 1983 to 1990 under the name Morflex, then was purchased by Reilly Industries, Inc., of Indiana.[14] By 2012, the chemical plant was owned by Wind Point Partners and operated by Vertellus Performance Materials. In its 2012 CDR form, Morflex reported that it manufactured DCHP, but did not import it. In 2016, Morflex’s answer to whether it imported or manufactured it in the U.S. is ”withhold.”

In 2016, according to U.S. shipping records, Vertellus imported 28,791 pounds of Morflex 1129. It reported manufacturing undisclosed amounts of DCHP in its 2012 and 2016 CDR forms.

Vertellus markets DCHP made in Greensboro under the trade name Morflex 150. In its reporting to EPA, Vertellus states that it uses DCHP in the production of adhesives, printing inks, paints, and other coatings. A Vertellus products page states that Morflex 150

> promotes pores in vinyl latex glove coatings, and is a plasticizer for marine & water resistant coatings. Other applications include specialty ink formulations, polyester ink formulations for food contact (break wrapper printing in single use drinking cups), nitrocellulose coatings to seal pores in cellophane, powder coatings (electrostatic coatings), PVC laminate for primal meat packaging, thermo-sensitive delayed tack adhesive for labels, and in acrylic heat seal coatings.[15]

A March 1, 2018, press release from Vertellus further noted that Morflex 150 is “approved for use in the United States as a food contact substance.”[16]

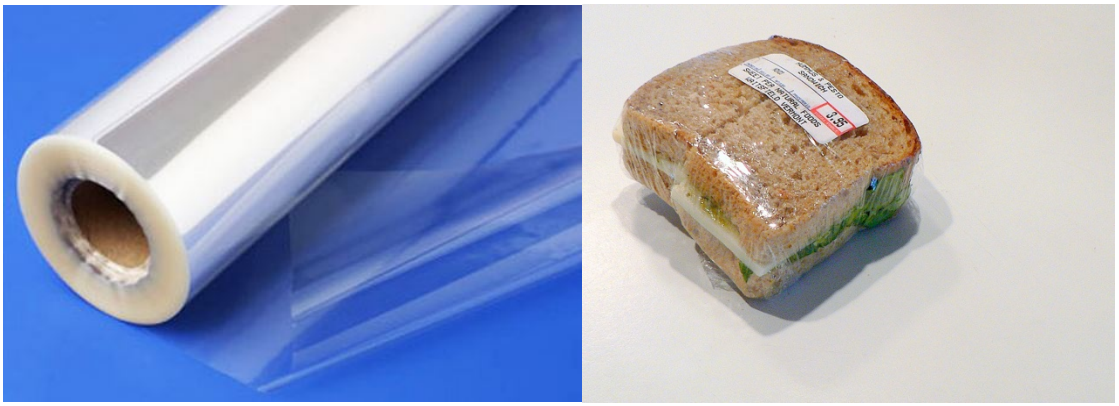
C. Importation and Processing

In addition to Lanxess and Vertellus, EPA’s CDR information identifies **Akzo Nobel (Chicago, Illinois)** and an undisclosed company as importers and processors of DCHP.

In its 2016 CDR filing, **Akzo Nobel** reported using an undisclosed amount of DCHP in the production of plastic materials, including paints and other coatings, and in rubber products.

Another company, whose identity in the public version is “Confidential Business Information,” reported to EPA in its 2012 CDR filing that it used an undisclosed amount of dry powder form DCHP, which it incorporated into building and construction adhesives and plastics.

An additional company, **Futamura USA (Tecumseh, Kansas)**, imported four shipments, totaling 85,704 pounds, of “DCHP Plasticizer” in 2019, the most recent being on November 8, 2019. These imports originated with a Futamura Chemical plant in the United Kingdom. Futamura, which bought the Tecumseh plant in 2016, manufactures cellophane and other packaging films, many of which it markets for food contact use.[17] There are no records of similar imports prior to 2019.



Figures 1 and 2. Common cellophane and packaging films. Photo credits: Aarnous8817 [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], and https://www.flickr.com/photos/dvs/65925723

D. Distribution

The Food and Drug Administration (FDA) and the Consumer Products Safety Commission (CPSC) have taken different approaches to consumer access to this chemical. The FDA allows the unlimited use of DCHP as an adhesive in food grade packaging.[18] The CPSC, as of 2019, prohibits the use of DCHP in children’s toys.

1. Food Contact Adhesives

As noted above, the leading manufacturers and a new importer (Futamura), market and use DCHP as a food-grade adhesive. The FDA allows the use of DCHP as, “components of paper and paperboard in contact with aqueous and fatty foods.”[19]

DCHP has been used widely in adhesives that affix price labels to PVC, cellophane, and other food-wrapping films. According to a 1977 report in the Journal of Occupational Medicine, “Since the early 1960's, label adhesives have contained dicyclohexyl phthalate (a solid plasticizer) as a major constituent (more than 60% by weight).”[20]

2. Children's Products

DCHP has been found in soap (1,000 ppb), modeling clay (4,000 ppm), and pajamas (3,400 ppm).[21]

In 2014, a committee of the Consumer Products Safety Commission recommended that the use of DCHP in children's toys be "permanently banned" at concentrations greater than 0.1% by weight.[22] In 2019, federal regulations followed: it is now illegal to sell children's toys or child care products containing over 0.1% DCHP.[23]

The State of Washington's Department of Ecology monitors incoming products for DCHP. DCHP has been identified 8 times between June 2012 and February 2019, but not at levels above 100 parts per million (0.01%).[24]

3. Other Applications

In addition to the above food packaging adhesive and children's products, DCHP applications include[25]:

- Alkyd resins
- Benzoyl peroxide-based curing agents[26]
- Book-binding adhesives
- Building material adhesives
- Cellophane lacquers
- Cellulose and nitrocellulose films
- Cosmetics. DCHP has been found in a sample of perfume at a concentration of 3 ppm.[27]
- Fluid-applied flooring[28]
- Foil lacquers
- Headphones
- Hearing protection aids
- Paper finishes
- Paints
- Pharmaceutical labels
- Polycarbonate plastics
- Polyvinyl acetate
- Polyvinyl chloride films and chlorinated rubber polyvinyl chloride[29]
- Printing inks
- Rigid extrusions, moldings and rigid foams[30]
- Rubber ducting (detected in sample analyzed in April 2019)[31]
- Varnishes
- Wire and Cable sheathing[32]

In addition to volumes distributed by U.S. product manufacturers, unknown quantities of DCHP are present in imported articles.

E. Releases

1. Releases from Manufacturing and Processing

DCHP is not regulated under EPA's Toxics Release Inventory and Chemical Data Exchange, so it is not possible to track releases from the manufacturing, processing, and disposal of this chemical. However, DCHP is produced using three TRI-reportable chemicals releases: phthalic anhydride, toluene, and cyclohexanol. The main manufacturers and processors of DCHP each reported releasing two of the three chemicals between 2012 and 2018.

Table 1. Air Releases by DCHP Manufacturers and Processors, Pounds, 2012 to 2018

		Air Releases, Pounds, 2012 to 2018		
Company	**Location**	**Cyclohexanol**	**Phthalic anhydride**	**Toluene**
Akzo Nobel	Columbus OH		490	992
Lanxess	Greensboro NC	2040	20	
Vertellus	Greensboro NC	388	50	

Source: US EPA Toxics Release Inventory
Blank = No information reported in TRI or Chemical Data Exchange

In addition, these companies transferred cyclohexanol, phthalic anhydride, and toluene waste to disposal facilities.

From 2012 to 2018:

Akzo Nobel transferred:

- 250 pounds of phthalic anhydride waste to Veolia ES in West Carrolton, Ohio, and 523 pounds of phthalic anhydride waste to Columbus Steel Drum Co., in Blacklick, Ohio.
- 168,448 pounds of toluene waste to Chemtron (Avon, Ohio), The Chemical Solvents (Cleveland, Ohio), Clean Harbors (Hebron, Ohio), Columbus Steel Drum Co. (Blacklick, Ohio), Hulkill Chemical (Bedford, Ohio), and Veolia ES (West Carrolton, Ohio),

Vertellus transferred:

- 12,399 pounds of cyclohexanol waste and 30 pounds of phthalic anhydride waste to the Ecoflo incinerator in Greensboro, North Carolina.[33]

There is no record of Lanxess transferring any of these 3 types of waste from its Greensboro plant during this time period.[34]

2. Releases from Distribution

DCHP has been found to migrate into foods and medicines.

- A test of an over-the-counter medicine in China found 10 parts per billion (ppb) DCHP.[35]

- A study of New York food found DCHP in 6% of samples (4 of 65).The highest concentration – 468.6 ppb – was in vegetable oil.[36]

- Studies found 9,100 ppb DCHP in chicken pie, 12,000 ppb in a pork pie, 16,000 ppb in a sandwich, and 16,900 ppb in a meat pie.[37]

- A study of confectioneries wrapped in polypropylene film found between 10 and 18,600 ppb DCHP, which is used as a plasticizer in film printing inks at levels of between 2% and 8% by weight. [38]

- A study of foods packaged with nitrocellulose-coated, regenerated cellulose film, plasticized in part by DCHP, found levels ranging from 50 to 19,800 ppb DCHP.[39]

3. Releases from Disposal

Tests of household waste in southern Denmark found DCHP in some samples. “DCHP concentration was greatest in household waste, followed by municipal waste, then virgin plastic,” the authors reported. The highest recorded concentration was 2.5 ppm.[40]

DCHP is combusted as waste from its manufacture and distribution in packaging film. Burning DCHP generates toxic substances, including cyclohexanol and phthalic anhydride, two substances that go into its manufacture.[41]

ENDNOTES

[1] U.S. National Library of Medicine. “Dicyclohexyl phthalate.” Hazardous Substance Data Base, n.d. https://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB.

[2] America’s Children and the Environment. “Biomonitoring: Phthalates.” US Environmental Protection Agency, 2017. https://www.epa.gov/sites/production/files/2017-08/documents/phthalates_updates_live_file_508_0.pdf.

[3]Ragsdale, John T. “Chemicals from Benzene.” Development Department, Organic Chemicals Division, December 11, 1944. https://cdn.toxicdocs.org/Ne/NernMMo5NeZ4y2LnvQr7GL62Q/NernMMo5NeZ4y2LnvQr7GL62Q.pdf.

[4] Klein, L.E. “Cyclohexanol: Recommenbdation for Transfer to Sales Department.” Monsanto Chemical Company, May 3, 1954. https://cdn.toxicdocs.org/6b/6b8aZXbNrgnRNdzdzwN9Jqq2m/6b8aZXbNrgnRNdzdzwN9Jqq2m.pdf.

[5] “Synthetic Organic Chemicals. United States Production and Sales, 1963.” United States Tariff Commission, 1964.

[6] “Synthetic Organic Chemicals. United States Production and Sales, 1972.” United States Tariff Commission, ca 1973.

[7] McGinnis, Patricia, Stephen Thiels, Jeanelle Marinez, Alison Willis, Bernard Gadagbui, Douglas Lee, and Amina Darwish. “Exposure Assessment: Composition, Production, and Use of Phthalate.” Consumer Product Safety Commission, 2015. https://www.cpsc.gov/s3fs-public/pdfs/TERAReportPhthalates.pdf.

[8] SRI. “1992 Directory of Chemical Producers: United States of America.” SRI International, 1992.

[9] U.S. Environmental Protection Agency. “ChemView,” 2019. https://chemview.epa.gov/chemview. To view CDR for a chemical, select output: 2012 and 2016 Chemical Data Reporting Years.

[10] Lanxess. “LANXESS Strengthens Global Phthalate-Free Plasticizer Portfolio.” Lanxess, October 12, 2011. https://lanxess.com/en/corporate/media/press-releases/financial-business/lanxess-strengthens-global-phthalate-free-plasticizer-portfolio-1/.

[11] U.S. Customs and Border Protection shipping records as obtained from the Panjiva database.

[12] Lanxess. “Dicyclohexyl Phalate Product Safety Assessment.” Lanxess, 2017. http://lanxess4you.com/psra/summaries/Dicyclohexyl%20Phthalate.pdf.

[13] America’s Children and the Environment. “Biomonitoring: Phalates.” US Environmental Protection Agency, 2017. https://www.epa.gov/sites/production/files/2017-08/documents/phthalates_updates_live_file_508_0.pdf.

[14] Morflex, Inc. “Morflex, Inc.” Look Chem, August 30, 2018. https://morflex.lookchem.com/About.html.

[15] Vertellus. “Morflex 150 (Dicyclohexyl Phalate).” Vertellus Holdings LLC, August 30, 2019. https://www.vertellus.com/products/plastics-polymers/morflex-plasticizers-sebacates-and-solvents/morflex-150-dicyclohexyl-phthalate.

[16] Ibid.

[17] Futamura. “Futamura - Compostable and Renewable Flexible Packaging Films.” Futamura Group, n.d. http://www.futamuragroup.com/divisions/cellulose-films/.

[18] U.S. Food and Drug Administration. “CFR - Code of Federal Regulations Title 21.” US Department of Health and Human Services, April 1, 2019. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfCFR/CFRSearch.cfm?fr=175.105.

[19] Ibid.

[20] Vandervort, Robert, and Stuart M Brooks. “Polyvinyl Chloride Fim Thermal Decomposition Products as an Occupational Illness.” *Journal of Occupational Medicine* 19, no. 3 (1977): 188–91. https://cdn.toxicdocs.org/jg/jgyqm7r3Yxdw3GM9Kz70ko7gZ/jgyqm7r3Yxdw3GM9Kz70ko7gZ.pdf.
see also Parchem. “Dicyclohexyl Phthalate.” Parchem Fine and Specialty Chemicals, n.d. https://www.parchem.com/chemical-supplier-distributor/Dicyclohexyl-phthalate-038878.aspx.

[21] Sweden. “Annex XV - Identification of Dicyclohexyl Phthalate As SVHC,” August 28, 2015. https://echa.europa.eu/documents/10162/b2fbb22c-72d7-491d-b417-39105e35b792.

[22] Consumer Product Safety Commission. “Prohibition of Children’s Toys and Child Care Articles Containing Specified Phthalates.” US Government, December 30, 2014.

https://www.federalregister.gov/documents/2014/12/30/2014-29967/prohibition-of-childrens-toys-and-child-care-articles-containing-specified-phthalates.

[23] Consumer Product Safety Commission. "Title: PART 1308 - PROHIBITION OF CHILDREN'S TOYS AND CHILD CARE ARTICLES CONTAINING SPECIFIED PHTHALATES: DETERMINATIONS REGARDING CERTAIN PLASTICS: Title 16 - Commercial Practices. CHAPTER II - CONSUMER PRODUCT SAFETY COMMISSION. SUBCHAPTER B - CONSUMER PRODUCT SAFETY ACT REGULATIONS." U.S. Government, January 1, 2019. https://www.govinfo.gov/content/pkg/CFR-2019-title16-vol2/xml/CFR-2019-title16-vol2-part1308.xml.

[24] Department of Ecology State of Washington. "Product Testing Data," 2019. https://apps.ecology.wa.gov/ptdbreporting/Reports/ReportViewer.aspx?ReportName=GetAllByDateAndChemicalCAS#to.

[25] Parchem. "Dicyclohexyl Phthalate." Parchem Fine and Specialty Chemicals, n.d. https://www.parchem.com/chemical-supplier-distributor/Dicyclohexyl-phthalate-038878.aspx. and Consumer Product Safety Commission. "Exposure Assessment: Composition, Production, and Use of Phthalates." US Government, 2015. https://www.cpsc.gov/s3fs-public/pdfs/TERAReportPhthalates.pdf.

[26] Hyde, David. "Comment Submitted by David Hyde, Director, Environmental Policy, Aerospace Industries Association (AIA)." US Government, August 2, 2019. https://www.regulations.gov/document?D=EPA-HQ-OPPT-2018-0504-0006.

[27] Sweden.

[28] Loft, Sarah. "Pharos Finds Plenty of Unanswered Questions in Fluid Applied Flooring Industry." Healthy Buildinng Network, June 21, 2013. https://healthybuilding.net/blog/404-pharos-finds-plenty-of-unanswered-questions-in-fluid-applied-flooring-industry.

[29] Hyde.

[30] Hogan, R.W. "Not Provided." Monsanto Chemical Company, 1960. https://cdn.toxicdocs.org/px/pxyZDeGR9Bz63kNY28xQpz9j/pxyZDeGR9Bz63kNY28xQpz9j.pdf.

[31] Agomoon Limited. "Test Report No. SZXEC1900616101." SGS, April 4, 2019. https://www.secretjardin.com/scripts/files/5cd1549c374022.68902990/15p-test-for-rubber-ducting-from-jk-sun.pdf.

[32] Vertellus. "Moroflex 150 (Dicyclohexyl Phthalate)." Vertellus Holdings LLC, n.d. https://www.vertellus.com/products/plastics-polymers/morflex-plasticizers-sebacates-and-solvents/morflex-150-dicyclohexyl-phthalate.

[33] "TRI Facility Report: VERTELLUS GREENSBORO LLC (27403MRFLX2110H)." U.S Environmental Protection Agency. Accessed November 18, 2019. https://enviro.epa.gov/facts/tri/ef-facilities/#/Facility/27403MRFLX2110H.

[34] "Envirofacts Report. Lanxess Corp." U.S Environmental Protection Agency, November 4, 2019. https://enviro.epa.gov/enviro/tris_control_v2.tris_print?pPrev=1&tris_id=27406NTXCH520BR.

[35] Wang, W., A.O.W. Leung, L.H. Chu, and M.H. Wong. 2018. Phthalates contamination in China: Status, trends and human exposure-with an emphasis on oral intake. Environmental Pollution 238:771–782.

[36] Schecter, Arnold, Matthew Lorber, Ying Guo, Qian Wu, Yun Se Yun, Kurunthachalam Kannan, Madeline Hommel, et al. "Phthalate Concentrations and Dietary Exposure from Food Purchased in New York State." *Environmental Health Perspectives* 121, no. 4 (n.d.): 473–79. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3620091/.

[37] Cao, X-L. 2010. Phthalate esters in foods: sources, occurrence, and analytical methods. Compr Rev Food Sci F. 9, 21-43.

[38] Ibid.

[39] Ibid.

[40] Pivnenko, K., M.K. Eriksen, J.A. Martín-Fernández, E. Eriksson, and T.F. Astrup. 2016. Recycling of plastic waste: Presence of phthalates in plastics from households and industry. Waste Management. 54:44–52.

[41] Vandervort, Robert, and Stuart M Brooks. "Polyvinyl Chloride Fim Thermal Decomposition Products as an Occupational Illness." *Journal of Occupational Medicine* 19, no. 3 (March 1977): 188–91.