Toxics Use Reduction Institute

Summary of Policy Analysis

Higher Hazard Substance Designation Recommendation: Methylene Chloride or Dichloromethane (CAS 75-09-2)

1. State of the Science

Methylene chloride has both acute and chronic adverse health effects. Acute effects can include skin, eye and respiratory irritation, depression of central nervous system function, headache, dizziness, nausea, incoordination, unconsciousness, and for very high exposures, death. IARC classifies methylene chloride in Group 2B (possibly carcinogenic to humans) and NTP classifies methylene chloride as reasonably anticipated to be a human carcinogen; other chronic effects may include liver, kidney or central nervous system damage.

2. Number of facilities affected

The TURA program estimates that the 1,000 pound reporting threshold that would apply to a higher hazard substance would affect between 23 and 47 facilities.

3. Opportunities for New Filers

Practical alternatives to methylene chloride are available for most uses. For paint stripping, metal degreasing, and brake cleaning, options include both drop-in substitutes (alternative solvents) and process changes (including aqueous systems and mechanical removal). Some of the drop-in substitutes pose health and environmental concerns. There are several options for changing processes that depend on methylene chloride to those that allow for safer alternatives.

4. Regulatory context

At the federal level, methylene chloride is a reportable Toxic Release Inventory (TRI) chemical, and is listed as a hazardous air pollutant under the Clean Air Act. Methylene chloride is recognized as a priority internationally as well. At the state level, California regulates methylene chloride as a carcinogen under Proposition 65 and the use of chlorinated solvents in vehicle repair is illegal in California as of 2002. In the European Union, paint strippers containing methylene chloride have been banned effective June 2012.

5. Implications for the TURA program

The TURA program is in a good position to offer services to new filers interested in reducing or eliminating their use of methylene chloride. The program has substantial expertise on methylene chloride alternatives. In addition, designating methylene chloride would be consistent with the program's decision in 2007 to designate trichloroethylene (TCE) as a higher hazard substance and in 2009 to designate perchloroethylene (PCE) in as a higher hazard substance. Designating methylene chloride as a higher hazard substance would ensure that the program does not inadvertently motivate facilities to shift from TCE or PCE to methylene chloride in those applications where that is feasible.

Toxics Use Reduction Institute

Policy Analysis

Higher Hazard Substance Designation Recommendation: Methylene Chloride or Dichloromethane (CAS 75-09-2)

The TURA Science Advisory Board (SAB) has recommended designating methylene chloride (also known as dichloromethane) as a higher hazard substance under TURA. With this designation, the reporting threshold for methylene chloride use would be lowered to 1,000 lb/year for companies in TURA-covered industry sectors with ten or more employees. New companies entering the program under the lower reporting threshold would be required to file annual toxics use reports, pay annual toxics use fees, and develop a toxics use reduction plan every two years. In addition, the TURA program would prioritize methylene chloride in allocating program resources, ensuring that facilities receive targeted assistance in reducing or eliminating use of this chemical.

This policy analysis summarizes key scientific information on methylene chloride; estimates the number of facilities that are likely to enter the program as a result of the lower reporting threshold; analyzes opportunities and challenges that new filers are likely to face; and discusses the implications of this policy measure for the TURA program. Based on this analysis, the Toxics Use Reduction Institute supports the SAB's recommendation that methylene chloride be designated as a higher hazard substance.

1. State of the Science

Methylene chloride has serious adverse effects on human health, including both acute and chronic health effects. Methylene chloride most often enters the environment through fugitive emissions from metal degreasing operations and by spills or accidental releases to air, soil or water. Exposure results from environmental contamination, presence in consumer products or occupational sources. [1] For a list of specific data points considered by the SAB in developing its recommendation, see Appendix A.

Acute toxicity

- Short term exposure to methylene chloride can cause symptoms including skin, eye and respiratory irritation, depression of central nervous system function, headache, dizziness, nausea, incoordination, and unconsciousness. Very high exposure can be lethal.[2]
- Methylene chloride was highlighted in the February 24, 2012 CDC *Morbidity and Mortality Weekly Report (MMWR)* due to the deaths of 13 bathtub refinishers (including one in Massachusetts) using methylene chloride containing products.[3] Subsequently, OSHA and NIOSH released a Hazard Alert, *Methylene Chloride Hazards for Bathtub Refinishers,* in 2013.[4]
- Methylene chloride is metabolized to CO and CO_2 and causes cardiovascular stress. CO successfully competes with oxygen, reducing the oxygen supply to the heart, which can result in myocardial infarction (heart attack). [5]

Chronic toxicity

- The International Agency for Research on Cancer (IARC) classifies methylene chloride in Group 2B (possibly carcinogenic to humans).[6] The US National Toxicology Program classifies methylene chloride as "Reasonably anticipated to be a human carcinogen."[7]
- Exposure to methylene chloride may cause liver, kidney or central nervous system damage. Some studies suggest that long term exposure to organic solvents such as methylene chloride may cause lasting and possibly permanent central nervous system effects. Fatigue, lack of muscle coordination, loss of concentration, short term memory loss, and personality changes exhibited as nervousness, anxiety or irritability are some of the potential long-term effects of chronic and frequent exposure.[8]

Uncertainty

Substantial information is available regarding both the acute and the chronic health effects of methylene chloride. Uncertainty does not play a significant role in the development of our recommendations for this substance.

2. Number of facilities affected

Methylene chloride is a widely used solvent in Massachusetts and nationally. Major uses are as a metal degreaser, a chemical intermediate, a reaction/extraction solvent in research labs, a paint stripper and as a component in adhesives. Methylene chloride is an ingredient in consumer products, such as automotive aerosol parts cleaners, degreasers and paint strippers and can be purchased as such at local hardware and automotive stores.

a. Historical data on sectors using methylene chloride in Massachusetts

Historically, methylene chloride has been reported under TURA by the sectors listed below.

2284	Thread mills
2399	Fabricated textile products
2531	Public building and related furniture
2821	Plastics materials and resins
2833	Medicinals and botanicals
2834	Pharmaceutical preparations
2851	Paints and allied products
2865	Cyclic crudes and intermediates
2869	Industrial organic chemicals
2891	Adhesives and sealants
2893	Printing ink
2899	Chemical preparations
3069	Fabricated rubber products
3081	Unsupported plastics film and sheet
3086	Plastics foam products
3089	Plastics products, nec

3291	Abrasive products
3399	Primary metal products, nec
3449	Miscellaneous metal products
3471	Plating and polishing
3484	Small arms
3491	Industrial valves
3498	Fabricated pipe & fittings
3499	Fabricated metal products
3545	Machine tool accessories
3561	Pumps and pumping equipment
3579	Office machines, nec
3612	Transformers, except electronic
3645	Residential lighting fixtures
3661	Telephone and telegraph apparatus
3672	Printed circuit boards
3674	Semiconductors and related devices
3675	Electronic capacitors
3679	Electronic components, nec
3724	Aircraft engines and engine parts
3728	Aircraft parts and equipment, nec
3821	Laboratory apparatus and furniture
3823	Process control instruments
3829	Measuring & controlling devices, nec
3861	Photographic equipment and supplies
5169	Wholesale Trade - Chemicals and allied products
5172	Petroleum products, nec
7389	Business services

b. Current data on methylene chloride use in Massachusetts

In 2010, the most recent year for which data are available, 11 companies reported use of methylene chloride.

- In SIC codes 2834-2835, "pharmaceutical preparations – diagnostic substances," 3 companies otherwise used methylene chloride.
- In SIC code 2851, "paints and allied products", 2 companies processed methylene chloride.
- In SIC code 2891, "adhesives and sealants", 2 companies processed methylene chloride.
- In SIC code 2899, "chemical preparations, nec," 2 companies processed methylene chloride.
- In SIC code 5169, "wholesale trade - chemicals and allied products, not elsewhere classified," 2 companies process methylene chloride.

c. Estimated number of companies that would be affected by a lower reporting threshold

To develop an estimate of the number and type of companies likely to be affected by a 1,000 lb reporting threshold for methylene chloride, the Institute consulted sources including the TURA data; facilities reporting under EPCRA Tier II requirements; and RCRA hazardous waste data. In addition, staff at the Office of Technical Assistance (OTA) and the TURI Laboratory developed estimates based on their experience working with industry. Estimates also considered Massachusetts industry information obtained from business databases. Based on these sources, OTA and TURI staff estimate the following impact:

- 2834-2835 (pharmaceutical preparations – diagnostic substances), is expected to result in 10 to 15 filers.
- 34XX (fabricated metal products), is expected to result in 5 to 10 filers
- 7641 (reupholstery, furniture repair), is expected to result in 3 to 7 filers
- The following sectors are expected to generate between one and three filers each: SICs 2284 (thread mills), 2851 (paints and allied products), 2891 (adhesives and sealants), 30XX (rubber and plastic products), 33xx (primary metal industries).
- The following sectors are not likely to be affected: 2399 (fabricated textile products), 2531 (public building and furniture), 3675 (electronic capacitors), 38xx (instruments and related products), 5169 (wholesale trade - chemicals and allied products).
- The following sectors are known to use methylene chloride, but are not reportable under TURA: Research and academic laboratories.

Based on this information, we estimate that a 1,000 lb reporting threshold would affect between 23 and 47 filers. These would include some facilities that are already reporting on their use of toxic chemicals and now have to include methylene chloride in their annual reporting, as well as some that will be new to the program as a result of their use of methylene chloride over the new reporting threshold.

3. Opportunities for New Filers

Feasible alternatives are available for most uses of methylene chloride. In the discussion below, we briefly review trends in methylene chloride use among existing TURA filers. We then consider the known alternatives for some of the most common uses of methylene chloride.

a. Trends in methylene chloride use

Methylene chloride use reported under TURA has decreased significantly since the program's inception. In 1990, 47 TURA filers reported methylene chloride use; by 2010, only 11 reported methylene chloride use. There has been a 55% reduction in reported methylene chloride use from 1990 to 2010, and a 98% reduction in reported methylene chloride releases from 1990 – 2010 (figures not adjusted for changes in production levels).

Table 1. Massachusetts TURA Methylene Chloride Use and Release Data: 1990 and 2010 (figures not adjusted for production)

	Year		Change In lbs	% Change
	1990	2010		
Methylene Chloride used (lbs)	7,768,203	3,530,716	-4,237,487	-55%
Methylene Chloride Released (lbs)	1,539,982	24,087	-1,537,495	-98%

A survey of facilities that reported methylene chloride use over the period 1995 to 1999 found that 15 of the 17 companies had either eliminated (10) or reduced to below threshold (5) their use of methylene chloride at the time of the survey in 2000.[9]

b. Opportunities to reduce Methylene Chloride use

i. Furniture Refinishers

Furniture refinishing shops use methylene chloride to strip paint off of wood products. Many alternative paint stripping chemicals and processes are available. Some may be more expensive and/or more time consuming to use. However, some have the added benefit of less hazardous waste disposal costs and other reduced costs associated with toxics.

Alternative solvents:

● n-methyl pyrrolidone (NMP), terpene based solvent mixtures, soy based solvents, dibasic ester and propylene carbonate can be used as drop-in replacements. These solvents often require a longer time to strip and some of them have performance issues as well. In addition NMP is a developmental and reproductive toxin.

● Some furniture refinishing shops use caustic soda (sodium hydroxide) or potassium hydroxide in dip tanks. While sodium hydroxide requires more time to strip it can be neutralized and disposed of as non-hazardous waste and it also evaporates more slowly than methylene chloride, making it possible to use smaller quantities.

● Mixed solvent pastes (including methanol, toluene, and acetone) are a viable alternative but require more floor space and more labor time. Methanol and toluene are TURA listed substances and VOCs. Acetone is a TURA listed substance as well.

● Benzyl alcohol based strippers are another viable alternative. This requires all metal equipment to be replaced with polypropylene, but total stripping costs are lower than with methylene chloride.

Mechanical removal systems:

● Infrared paint removal systems, steam stripping, baking soda, dry ice, and wheat starch blasting, and wet volcanic rock stripping are all potential methods for mechanical removal of paint. These methods all require capital investments and process changes.

ii. Metal Degreasing

Methylene chloride is used as a metal degreaser in a variety of applications. It is sometimes used in wipe cleaning and, rarely, in vapor degreasing. Alternatives to methylene chloride for vapor degreasing include either drop-in substitute solvents, or a process change (conversion to ultrasonics using alternative solvents, media blasting or aqueous cleaning).

Drop-in substitutes: Many alternative solvents have been tested for performance in TURI's Lab and elsewhere. Effective drop-in replacement solvent alternatives include n-propyl bromide (nPB), n-methyl-pyrollidone (NMP) and hydrocarbon solvents, although health, safety, and environmental concerns exist about each of these options. Depending on the substance, concerns include reproductive toxicity, central nervous system effects, flammability, combustibility, and ozone depleting and global warming potential. These drop-in substitutes have purchase costs that are greater than that of methylene chloride on a per gallon basis. NPB and NMP are TURA listed substances.

Process change: Aqueous systems are a feasible alternative to many solvent-based vapor degreasing operations, although they may involve additional process time and capital investment. Each company's cleaning needs are unique and cleaning processes should be specifically tailored for those needs, for example, ultrasonic systems are effective for some parts cleaning operations.

From a health and environmental standpoint, the best alternatives to methylene chloride for vapor degreasing are:

- Switching to an aqueous or semi-aqueous system;
- Ultrasonic immersion cleaning;
- Mediablasting;
- Working within the supply chain to change the contaminant on the part that requires cleaning; or
- Investigating a materials change to prevent contamination and cleaning altogether.

iii. Automotive Aerosols

Alternatives for brake cleaning include drop-in substitutes (aerosol products that do not contain methylene chloride), and process changes (aqueous parts washers).

Drop-in substitute: Both solvent-based and aqueous products are available as drop-in substitutes for methylene chloride brake cleaners. The TURI Lab has conducted performance testing on alternative aerosol brake cleaners. Preliminary results indicate that these alternative brake cleaning aerosols have equivalent performance, and are cost comparable, to the methylene chloride based products.

- Many solvent mixtures can be aerosolized and used for brake and automotive parts cleaning or degreasing. Main components in some of the cleaners found on the market are heptane, C9-C12 hydrocarbons, toluene and xylene. Many of these alternatives also pose significant health and safety hazards. Toluene and xylene are TURA listed chemicals.
- Aqueous aerosolized products have also proven to be effective, and pose fewer health and environmental concerns than any of the solvent-based products.

Process change: Aqueous parts cleaners have also proven to be effective as a process change for aerosol products. This option would require a capital equipment investment.

iv. Adhesives

Methylene chloride can be a component in adhesives and sealants. Many facilities have moved away from the use of methylene chloride in this application. Methylene chloride is non-flammable and fast drying. For applications where the use of flammables is acceptable, methyl acetate and ethyl acetate are viable alternatives. Ethyl acetate is a TURA listed substance. For applications where non-flammable materials are required, water-based systems (with drying systems) are a viable alternative. Reformulation and customer approvals may be required for these alternatives.

v. Pharmaceutical preparations & Research labs

Methylene chloride is a common reaction and extraction solvent in research labs and pharmaceutical preparations. Ethyl acetate, benzotrifluoride, 2-methyl tetrahydrofuran, diethoxymethane, and dibasic esters are all potential alternatives for methylene chloride in some of these applications.[10] These changes involve reformulation and processing changes. In some cases they may require FDA approval and certification/ recertification of products.

c. Implementation: Opportunities and challenges

The services of the Office of Technical Assistance and the TURI Lab can facilitate the transition from methylene chloride to safer alternatives. Both OTA and the TURI Lab have extensive experience providing assistance to facilities working to replace chlorinated solvents with safer alternatives, and are engaged in on-going projects to help users identify alternatives that are appropriate to their specific needs.

Smaller users working to reduce or eliminate methylene chloride use could face financial challenges in cases in which an up-front capital investment is necessary to shift to a safer alternative. In these cases, subsidies and grant programs can facilitate the transition. The TURA program is uniquely positioned to facilitate this task.

For cases in which a process change is involved, training programs and demonstration sites can help to provide facilities with the opportunity to explore and evaluate new options. For example, TURI has a current program funded by US EPA where a small subsidy is provided to selected auto shops to provide them with a cost-free trial period to experiment with using aqueous parts cleaners.

4. Regulatory context

Due to its toxicity, methylene chloride is subject to extensive regulation at the federal, state, and international level.[11] For a glossary of regulations referred to in this section, see Appendix B.

EPCRA	• Reportable TRI chemical[12] • Subject to US EPA Tier II reporting requirements[13]
CAA	• CAA Amendment of 1990 List of Hazardous Air Pollutants[14] • Exempt from VOC regulations due to determination of negligible photochemical reactivity.
CWA	• "Toxic pollutant designated pursuant to section 307(a)(1) of the Federal Water Pollution Control Act and is subject to effluent limitations."[15]
RCRA	• Considered hazardous as a spent solvent: "When dichloromethane is a spent solvent, it is classified as a hazardous waste from a nonspecific source (F002), as stated in 40 CFR 261.31, and must be managed according to state and/or federal hazardous waste regulations."[16] • "U080; As stipulated in 40 CFR 261.33, when dichloromethane, as a commercial chemical product or manufacturing chemical intermediate or an off-specification commercial chemical product or a manufacturing chemical intermediate, becomes a waste, it must be managed according to Federal and/or State hazardous waste regulations. Also defined as a hazardous waste is any residue, contaminated soil, water, or other debris resulting from the cleanup of a spill, into water or on dry land, of this waste. Generators of small quantities of this waste may

	qualify for partial exclusion from hazardous waste regulations (40 CFR 261.5)."[17]
CERCLA	• Reportable Quantity = 1,000 lbs.[18]
OSHA PEL	• TWA 25 ppm ST 125 ppm (15 minutes)[19]
ACGIH TLV (TWA)	• 50 ppm (174 mg/m3) TWA, A3[20]
ACGIH TLV-STEL	• 500 ppm (1999); "Excursion Limit Recommendation: Excursions in worker exposure levels may exceed 3 times the TLV-TWA for no more than a total of 30 minutes during a work day, and under no circumstances should they exceed 5 times the TLV-TWA, provided that the TLV-TWA is not exceeded."[21]
SDWA	• MCL for $MeCl_2$ in drinking water = 0.005 milligrams per Liter (mg/L) or 5 parts per billion (ppb)[22]

Massachusetts

Occupational	• Subject to Right-to-Know requirements[23]
Environmental & Public Health	• Subject to Right-to-Know requirements[24] • The 24-hour acceptable ambient air exposure limit for $MeCl_2$ is 2.72 ppb while the annual acceptable exposure limit is 0.07 ppb.[25]

Other state regulations

California regulates methylene chloride under the Safe Drinking Water and Toxics Enforcement Act of 1986 (Proposition 65).[26] Nationally, California is a leader in efforts to eliminate methylene chloride use in vehicle repair. In addition, "sale of automotive repair products containing perchloroethylene, methylene chloride, or trichloroethylene are prohibited in California, effective as of June 2001; use is prohibited, effective as of December 2002."[26] The California Air Resources Board (CARB) has not regulated methylene chloride in paint strippers due to the lack of available substitutes.

International:

- Methylene chloride is on Priority List 1 of Canada's Domestic Substances List categorization.[27]
- In the European Union, methylene chloride is on the European Trade Union Priority List for REACH Authorization.
- The Swedish Chemical Products Ordinance of 1998 bans the sale of products containing chlorinated solvents (methylene chloride, trichloroethylene, or PCE) for private use by consumers.[28]
- Paint strippers containing methylene chloride have been banned by the EU effective June 2012.[29]

5. Implications for the TURA program

The TURA program is in a good position to offer services to new filers interested in reducing or eliminating their use of methylene chloride. The program has substantial experience with and expertise on methylene chloride alternatives, and has a history of working successfully with users on these issues.

Activities of both OTA and TURI already provide infrastructure which could help smaller users to reduce their use of methylene chloride. Several on-going program activities would help meet the demand for services.

- In 2007, the TURA program designated TCE as a higher hazard substance and in 2009, the TURA program designated PCE as a higher hazard substance. Since methylene chloride may be used interchangeably with TCE or PCE in limited applications, designating methylene chloride as a higher hazard substance will communicate a consistent message to users of TCE, PCE, and methylene chloride. Designating TCE and PCE as a higher hazard substance without designating methylene chloride in the same status could lead to unintended consequences, motivating TCE or PCE users to shift to methylene chloride in those applications where that is possible.
- Both the Office of Technical Assistance and the TURI Lab have significant experience helping large and small users identify safer alternatives to methylene chloride and both are available as a resource for new filers entering the program. The TURI Lab has conducted solvent cleaning alternative testing since 1993, assisting businesses in making the transition to less toxic alternatives without compromising performance.
- The Institute's community grant program has worked with auto shops; one past grantee, the Safe Shops project of the Boston Public Health Commission (BPHC), now has significant capacity and expertise for providing training and technical assistance for auto shops wishing to shift to safer alternatives for brake cleaning. The BPHC Safe Shops project has also developed excellent outreach materials, which the program could use in future outreach. Under an EPA Region 1 grant, TURI is currently working with numerous auto shops to help them move away from solvent based brake cleaners and adopt aqueous-based alternatives. This work builds on the BPHC work, with a goal of enhanced implementation of safer brake cleaning methods.
- OTA has conducted studies that help to inform their on-going work with methylene chloride users. In 2005, OTA published the results of a survey on barriers to substituting chlorinated solvents which found that understanding the viability of alternatives and accurately comparing them to current practice involves significant effort for many companies.[30] The TURA program's ability to help facilities choose the best possible alternative for a given use is particularly important given that some of the available alternatives to methylene chloride are preferable to others from a health and environmental perspective. The TURA program is able to assist facilities both in analyzing alternatives, and in adopting the alternatives that pose the fewest health and environmental concerns.
- TURI has an academic research grant program that can target seed funding to researchers who are developing safer alternatives to toxic chemicals for specific applications. When specific industry needs are identified, along with companies willing to share performance criteria, materials and/or other forms of expertise, TURI can identify university researchers interested in focusing their R&D efforts for solutions. If a specific application of the use of methylene chloride presents an on-going challenge for companies with respect to shifting to safer alternatives, TURI could direct R&D to find feasible solutions.

There would be some additional cost to companies that would begin reporting methylene chloride based on a lower reporting threshold, including preparing annual toxics use reports and biennial toxics use reduction plans, and paying toxics use fees. The average base fee paid by TURA filers in 2010 was $3,425. However, most new filers for methylene chloride are likely to be facilities with less than 50 employees. The base fee for this size facility is $1,850. Some filers would not be new to the program and already pay a base fee, but would begin to pay a per-chemical fee of $1,100.

After two years of reporting toxics use, companies are required to engage in TUR planning. For companies that only need to report methylene chloride the cost of hiring a planner will likely be in the range of $1,000 - $3,000. Companies that want to have their own in-house TUR planner can qualify either by relying on past work experience in toxics use reduction or by having a staff member take the TUR Planners' training course. Those companies with experienced staff can become certified for as little as $100. For those that want staff to take a course the cost will be between $650- $2000 depending on whether the company has previously filed a TURA report. Companies with in-house toxics use reduction planners are likely to reap ancillary benefits from having an employee on staff that is knowledgeable about methods for reducing the costs and liabilities of toxics use. Additionally, through the process of planning and reducing or eliminating methylene chloride use, companies may be able to expand their markets, better comply with other regulations and reduce their overall regulatory burden.

The total additional cost in fees to filers (and revenue to the program) could be $25,300 to $51,700 in per-chemical fees (23-47 filers for methylene chloride) plus an estimated $20,350-$42,550 (base fee for 11-23 small sized companies reporting methylene chloride only).

6. Summary

Methylene chloride is recognized as a priority toxic chemical at the international, national, and state levels. The US EPA and the State of California have taken leadership roles in encouraging methylene chloride users to adopt safer alternatives. Designating methylene chloride as a higher hazard substance will make it possible to extend the benefits of the TURA program and TURA planning to a wider community of users. A range of services would be available to the regulated community; these include training in TUR planning methods, assistance in identifying safer alternatives for specific uses, and in some cases, direct grants for capital investments in new equipment.

Appendix A: Data the SAB considered for Methylene Chloride

International Agency for Research on Cancer (IARC)	Group 2B (possible human carcinogen)
National Toxicology Program (NTP)	Reasonably Anticipated to be a human carcinogen
PBT Profiler:	
Half life in water	38 days
Half life in soil	75 days
Half life in sediment	340 days
Half life in air	120 days
Bioconcentration factor	3.1
Chronic fish ChV (mg/l)	25
ATSDR Minimum Risk Level: acute inhalation	0.6 ppm
ATSDR Minimum Risk Level: chronic inhalation	0.3 ppm
ATSDR Minimum Risk Level: acute oral	0.2 mg/kg/day
OSHA PEL (TWA)	25 ppm
ACGIH TLV (TWA)	50 ppm
ACGIH TLV-STEL	125 ppm
LD50 (mg/kg) – oral rat	1600
LC50 (ppm/7H) – mouse	14,400
RfD (mg/kg/day)	6×10^{-3}
Vapor Pressure	435 mm Hg at 25 deg C

Appendix B: Glossary of Regulatory Terms & Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
EPCRA	Emergency Planning and Community Right to Know Act
ERP	Environmental Results Program
FDA	Food and Drug Administration
MACT	Maximum Achievable Control Technology
MCL	Maximum Contaminant Level
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NIOSH	National Institutes of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
RfD	Reference Dose
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
STEL	Short Term Exposure Limit
Tier II	Chemical inventory reporting requirements for facilities subject to EPCRA
TRI	Toxic Release Inventory
TWA-PEL	Time-weighted average - Permissible Exposure Limit
TWA-REL	Time-weighted average – Recommended Exposure Limit
TWA-TLV	Time-weighted average - Threshold Limit Value

[1] Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Methylene Chloride*, September 2000, available at http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=234&tid=42,viewed February 2013.
[2] Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Methylene Chloride*, September 2000, available at http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=234&tid=42,viewed February 2013.
[3] Centers for Disease Control and Prevention Morbidity and Mortality Weekly Report (MMWR) February 24, 2012, accessed at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6107a2.htm
[4] http://www.osha.gov/dts/hazardalerts/methylene_chloride_hazard_alert.pdf
[5] Regulatory Review of 29 CFR 1910.1052 OSHA, February 2010 http://www.osha.gov/dea/lookback/MC-lookback-Feb-2010-final-for-publication-May-2010.pdf
[6] International Agency for Research on Cancer (IARC), "Agents Classified by the IARC Monographs" available athttp://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf viewed February 2013.
[7] National Toxicology Program,12th *Report on Carcinogens,*Available at http://ntp.niehs.nih.gov/ntp/roc/twelfth/ListedSubstancesReasonablyAnticipated.pdf viewed February 2013.
[8] Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Methylene Chloride*, September 2000, available at http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=234&tid=42,viewed February 2013.
[9] Roelofs CR, Ellenbecker MJ, "Results of the Massachusetts methylene chloride end-users survey." Applied Occupational and Environmental Hygiene, 2003 Feb; 18(2): 132-137.
[10] Green Chemistry in Practice. Cannon, 2009.
[11] Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Methylene Chloride*, September 2000, available at http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=234&tid=42,viewed February 2013.
Hazardous Substances Data Bank (HSDB), a database of the National Library of Medicine's TOXNET system, http://toxnet.nlm.nih.gov
[12] United States Environmental Protection Agency, Toxics Release Inventory, http://www.epa.gov/tri/trichemicals/reg_requirements/list_of_lists_revised_7_26_2011.pdf
[13] US EPA, Emergency Planning and Community Right-to-Know Act (EPCRA) Hazardous Chemical Storage Reporting Requirements, available at http://www.epa.gov/emergencies/content/epcra/epcra_storage.htm#msds.
[14] U.S. EPA, Clean Air Act Amendments of 1990 List of Hazardous Air Pollutants; http://www.epa.gov/ttn/atw/orig189.html
[15] Hazardous Substances Data Bank (HSDB), a database of the National Library of Medicine's TOXNET system, http://toxnet.nlm.nih.gov
[16] Hazardous Substances Data Bank (HSDB), a database of the National Library of Medicine's TOXNET system, http://toxnet.nlm.nih.gov
[17] Hazardous Substances Data Bank (HSDB), a database of the National Library of Medicine's TOXNET system, http://toxnet.nlm.nih.gov
[18] U.S. EPA, "Reportable Quantities for Some Chemicals Used in Semiconductor Packaging; Reportable Quantities for Some Chemicals Used in Printed Wiring Board Manufacturing", Accessed online, February 1, 2013 at: http://www.epa.gov/dfe/pubs/pwb/tech_rep/fedregs/regsectd.htm
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