Summary of Technical Information and Scientific Conclusions for Designating Paint or Varnish Strippers Containing Methylene Chloride as a Priority Product

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I. Executive Summary

The Department of Toxic Substances Control (DTSC) conducted an extensive literature review of the hazard traits and exposure potential associated with methylene chloride and the potential for methylene chloride in paint and varnish stripping products to contribute to or cause significant or widespread adverse impacts. This document summarizes the technical information that DTSC relied upon to evaluate methylene chloride and illustrates how DTSC identified and prioritized paint and varnish stripping products containing methylene chloride for listing as a Priority Product.

Methylene chloride is colorless and highly volatile, and its vapors are heavier than air and may concentrate in or near the breathing zone during use. Inhalation of methylene chloride vapors during the use of paint and varnish strippers is a primary exposure route for humans (ATSDR 2000; CDC 2012). Methylene chloride has a number of recognized acute and chronic hazard traits, including numerous worker and consumer deaths associated directly with the use of paint and varnish strippers containing methylene chloride (CDC 2012; CDPH 2012; Fechner et al. 2001; Kim et al. 1996; Manno et al. 1992; Novak and Hain 1990; OSHA 2013; Sanchez 2012; Stewart and Hake 1976). There have also been severe cases of carbon monoxide intoxication caused by inhaling methylene chloride during the use of paint and varnish strippers (Fagin et al. 1980; Mahmud and Kales 1999; OEHHA 2001; U.S. EPA 1994). Methylene chloride is a carcinogen, dermatotoxicant, and ocular toxicant, and can cause adverse effects on the central nervous system (see section IV of this report).

Methylene chloride is commonly used in paint and varnish strippers (Hodgson and Girman 1987; Joe et al. 2013; U.S. EPA 2015b). A recent survey suggests that the majority of paint and varnish stripping formulations sold in California contain methylene chloride (Joe et al. 2013; Morris and Wolf 2006). It has been suggested that nearly one third of all methylene chloride manufactured worldwide is used as a solvent in paint and varnish strippers (NTP 2011). U.S. production and imports of methylene chloride totaled 500 million to 1 billion pounds between 1986 and 1990, and 100 million to 500 million pounds between 1996 and 2006 (NTP 2011).

As of 2006, there were at least six industrial facilities in California using "relatively large quantities" (i.e., > 1,200 gallons per year) of paint and varnish strippers containing methylene chloride, and as many as 490 smaller businesses (e.g., antique stores) using paint and varnish strippers containing methylene chloride in smaller quantities (i.e., from less than 5 gallons per year up to 1,200 gallons per year) (Morris and Wolf 2006). Many furniture stripping firms that use methylene chloride-based paint and varnish strippers in California have poor ventilation (Morris and Wolf 2006). The federal Occupational Safety and Health Administration (OSHA) and the California Occupational Safety and Health Administration (Cal-OSHA) have established a permissible exposure limit (PEL) of 25 parts per million and an action level of 12.5 parts per million for methylene chloride in air (DIR 2015a; Morris and Wolf 2006).[1] According to a 2006 study most furniture stripping firms routinely exceeded the PEL or the action level for methylene chloride (Morris and Wolf 2006).

The use of methylene chloride-based products in home settings can result in high concentrations of methylene chloride in air, often exceeding OSHA PELs (MacIsaac et al. 2013). In a home simulation study of furniture stripping methylene chloride concentrations in air exceeded 2,000 parts per million when paint and varnish strippers were used indoors without local exhaust ventilation (Hodgson and Girman 1987). Concentrations in air of 2,300 parts per million are considered "Immediately Dangerous to Life and Health" by the National Institute for Occupational Safety and Health (NIOSH 1994).

Methylene chloride exposure may also occur by dermal contact, and common glove types such as latex, rubber, and nitrile are easily penetrated by methylene chloride (Joe et al. 2013). A survey found that sales people at retail outlets where methylene chloride paint strippers are sold in California failed to recommend appropriate gloves to consumers purchasing methylene chloride stripping products (Joe et al. 2013). Further, cartridge-type air purifying respirators and dusts masks do not provide adequate protection against methylene chloride vapors, putting consumers who use these types of inadequate protective equipment at risk for inhalation exposure (CDPH 2012). It has been suggested that precautionary labeling on methylene chloride paint strippers is not sufficient to influence how they are used by consumers (Joe et al. 2013).

Methylene chloride has a penetrating, ether-like odor. However, people can become desensitized to the odor, and odor alone cannot be relied upon as a means to detect the presence of methylene chloride in air. Those who work frequently with methylene chloride risk becoming desensitized to its odor and, therefore, may be at increased risk of exposure via inhalation.

[1] *The PEL is the maximum concentration of a chemical that workers may be exposed to for a certain period of time, typically 8 hours. Workers may be exposed to concentrations that exceed the PEL provided they do not exceed the time-weighted average specific to that PEL or any applicable excursion limits.*

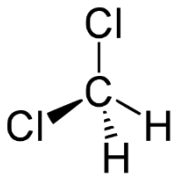
Based on consideration of these factors, DTSC has determined that the exposure to methylene chloride related to the use of paint and varnish strippers may contribute to or cause significant or widespread adverse impacts to human health within California.

II. Identification of the Priority Product and Chemical of Concern

DTSC has identified as a proposed Priority Product any product that is placed into commerce in California that contains methylene chloride (dichloromethane), and that may be marketed, sold or offered for sale as a chemical substance designed to break down paint or varnish to facilitate its removal from a surface. Such products may be designed for indoor or outdoor use, and can be used to remove varnish or paint from any chosen surface. This product category is collectively referred to as paint and varnish strippers. This product category does not include products specifically marketed and sold as paint or varnish thinners, graffiti removers or adhesive removers as defined in California Code of Regulations, title 17, section 94508.

The Chemical of Concern contained in this Priority Product is methylene chloride:

- Chemical abstract service (CAS) registry number: 75-09-2
- Common synonyms or trade names: Methylene chloride, dichloromethane, methylene dichloride
- Chemical formula: CH_2Cl_2
- Chemical structure:



Methylene chloride meets the conditions specified in California Code of Regulations, title 22, section 69503.6 (a): It appears on one or more of the authoritative lists in California Code of Regulations, title 22, section 69502.2(a)(1) and is a chemical listed in California Code of Regulations, title 22, section 69502.2(a)(2). Methylene chloride is listed on four of the lists described in section 69502.2(a)(1) for carcinogenicity, and one list for neurotoxicity. It also appears on five of the lists described in section 69502.2(a)(2) for a variety of other traits.

III. Physicochemical Properties of Methylene Chloride

- Molecular weight: 84.9 g/mol (Chemspider 2015).
- Specific gravity: 1.33 (Chemspider 2015).
- Melting point: between -95°C and -97°C (Chemspider 2015).

- Boiling point: between 39°C and 40°C (Chemspider 2015).
- Log K_{ow} : 1.25 (Chemspider 2015).
- Water solubility: 13.0 g/L at 25°C (Chemspider 2015).
- Vapor pressure: 400 mm Hg at 24.1°C (Mahmud and Kales 1999).
- Vapor density relative to air: 2.93 (CDPH 2012).
- Methylene chloride has a penetrating, ether-like odor (NIOSH 1986).

IV. Hazard Traits of Methylene Chloride

1. Volatility

a. Methylene chloride is considered highly volatile (NIOSH 1986). Thus, there is a significant risk of exposure via inhalation during the use of products containing methylene chloride.

2. Acute Toxicity

a. Exposure to methylene chloride vapor can be fatal (ATSDR 2000). There have been numerous worker deaths associated with the use of paint and varnish strippers containing methylene chloride (CDC 2012; CDPH 2012; Fechner et al. 2001; Kim et al. 1996; MacIsaac et al. 2013; Manno et al. 1992; McDonald and Olmedo 1996; Novak and Hain 1990; OSHA 2013; Tay et al. 1995).

b. Consumer deaths related to the use of paint and varnish strippers containing methylene chloride have been documented, but the total number is unknown (Sanchez 2012; Stewart and Hake 1976).

c. Methylene chloride is metabolized to carbon monoxide in the body and may cause carbon monoxide poisoning depending on the level of methylene chloride exposure. There have been severe cases of carbon monoxide intoxication caused by inhaling methylene chloride from paint and varnish strippers (Fagin et al. 1980; Mahmud and Kales 1999; OEHHA 2001; U.S. EPA 1994). The California Office of Environmental Health Hazard Assessment (OEHHA) previously evaluated methylene chloride and noted that, while there are no studies evaluating whether methylene chloride exposure differentially affects children relative to adults, the effects of metabolically-produced carbon monoxide following methylene chloride exposure may be exacerbated in fetuses and infants (OEHHA 2001). This is due to the fact that fetal hemoglobin has a higher affinity for carbon monoxide than adult hemoglobin (OEHHA 2001). Although DTSC is unaware of any studies correlating methylene chloride exposure to the level of carbon monoxide generated from the metabolism of methylene chloride *in Vivo*, a number of studies have examined the potential adverse effects of carbon monoxide on fetuses, infants and young children. It has been suggested that carbon monoxide in cigarette smoke leads to reduced fetal weight in rats (Carmines and Rajendran 2008). Venditti et al. observed increased fetal mortality and decreased fetal weight and litter size in mice exposed to carbon monoxide during pregnancy (Venditti et al. 2011). Abnormal fetal cardiac

rhythms were observed in women poisoned by carbon monoxide (Towers and Corcoran 2009). An increase in the spontaneous abortion rate was observed for female workers exposed to organic solvents, and it has been suggested that women exposed to methylene chloride may have increased risk of spontaneous abortion (Axelsson et al. 1984; Taskinen et al. 1986). In addition, evidence of oxidative stress has been observed in the offspring of rats exposed to carbon monoxide during pregnancy, and a number of studies have demonstrated impaired learning and memory following prenatal and postnatal low-level carbon monoxide exposure (Cheng et al. 2012; Levy 2015). Children are expected to metabolize more methylene chloride to carbon monoxide than adults due to their relatively large liver size and high activity of cytochrome P4502E1 (Hines 2008).

d. Acute exposure to methylene chloride may result in Central Nervous System (CNS) depression, dizziness, confusion, intoxication, loss of coordination, memory loss, personality changes, and unconsciousness (ATSDR 2000). In fact, the primary cause of death and other common effects from methylene chloride exposure is CNS depression (NAS and Sciences 2009). The California Department of Public Health (CDPH) relates short-term exposure to methylene chloride to a variety of symptoms including headaches, dizziness, eye, nose and throat irritation, chest pain, and trouble breathing (CDHS 2006; CDPH 2012). Usually these symptoms clear up within a few hours after exposure stops. However, repeated exposure over months and years may have long-lasting and possibly permanent adverse effects on the CNS.

e. Acute exposure to methylene chloride by inhalation may cause gastrointestinal effects, including nausea and vomiting, and respiratory effects, such as cough, shortness of breath, chest tightness and asphyxiation (ATSDR 2000). Long term exposure to high levels of methylene chloride may also lead to a debilitating degenerative condition known as chronic solvent encephalopathy (Bruckner et al. 2013).

3. Carcinogenicity

a. Methylene chloride is known to the State of California to cause cancer under Proposition 65 (the Safe Drinking Water and Toxic Enforcement Act of 1986) (OEHHA 2015).

b. Methylene chloride is classified as “likely to be carcinogenic in humans” by the U.S. Environmental Protection Agency (U.S. EPA) (Cooper et al. 2011).

c. Epidemiological data have linked methylene chloride to cancers of the brain, liver, and the biliary tract (bile system) (Cooper et al. 2011; U.S. EPA 2011).

d. Methylene chloride is classified as “possibly carcinogenic to humans” (i.e., a group 2B carcinogen) by the International Agency for Research on Cancer (IARC) (Cooper et al. 2011; IARC 1999).

e. Methylene chloride is classified as “reasonably anticipated to be a human carcinogen” in the Twelfth Edition of the Report on Carcinogens published by the U.S. Department of Health and Human Services, National Toxicology Program (NTP 2011).

f. Methylene Chloride is considered a “Potential Occupational Carcinogen” by the National Institute of Occupational Safety and Health (NIOSH 1986).

g. Methylene Chloride is classified as a “Potential Occupational Carcinogen” by the Federal Occupational Safety and Health Administration (OSHA 2003).

h. Methylene Chloride is classified as a “Regulated Carcinogen” by the California Department of Industrial Relations (DIR 2015b).

4. Dermatotoxicity

a. In humans, direct skin contact with large amounts of methylene chloride causes intense burning and mild redness of the skin (CDC 2012).

5. Ocular toxicity

a. Exposure to high levels of methylene chloride vapors may irritate the eyes and adversely affect the cornea (CDC 2012; CDHS 2006).

b. There is a reported case of optic neuropathy in a 65 year old man that resulted from methylene chloride inhalation (Kobayashi et al. 2008).

6. Other hazard considerations

a. The U.S. Department of Labor has warned that the use of methylene chloride paint stripping products in small or enclosed spaces represents an extreme danger (OSHA 2013).

b. Methylene chloride is classified as a toxic air contaminant in California (ARB 2011).

c. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), requires the Agency for Toxic Substances Disease Registry (ATSDR) and the U.S. EPA to prepare a priority list of hazardous substances that are most commonly found at facilities on the National Priorities List (NPL), and that are determined to pose the most significant potential threat to human health due to their known or

suspected toxicity and potential for human exposure (ATSDR 2013).[2] Methylene chloride is included on the priority list of hazardous substances.

d. Although experimental data are lacking, methylene chloride is not expected to bioconcentrate due to its low octanol/water partition coefficient (log $_{Kow}$ is 1.25), from which a bioconcentration factor of 5 can be estimated (U.S. EPA 2015b).

V. Environmental Fate of Methylene Chloride

1. Atmosphere

Because of its high vapor pressure, most methylene chloride will volatilize into the atmosphere during use (U.S. EPA 2015b). Of the total methylene chloride released to the environment annually in the U.S., ~90% is released to the atmosphere (U.S. EPA 1994). Releases occur from both industrial and consumer uses (U.S. EPA 1994). The average atmospheric lifetime for methylene chloride is 130 days (ATSDR 2000).

2. Water

Methylene chloride released to water will be removed primarily by evaporation. The half-life of methylene chloride volatilization from water has been found to be 21 minutes under experimental conditions, but the actual rate of volatilization from natural waters may vary, as it may depend on a variety of environmental factors such as temperature and pH (ATSDR 2000). Biodegradation is possible in natural waters but is likely to be very slow compared with evaporation.

3. Land

The principal releases of methylene chloride to land are via the disposal of methylene chloride containing products and discarded product containers to landfills (U.S. EPA 1994).

VI. Exposure Potential of People or Wildlife to Methylene Chloride in Paint and Varnish Strippers

[2] *The NPL is the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the U.S. and its territories. The NPL is intended primarily to guide the EPA in determining which sites warrant further investigation U.S. EPA (2015a) United States Environmental Protection Agency National Priorities List. In. http://www.epa.gov/superfund/sites/npl/ Accessed February 12 2015*.

Pursuant to Article 3 of the Safer Consumer Product (SCP) regulations, DTSC may draw from a large number of information sources to evaluate exposure including, but not limited to, biomonitoring data, market share data, data regarding the volume of a chemical or product in commerce, the physicochemical properties of the chemical under evaluation, data showing a chemical to be present in household dust, indoor air, drinking water, or on interior surfaces, or data showing a chemical to be present in, or released from, products present in homes, schools, or places of employment.[3] In evaluating the potential for exposure to methylene chloride in paint and varnish strippers DTSC considered the following factors:

1. People

a. *Presence in places of employment*: As of 2006, there were at least 6 industrial facilities in California using "relatively large quantities" (more than 1200 gallons per year) of paint and varnish strippers containing methylene chloride, and as many as 490 smaller businesses (e.g., antique stores) using paint and varnish strippers containing methylene chloride in smaller quantities (ranging from less than 5 gallons per year up to 1200 gallons per year) (Morris and Wolf 2006). Moreover, many furniture stripping facilities that use methylene chloride-based stripping formulations in California have poor ventilation and have not met the PEL or the action level for methylene chloride (Morris and Wolf 2006). Bathroom and kitchen remodelers may also use paint and varnish strippers containing methylene chloride to strip cabinets and bathtubs for refinishing. The number of remodelers and other workers who may use paint and varnish strippers containing methylene chloride is unknown.

b. *Presence in homes*: Available data suggest that the most widely used paint and varnish stripper formulations sold in California contain methylene chloride (Morris and Wolf 2006). A 2013 survey of retail stores in the San Francisco Bay Area showed that methylene chloride-based paint and varnish strippers are widely available for purchase by consumers, demonstrating considerable market demand (Joe et al. 2013). Further, available data suggest that methylene chloride-based paint and varnish strippers are more widely available in retail stores than alternative paint stripping formulations (Joe et al. 2013). The indoor, residential use of methylene chloride-based products can result in high concentrations of methylene chloride in air that often exceed OSHA PELs.[4] In a home simulation study of furniture stripping, methylene chloride concentrations in air exceeded 2,000 parts per million when used indoors without local exhaust ventilation (Hodgson and Girman 1987). Concentrations in air of 2,300 parts per million are considered "Immediately Dangerous to Life and Health" (NIOSH 1994).

c. *Instances of exposure and actual harm*: The annual reports of the National Poison Data System show that in 2011 there were 337 reported exposures to methylene chloride from paint and varnish strippers (Bronstein et al. 2012). Of those, 41 occurred in individuals under the age of 5 and 45

[3] http://www.dtsc.ca.gov/LawsRegsPolicies/Regs/SCPA.cfm
[4] *California Code of Regulations, title 8, section 5155*

occurred in individuals between the ages of 6 and 19. Of the reported exposures, 324 were classified as "unintentional" and six were classified as "intentional." In 114 of the 337 exposure cases the affected individuals required treatment in a medical facility. Worker deaths associated with the use of paint and varnish strippers containing methylene chloride have been documented by regulatory agencies (CDC 2012; CDPH 2012; Joe et al. 2013; OSHA 2013). Consumer deaths related to the use of these products have also been documented but not quantified (Sanchez 2012; Stewart and Hake 1976). Because methylene chloride can have adverse effects on a number of different organ systems, it is possible that some deaths caused by methylene chloride exposure have gone undetected (CDC 2012).

d. Generally, the higher the concentration of a given chemical in a given product, the greater the potential for exposure to that chemical while using that product. The concentration of methylene chloride in paint and varnish stripping products can be very high, ranging from 16% to 100%, with the majority of products containing more than 60% methylene chloride by volume (CDPH 2013).

e. In 1998, 44 facilities in California reported releasing more than 986,000 pounds of methylene chloride to the air based on Toxics Release Inventory data (ATSDR 2000).[5]

f. The California Air Resources Board (CARB) periodically publishes the California Almanac of Emissions and Air Quality.[6] The Almanac contains information on statewide emissions of certain Toxic Air Contaminants (TACs), including methylene chloride, for a number of years going back to 2000.[7] Emissions are estimated based on the actual measurement of TACs in ambient air. Each Almanac contains information on emissions for the prior calendar year. Therefore, for example, emissions reported for 2000 are published in the 2001 Almanac. Los Angeles, Orange, and Santa Clara counties accounted for more than 50% of all reported statewide emissions of methylene chloride in California until 2005, when San Diego replaced Santa Clara as one of the three counties with the highest reported emissions of methylene chloride. Between 2001 and 2006 reported emissions of methylene chloride declined by ~20%, as shown in the following table. It is not clear if this decline is associated with declining use or with measures taken to mitigate releases, and the Almanac does not identify emission sources.

[5] *Note that the ATSDR data differs from the CARB data reported in paragraph f of this same section. The reason for the differences is not known with certainty, but one reason for this difference is likely the fact that CARB actually measures emissions from all sources in ambient air where as ATSDR summarized data self-reported by specific facilities.*

[6] *http://www.arb.ca.gov/aqd/almanac/almanac.htm*

[7] *Note that no data was published on CARBs website for 2009 through 2011, and the most recent Almanac published for 2013 did not provide any methylene chloride release data. The 2008 Almanac, reporting for 2007, repeated the 2006 data and did not provide new data for methylene chloride.*

Table Summarizing Statewide Releases of Methylene Chloride by Year:

Year	Total Reported Release (Tons)
2000	8166
2001	8124
2002	7739
2003	7588
2004	7637
2005	6557
2006	6527
2007	*No new data reported
2008	6436

g. Methylene chloride is a chemical for which primary Maximum Contaminant Levels (MCLs) have been established and adopted under section 64444 of chapter 15 of title 22 of the California Code of Regulations. MCLs are health protective drinking water standards that must be met by public water systems (SWRCB 2015). For a drinking water contaminant to be regulated, it must have the potential to expose a significant portion of the population to health risk at concentrations that might cause health effects. Methylene chloride has been detected in finished and raw water supplies in the U.S., and in groundwater wells used as drinking water sources in California (OEHHA 2000).

2. Wildlife

DTSC could not find any data regarding wildlife exposures to methylene chloride. Therefore, exposure of wildlife to methylene chloride was not a factor that was considered in proposing to designate paint and varnish strippers containing methylene chloride as a Priority Product.

VII. Sensitive Subpopulations with Potential for Adverse Impacts from Methylene Chloride

Methylene chloride is recognized as a carcinogen. Methylene chloride is also recognized as an acute toxicant that may adversely affect a number of organ systems. All segments of the human population may be adversely impacted by exposure, but some segments of the population may be more sensitive to exposure than others.

1. Fetuses, Infants and Children

a. California assumes increased susceptibility of the fetus, infants and children to all carcinogens (OEHHA 2009).

b. When methylene chloride is metabolized by the human body reactive compounds are produced that may cause DNA damage and lead to cancer (Cooper et al. 2011). Although there are no direct studies on whether methylene chloride affects children differently than adults, children exposed to

cancer-causing agents that act by damaging DNA are generally assumed to have increased early-life susceptibility (Hugh Barton et al. 2005).

c. Methylene chloride vapors are heavier than air and tend to concentrate near the ground. Vapors may concentrate in the breathing zone (OEHHA 2001). OEHHA has concluded that because of their shorter stature, children may be more at risk of exposure than adults during accidental spills or through the use of methylene chloride in unventilated areas (OEHHA 2001). Moreover, the higher breathing rates in children compared to adults mean that children are likely to receive a higher dose of methylene chloride than adults during inhalation exposures (OEHHA 2001).

d. Methylene chloride is metabolized to carbon monoxide. The central nervous system and cardiovascular effects of methylene chloride may be exacerbated in fetuses and infants because methylene chloride may be more rapidly metabolized to carbon monoxide in children, and fetal hemoglobin has a higher affinity for carbon monoxide than adult hemoglobin (Hines 2008; OEHHA 2001). A number of studies have examined the potential adverse effects of carbon monoxide on fetuses, infants and young children. It has been suggested that carbon monoxide in cigarette smoke leads to reduced fetal weight in rats (Carmines and Rajendran 2008). Venditti et al. observed increased fetal mortality and decreased fetal weight and litter size in mice exposed to carbon monoxide during pregnancy (Venditti et al. 2011). Abnormal fetal cardiac rhythms were observed in women poisoned by carbon monoxide (Towers and Corcoran 2009). In addition, evidence of oxidative stress has been observed in the offspring of rats exposed to carbon monoxide during pregnancy, and a number of studies have demonstrated impaired learning and memory following prenatal and postnatal low-level carbon monoxide exposure (Cheng et al. 2012; Levy 2015). Children are expected to metabolize more methylene chloride to carbon monoxide than adults due to their relatively large liver size and high activity of cytochrome P4502E1 (Hines 2008).

2. Pregnant Women and Women of Child-Bearing Age

Studies of female pharmaceutical workers suggest that methylene chloride exposure may be associated with an increased rate of spontaneous abortions and may have adverse effects on pregnancy (Axelsson et al. 1984; OEHHA 2001; Taskinen et al. 1986). An increase in the spontaneous abortion rate was observed for female workers exposed to organic solvents, and it has been suggested that women exposed to methylene chloride may have increased risk of spontaneous abortion (Axelsson et al. 1984; Taskinen et al. 1986).

3. Workers

Workers who use paint and varnish strippers containing methylene chloride may be at especially high risk of exposure due to poor ventilation or improper selection and/or use of personal protective equipment. Worker deaths have occurred during use of paint and varnish strippers containing methylene chloride (CDC 2012; CDPH 2012; Joe et al. 2013; OSHA 2013).

4. Chronically Ill and Others

According to CDPH methylene chloride can cause chest pains (angina) and "other symptoms" in people with heart disease (CDHS 2006; Stewart and Hake 1976). Other groups that may be at increased risk when exposed to methylene chloride include the elderly, people taking medications that depress the central nervous system, and those with respiratory problems such as asthma or emphysema (Raub and Benignus 2002).

VIII. Conclusions

DTSC has identified paint and varnish strippers containing methylene chloride as a Priority Product. This determination was based on the consideration of available, reliable information regarding the potential for widespread and adverse human health impacts from exposures related to the use of methylene chloride in paint and varnish strippers, as described in preceding sections and summarized in this section.[8]

1. Hazards

Methylene chloride has numerous recognized acute and chronic hazard traits. The use of paint and varnish strippers containing methylene chloride has led to the deaths of consumers and numerous workers due to acute methylene chloride poisoning. Methylene chloride also has the potential to significantly and adversely impact the health of certain sensitive subpopulations including pregnant women and women of child-bearing age, infants and children, workers who use paint strippers on the job, and certain chronically ill individuals.

2. Potential for Exposure and Significant or Widespread Adverse Impacts

DTSC has determined that there is a potential for exposure related to the use of paint and varnish strippers containing methylene chloride, and there is the potential for one or more of these exposures to cause significant or widespread adverse impacts. This determination was based in large part on the fact that methylene chloride is highly volatile and is likely to become airborne during the use of products that contain this chemical, and on the hazard traits of methylene chloride. The concentration of methylene chloride in paint and varnish stripping products can be very high, ranging from 16% to 100%, with the majority of products containing more than 60% methylene chloride by volume (CDPH 2013). Such high concentrations increase the potential for exposure during use. A survey of retail stores in California concluded that paint and varnish strippers containing methylene chloride are the most commonly purchased paint stripping product, suggesting that their use is widespread (Joe et al. 2013).

[8] *"Reliable information" and "reliable information demonstrating exposures" are defined in sections 69501.1(a)(57) and (58), respectively, and include sources of information other than primary, peer-reviewed scientific literature.*

Methylene chloride vapors are heavier than air and may concentrate in the breathing zone in the absence of adequate ventilation, further increasing the potential threat of exposure during use. It has been shown that the use of methylene chloride-based products in home settings can potentially result in high concentrations of methylene chloride in air, in some cases approaching concentrations that are immediately dangerous to life and health (Hodgson and Girman 1987; MacIsaac et al. 2013; NIOSH 1994). Moreover, many consumers may not be aware that the most commonly used gloves and cartridge-type air purifying respirators do not provide adequate protection from exposure to methylene chloride.

DTSC has also determined that there is potential for exposure to methylene chloride for workers who use paint and varnish strippers, and that these exposures have the potential to cause or contribute to significant adverse impacts. This determination was based on the fact that paint and varnish strippers containing methylene chloride are widely used in industrial paint stripping operations where workers may be exposed, and there are industrial stripping facilities in California that use paint and varnish strippers containing methylene chloride (IARC 1999; Morris and Wolf 2006). Many furniture stripping firms that use methylene chloride-based stripping formulations in California have poor ventilation (U.S. EPA 2015a). OSHA and Cal-OSHA established a PEL of 25 parts per million and an action level of 12.5 parts per million for methylene chloride in air (DIR 2015a; Morris and Wolf 2006). According to a 2006 study, most furniture stripping firms exceeded the PEL or the action level for methylene chloride (Morris and Wolf 2006). In addition, bathroom and kitchen remodelers and other workers may use paint and varnish strippers containing methylene chloride to strip cabinets, bathtubs, or other items for refinishing, and deaths attributed to methylene chloride poisoning have been documented among these workers. The number of remodelers and other workers who may use paint and varnish strippers containing methylene chloride is unknown.

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APPENDIX A. Summary of Revisions

The Department of Toxic Substance Control (DTSC) revised this document following external scientific peer review in June 2016, to include additional references, and improve the focus and clarity of the report. The following table summarizes revisions made in response to the reviewers' recommendations.

Section	Summary of Revisions
Section IV., Hazard Traits of Methylene Chloride, Subsection 2., Acute Toxicity	• Added additional references relating to accounts of deaths associated with methylene chloride poisoning. • Added additional references regarding acute toxicity related to carbon monoxide poisoning. • Revised to specify that neurotoxicity is related to acute exposure.
Section. IX. References, Section IV. Hazard Traits of Methylene Chloride *Subsection 2. Acute Toxicity*	The following references were added to this document: • Axelsson, G., Lutz, C., Rylander, R. 1984. Exposure to Solvents and Outcome of Pregnancy in University Laboratory Employees. British Journal of Industrial Medicine, 41, 305-312. • Bruckner, J.V., Anand, S.S., Warren, D.A., 2013. Toxics Effects of Solvents and Vapors. Casarette & Doull's Essentials of Toxicology: The Basic Science of Poisons. McGraw Hill, New York, New York. • Cheng, Y., Thomas, A., Mardini, F., Bianchi, S.L., Tang, J.X., Peng, J., Wei, H., Eckenhoff, M.F., Eckenhoff, R.G., Levy, R.J. 2012. Neurodevelompmental Consequences of Sub-clinical Carbon Monoxide Exposure in Newborn Mice. PLoS One, 7, e32029. • Fechner, G., Ortmann, A., Kohler, H. 2001. Fatal Intoxication Due to Excessive Dichloromethane Inhalation. Forensic Science International, 122, 69-72. • Hines, R.N. 2008. The Ontogeny of Drug Metabolish Enzymes and Implications for Adverse Drug Events. Pharmacology and Therapeutics, 118, 250-267. • Levy, R.J. 2015. Carbon Monoxide Pollution and Neurodevelopment: A Public Health Concern. Neurotoxicology and Teratology, 49, 31-40. • Mano, M., Rugge, M., Cocheo, V. 1992. Double Fatal Inhalation of Dichloromethanes. Human Experimental Toxicology, 11, 540-545. • McDonald, W., Olmedo, M. 1996. Accidental Deaths Following Inhalation of Methylene Chloride. OSHA Compliance Issues, Applied Occupational and Environmental Hygiene, 11, 17-19. • Novak, J.J., Hain, J.R. 1990. Furniture Stripping Vapor Inhalation Fatalities: Two Case Studies. Applied Occupational and Environmental Hygiene, 5, 843-847. • Taskinen, H., Lindbohm, M-L., Hemminiki, K. 1986. Spontaneous Abortions Among Women Working in the Pharmaceutical Industry. British Journal of Industrial Medicine, 43, 199-205. • Tay, P., Tan, K.T., Sam, C.T. 1995. Fatal Gassing Due to Methylene Chloride – A Case Report. Singapore Medical Journal, 43, 199-205. • Towers, C.V., Corcoran, V.A., 2009. Influence of Carbon Monoxide Poisoning on the Fetal Heart Monitor Tracing: A Report of 3 Cases. Journal of Reproductive Medicine, 54, 184-188. • Venditti, C.C., Casselman, R., Smith, G.N., 2011. Effects of Chronic Carbon Monoxide Exposure on Fetal Growth and Development in Mice. BMC Pregnancy and Childbirth, 11, 101-109.