Appendix G: Analysis of the Potential Impacts of Increased Use of Methylene Chloride

Exposure Analysis: Long-Term Exposure in the Workplace

To determine the long-term exposure in the workplace (i.e., during a full workday) to methylene chloride, we used the following 8-hour time-weighted average (TWA) predictive model. This model was used in a study on perchloroethylene emissions from the use of chemical brake cleaners in automotive repair facilities (ARB, 1996). We determined the use of this model was appropriate for aerosol coating products that contain methylene chloride because the model is designed to estimate exposure to a compound from an aerosol product and is not defined to one specific compound.
The predictive model consists of the following:

$$C_s = \frac{(24.45 \times 10^{-3}\ m^3/mol)(A)(B)(10^6)}{(M)(V)(1 + D)}$$

where,

C_s = Predicted room concentration of Methylene chloride, ppm
A = Methylene chloride content per can, grams/can
B = Number of cans used per work period
M = Molecular weight of methylene chloride, 84.94
V = Shop volume, m^3
D = Shop volume changes/work period
$= \frac{(F)(60\ min/hr)(8\ hr/work\ period)}{H}$
F = Air turnover rate, 1.5 $ft^3/min\text{-}ft^2$ (the Building Officials and Code Administrators (BOCA) standard air flow in an automotive repair facility)
H = Repair shop ceiling height, ft (15.6 ft.)

To run the model, we used the input parameters shown in Table-1. The parameters were chosen to represent "worst-case" scenarios for two different products in two different conditions. In a 13 ounce can of aerosol coating product we assumed the content of methylene chloride per can to be 92 to 184 grams. We also assumed that the number of cans used would be one to two per work period. The shop volumes chosen were based on data gathered for the perchloroethylene needs assessment for automotive consumer products (ARB, 1997b). "Real-life" conditions likely would consist of larger work areas with greater air turnover rates, use of products with lower methylene chloride content, and lower usage of the aerosol coating product.

TABLE-1.
Predictive Model Input Parameters for Emissions of Methylene Chloride from Aerosol Coating Products

Parameter	Description	Range of Values	Source	Comments
A	grams of methylene chloride/13 oz. Can	92 - 184	ARB, 1998	Methylene Chloride Range = 25% - 50%
B	no. cans/work period	1 - 2	ARB, 1998	Assumed a worst-case scenario for the number of cans used per work period
V	shop volume, m^3	896 - 4733	ARB, 1997	Assumed height = 15.6 ft. (4.76 meters)
D	Shop air turnover, hr	12 - 46	Norton, 1993	Typical D at height = 15.6 ft. Assumed Low D = 25% of typical

Table -2 shows the predictive model results using the input parameters in Table-1. These results indicate that an individual using the particular aerosol coating product under assumed worst-case conditions would be exposed to TWA room concentrations of 0.1 to 9.1 ppm. The "worst-case" condition that generated the highest concentration of methylene chloride consisted of a shop volume of 896 m^3 and usage of two cans per 8-hour work period of an aerosol coating product containing 50 percent methylene chloride. These results, when compared to the State and Federal OSHA permissible exposure limit (PEL), are at least 3-fold below the standard and at the most, 15-fold below. However, PELs have been used to derive chemical exposure guidelines for a worker's exposure and are not designed or recommended for protection of the general public. They do not address the potential adverse health effects to the sensitive population (e.g., children, elderly, population with respiratory diseases, etc.). Therefore, we used the following analysis to estimate what the maximum, or "worst-case," ambient exposure would be to determine what the health impact would be to the sensitive population.

TABLE-2.
Predicted Time-Weighted Average Methylene Chloride Concentrations Under Varying Shop Volumes, Methylene Chloride Contents, and Aerosol Coating Products

	Predicted TWA Range Over 8-hour Work Period* (ppm)		Comparison to State and Federal Permissible Exposure Levels (PELs)
	Methylene chloride content, grams (13 oz. can)		
	Automotive Bumper and Trim Product	Clear Coating Product	
Shop Volume	184 grams (50%)	92 grams (25%)	Federal and State PEL (25 ppm)*
896 m^3	1.2 - 9.1 ppm	0.6 - 4.6 ppm	3-fold below
1874 m^3	0.6 - 4.4 ppm	0.3 - 2.2 ppm	6-fold below
4733 m^3	0.2 - 1.7 ppm	0.1 - 0.9 ppm	15-fold below

* OSHA, 1998; CCR, 1997.

Exposure Analysis -Health Risk Assessment for Ambient Exposure

To evaluate the impact from methylene chloride emissions from aerosol coating use on surrounding areas, we conducted a health risk assessment of a hypothetical ”typical” work area. A health risk assessment consists of the evaluation of possible adverse health effects to the community surrounding a facility that emits potentially toxic substances. Potential adverse health effects may include acute noncancer effects, chronic noncancer effects, and cancer effects. To conduct the risk assessment, we used the Office of Environmental Health Hazard Assessment, Air Toxics Hot Spots Program Risk Assessment Guidelines (OEHHA, 1999a,b; 2000).

Potential Noncancer Health Effects. Adverse acute effects may result from short-term exposure to a pollutant. Acute exposure to high concentrations of methylene chloride can cause irritation to the eyes, respiratory tract, and skin. Chronic noncancer health effects are those that may result from long-term exposure to relatively low pollutant concentrations. Long-term exposure to low concentrations of methylene chloride can lead to effects on the central nervous system, gastrointestinal system, and liver (OEHHA, 2000). Noncancer reference exposure levels (RELs) have been developed from animal or human studies for a number of substances. Table-3 shows the noncancer RELs for methylene chloride. These RELs generally include a margin of safety to protect the most sensitive individuals. Potential acute effects can be evaluated by comparing a one-hour maximum ground level concentration with the REL in Table-4. Chronic noncancer effects are also evaluated by comparing an estimated annual average ground level concentration of methylene chloride with the chronic REL in Table-3.

The one-hour maximum and annual average concentrations needed for this analysis are derived from an appropriate air quality dispersion analysis performed on the source emitting methylene chloride.

TABLE-3
Noncancer Reference Exposure Levels (RELs) for Methylene Chloride

Noncancer Effect	Reference Exposure Levels	
	(ug/m^3)	(parts per million)
Acute	14,000	4
Chronic	400	0.12

Note: Acute and chronic RELs are from OEHHA, 1999a; 2000.

The potential for acute and chronic health effects from exposure to a toxic substance can also be evaluated using the hazard index approach. An acute hazard index is calculated by dividing the estimated maximum one-hour exposure level by the acute REL. The chronic hazard index is also calculated by dividing the estimated annual average concentration by the chronic REL. Hazard indices of one or less are not considered to be indicative of public health impacts from noncancer toxicity of the evaluated substance. If the total chronic hazard index exceeds 0.5, in its guidelines OEHHA recommends that the effects from background concentrations of criteria pollutants be added to the source’s or facility’s total chronic hazard index. The criteria pollutants recommended for inclusion in such cases are ozone, nitrogen dioxide, sulfur dioxide, sulfates, and hydrogen sulfide (OEHHA, 1999a; 2000).

Potential Cancer Effects. For this analysis, we will express the potential additional effect of cancer from exposure to methylene chloride emissions from use of an aerosol coating product as a maximum individual risk. The maximum individual risk is the probability (expressed as chances in a million) that an individual will develop cancer, under a worst case scenario of being exposed continuously for 70 years to the maximum ground level concentration of a pollutant. The risk is calculated as the product of the maximum annual average concentration of the pollutant and the unit risk factor specified for the pollutant.

Methodology for Estimating the Potential Health Impacts. The methodology used to estimate the potential health impacts from emissions of methylene chloride from aerosol coating use was to model the airborne methylene chloride emissions for a hypothetical "typical" source. This modeling gives estimated ground level concentrations at varying distances. The input parameters as listed in Table-4 are the parameters the SCREEN3 model (SCREEN3 Modeling Results for Methylene Chloride is included with this Appendix) uses to estimate the downwind, ground-level, maximum 1-hour concentrations for designated distances from the center of the volume source.

TABLE-4.
Input Parameters Used in SCREEN3 Modeling (v. 96043)

Methylene Chloride Emission Rate (acute) [grams/second]	0.013
Methylene Chloride Emission Rate (annualized) [grams/second]	0.01
Receptor Height [meters][1]	0
Source Release Height [meters][2]	2.38
Initial Lateral Dimension of Volume [meters][3]	3.19
Initial Vertical Dimension of Volume [meters][4]	2.21
Meteorology Option	Full
Land Type [Urban or Rural]	Urban
Receptor Distance (from center of source) [meters]	20
Operating Schedule [hrs/yr]	2808

1. Selected by convention as ground-level receptor.
2. One-half of building height (15.6 ft., 4.76 meters).
3. Exterior building width (45 ft., 13.7 meters) divided by factor 4.3 per SCREEN3 User's Guide.
4. Exterior building height (15.6 ft., 4.76 meters) divided by factor 2.15 per SCREEN3 User's Guide.

The methylene chloride emission rates for acute exposure are based on the assumption of a worst-case scenario of a facility using 13 ounce cans of an aerosol coating product containing a

50 percent methylene chloride content by weight and using 520 cans per year (10 cans per week).

The methylene chloride usage in terms of grams per year is given by Equation 1.

(1) (13 oz of product per can)(520 cans/year)(28.35 grams/oz)(50% methylene chloride)

= 95,823 grams/year

With the methylene chloride usage calculated, the acute and annualized emission rates in terms of grams per second are calculated using Equations 2 and 3, respectively.

(2) Emission Rate = (95,823 grams/year)(year/520 cans)(0.25 cans/hr)(1 hr/3600 secs)

= 0.013 grams/sec

(3) Emission Rate (Annualized) = (95,823 grams/year)(year/2808)(1 hr/3600 secs)

= 0.01 grams/sec

Using the input parameters for a worst-case scenario, the estimated acute maximum 1-hour concentration at 20 meters from the center of the facility is 169.1 ug/m^3 and the estimated annualized (chronic) 1-hour concentration is 130.1 ug/m^3. It should be noted that the SCREEN3 model must be run twice; once using the acute emission rate and once using the annualized emission rate. A summary of the output from the SCREEN3 model is shown in Appendix H SCREEN3 Modeling Results for Methylene Chloride. For more information on the SCREEN3 model, please refer to the SCREEN3 model user's guide (U.S. EPA, 1995).

Since potential cancer risks and noncancer chronic health impacts require an assessment of the annual average concentration of methylene chloride, the U.S. EPA conversion factor of 0.08 (U.S. EPA, 1992) is used to estimate the maximum annual average concentration from the annualized maximum-hour concentration. In addition the maximum annual average concentration is discounted by the operating schedule for the hours the facility does not emit. The maximum annual average concentration is calculated by using Equation 4.

(4) Maximum Annual Average Concentration

= [Max. 1-hr Conc.(annualized)][Operating Schedule (hrs/yr)][1 yr/8760 hrs][0.08]

= [130.1 ug/m^3][2808 hrs/yr][1 yr/8760 hrs][0.08]

= 3.33 ug/m^3

Calculation of Potential Cancer Risk and Noncancer Acute and Chronic Hazard Indices. To determine the potential cancer risk and the noncancer acute and chronic hazard indices, we compared the modeling output with the unit risk factor (cancer) and the RELs (noncancer). The risk assessments are conducted using the Office of Environmental Health Hazard Assessment, Air Toxics Hot Spots Program Risk Assessment Guidelines (OEHHA, 1999a,b; 2000). For this scenario, we calculated the potential cancer and noncancer health impacts at a near source location of 20 meters from the center of the volume source. When compared to the acute and chronic RELs in Table VIII-4 (14,000 and 400 ug/m^3, respectively), the modeling results indicate it is unlikely for significant acute or chronic noncancer effects to result from the emissions of methylene chloride in this example as assumed in this analysis. In addition this finding is also supported by the calculated acute and chronic hazard indices, which are all below 1.0 and 0.5. The modeling results in Table VIII-4, as discussed above, are also assessed for the potential cancer risk posed by the scenario. The resulting potential 70-year maximum individual risk per million is 3.3. This is calculated by multiplying the unit risk value for methylene chloride ($1X10^{-6}$) by the maximum annual average concentration.

Summary of Potential Health Effects

The results of the analysis, as shown in Table VIII-6, shows that a worst-case scenario for an aerosol coating product containing 50 percent methylene chloride does not pose a significant risk for acute and chronic noncancer effects. However, the risk assessment analysis shows that there is a potential to increase the cancer risk if there is an increased use of an aerosol coating product containing methylene chloride, or if there is an increase in the content of methylene chloride in the aerosol coating product. Therefore, because of the potential for an increased cancer risk and because methylene chloride is already listed as a toxic air contaminant (TAC), in the proposed amendments to the Aerosol Coatings Regulation we are proposing a provision to restrict the amount of methylene chloride that can be used in an aerosol coating product. This provision is further explained in Chapter X, section E, of this Technical Support Document.

TABLE-5.
Results of SCREEN3 Modeling (Maximum Exposed Individual (MEI) at 20 meters)

Health Criteria	Worst-Case Scenario
Methylene Chloride Emission Rate (lb/day)	0.81
Max. 1-hour Concentration (ug/m^3)	169.1
Max. Annual Average Concentration (ug/m^3)	3.33
Individual Cancer Risk (per million)	3.33
Acute Hazard Index	0.012
Chronic Hazard Index	0.33

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OEHHA (1999a) Air Toxics Hot Spots Program Risk Assessment Guidelines, Part I, The Determination of Acute Reference Exposure Levels for Airborne Toxicants. Office of Environmental Health Hazard Assessment, March 1999.

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