



August 16, 2018

Ana Corado  
Office of Pollution Prevention and Toxics  
Environmental Protection Agency  
1200 Pennsylvania Avenue, NW  
Washington, DC 20460

Re: Docket No. EPA-HQ-OPPT-2016-0742

Dear Ms. Corado:

The Halogenated Solvents Industry Alliance, Inc. (HSIA) represents producers and users of methylene chloride. We offer these comments on EPA's problem formulation for the risk evaluation of methylene chloride under the Toxic Substances Control Act (TSCA), as amended by the Frank R. Lautenberg Chemical Safety for the 21<sup>st</sup> Century Act enacted in June 2016. 83 Fed. Reg. 26998 (June 11, 2018). HSIA agrees with the condition of use proposed in the problem formulation document as being appropriate for the risk evaluation and is pleased that EPA is implementing systematic review approaches in all aspects of the risk evaluation.

**I. Requirements of TSCA §§ 6 and 26**

TSCA § 6(b)(4)(F), as revised by the Lautenberg Act, requires that EPA's risk evaluations must, among other things:

- “integrate and assess available information on hazards and exposures for the conditions of use of the chemical substance, including information that is relevant to specific risks of injury to health or the environment and information on potentially exposed or susceptible subpopulations identified as relevant by the Administrator;”
- “take into account, where relevant, the likely duration, intensity, frequency, and number of exposures under the conditions of use of the chemical substance;” and
- “describe the weight of the scientific evidence for the identified hazard and exposure.”

New TSCA § 26(h) requires that, in carrying out § 6, “to the extent that the Administrator makes a decision based on science, the Administrator shall use scientific information, technical procedures, measures, methods, protocols, methodologies, or models, employed in a manner consistent with the best available science, and shall consider as applicable—

- (1) the extent to which the scientific information, technical procedures, measures, methods, protocols, methodologies, or models employed to generate the information are reasonable for and consistent with the intended use of the information;
- (2) the extent to which the information is relevant for the Administrator's use in making a decision about a chemical substance or mixture;
- (3) the degree of clarity and completeness with which the data, assumptions, methods, quality assurance, and analyses employed to generate the information are documented;
- (4) the extent to which the variability and uncertainty in the information, or in the procedures, measures, methods, protocols, methodologies, or models, are evaluated and characterized; and
- (5) the extent of independent verification or peer review of the information or of the procedures, measures, methods, protocols, methodologies, or models.”

Further, new TSCA § 26(i) provides: “The Administrator shall make decisions under sections 4, 5, and 6 based on the weight of the scientific evidence.”

More generally, the Office of Pollution Prevention and Toxics (OPPT) has released a guidance document that describes the general systemic review principles it will use to conduct risk evaluations under the amended TSCA.<sup>1</sup> As noted in its risk evaluation rule, EPA has concluded that systematic review is an integral part of a weight of the scientific evidence approach and that integrating systematic review into risk evaluations is critical to meet the statutory requirements of TSCA.<sup>2</sup> In the systematic review, HSIA supports the use of a numerical scoring system to inform the characterization of the data information sources during the data integration phase. We also see as critical the evaluation of data quality prior to incorporation of the information into the risk evaluation. OPPT's systematic review approach should provide an objective platform upon which to address ongoing controversies regarding data quality for key endpoints.

## **II. Cancer Risk Assessment**

In its IRIS assessment,<sup>3</sup> EPA classified methylene chloride as “likely to be carcinogenic in humans” based primarily on liver and lung tumors in male and female B6C3F<sub>1</sub> mice

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<sup>1</sup> EPA, Application of Systematic Review in TSCA Risk Evaluations, Office of Chemical Safety and Pollution Prevention EPA-740-P1-8001 (May 2018).

<sup>2</sup> Procedures for Chemical Risk Evaluation under the Amended Toxic Substances Control Act, 82 *Fed Reg* 33726, 33734 (July 20, 2017).

<sup>3</sup> Toxicological Review of Dichloromethane (Methylene Chloride) (CAS No. 75-09-2) in Support of Summary Information on the Integrated Risk Information System (IRIS) (2011) (“IRIS Assessment”)

(inhalation exposure) and liver tumors in male B6C3F<sub>1</sub> mice (drinking water exposure) in two-year cancer bioassays. EPA also concluded that human studies showed evidence of an association between occupational exposure to methylene chloride and brain cancer, non-Hodgkin lymphomas, and multiple myeloma. A primary concern is that EPA has not seriously addressed the well-conducted worker cohort studies that show no increase in overall cancer incidence or in the specific cancers mentioned above. EPA also interpreted the results differently from the original study authors, made findings of adverse effects that are not supported by the evidence, and applied a methodology that was not scientifically justified and led to unreasonably conservative outcomes. Moreover, the IRIS assessment used a “strength of the evidence” approach, whereas TSCA § 26(i) expressly requires “decisions under sections 4, 5, and 6 [to be] based on the weight of the scientific evidence.” Finally, new state-of-the-art science involving genomics and PBPK modeling challenge EPA’s position that methylene chloride causes cancer in the liver and lungs of laboratory mice through a mutagenic/genotoxic mode of action.

The epidemiology studies showing no clear carcinogenic effects in humans, along with the toxicokinetic and mode of action data on methylene chloride in laboratory animals and humans, support a threshold approach to estimating cancer risk for methylene chloride. This is consistent with the position of the EU Scientific Committee on Occupational Exposure Limit (SCOEL), which has classified methylene chloride as a “genotoxic carcinogen for which a practical threshold is supported.”<sup>4</sup>

A. Epidemiological evidence does not support the conclusion that methylene chloride poses a cancer risk.

The available epidemiology data base for methylene chloride is one of the most robust available for any industrial chemical. Studies of five occupational cohorts are available for the assessment of mortality effects. These include two cohorts of photographic film base manufacturing workers at an Eastman Kodak facility in New York, two cohorts of fiber production employees at plants in Maryland and South Carolina owned by Hoechst Celanese, and a cohort of fiber production workers in the United Kingdom. None of these studies shows an association between increased cancer risk and exposure to relatively high concentrations of methylene chloride.

The cohort studies have many features that make them useful for evaluating potential health effects associated with methylene chloride, including: (i) relatively large study groups with significant numbers of long-term employees; (ii) large numbers of workers with career mean and hourly exposures above currently permitted levels; and (iii) lengthy intervals between first exposure and the end of follow-up. In addition, as discussed below, the Eastman Kodak studies contain a detailed exposure characterization allowing dose-response analyses:

*“Kodak summary.* Collectively, the studies conducted on the Kodak employees exposed to methylene chloride represent one of the best sources of information on the possible human health effects of occupational methylene chloride exposure. Although the early reports did not assess individual workers' methylene chloride

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<sup>4</sup> EC [European Commission], Recommendation from the Scientific Committee on Occupational Exposure Limits for Methylene Chloride (dichloromethane), SCOEL/SUM/130 (1999).

exposure, the later updates drew on extensive exposure information. Corroborating the ambient methylene chloride exposure estimates were the biological monitoring of COHb in the blood and carbon monoxide (CO) in expired air (DiVincenzo and Kaplan 1981).

“The more recent updates also provided between 20 and 50 years of follow-up; however, no clear cancer risk or exposure-response effect has been observed. In summary, the Kodak research was well designed, thoughtfully conducted, and appropriately expanded over time. Findings were consistently negative for causes of death hypothesized to be related to methylene chloride exposure, such as ischemic heart disease and cancers of the lung and liver, as well as for any other specific cause of death. The excess of pancreatic cancer noted for the 1964-1970 cohort followed through 1984 was attenuated upon additional follow-up and was not seen in the overlapping 1946-1970 cohort (Hearne et al. 1992b).”<sup>5</sup>

Considered as a whole, the available epidemiological evidence does not indicate a cancer risk associated with occupational exposures to methylene chloride. The studies consistently demonstrate no excess mortality for all causes of death, total cancer, or the cancers that were observed in the one positive mouse bioassay – lung and liver cancers. EPA, as reflected in the 2011 IRIS Assessment, has tended to minimize the contribution of the occupational cohort studies while failing to recognize the weaknesses of the case control studies.

The epidemiology studies also do not support an association between methylene chloride exposure and brain cancer. A study referenced by EPA as "suggestive" evidence for an association between methylene chloride exposure and astrocytic brain cancer is that of Heinemann et al. (1994);<sup>6</sup> the association resulted from the exposure matrix developed by the authors that used job codes to estimate whether and to what extent the workers had been exposed to methylene chloride and five other chlorinated compounds. The bases for assigning methylene chloride exposures and the grading of the exposures are not explicit even in the paper dedicated to describing the framework of the job exposure matrix (Gomez et al., 1994),<sup>7</sup> which links a "high probability of exposure" to the occupations of painting, paint or varnish manufacture, ship or boat building and repair, and electronics manufacture. None of these occupations, however, carries a high probability of exposure to methylene chloride. These supposed high-probability occupations are also considered to involve high-intensity exposures as are those in roofing and pharmaceutical manufacture. As expressed in the publication, it appears that exposures to methylene chloride may have been grossly misclassified, which would render the marginal results uninterpretable. Put another way, as described in Norman (1996),<sup>8</sup> the problem with the

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<sup>5</sup> Dell, LD, Mundt, KA, McDonald, M, Tritschler II, JP, Mundt, DJ, Critical review of the epidemiology literature on the potential cancer risks of methylene chloride, *Int. Arch. Occup. Environ Health* 72: 429-442 (1999).

<sup>6</sup> Heineman EF, Cocco P, Gomez MR, Dosemeci M, Stewart PA, Hayes RB, Hoar Zahm S, Thomas TL, Blair A, Occupational exposure to chlorinated aliphatic hydrocarbons and risk of astrocytic brain cancer, *Am. J. Ind. Med.* 26: 155-169 (1994).

<sup>7</sup> Gomez MR, Cocco P, Dosemeci M, Stewart PA, Occupational exposure to chlorinated Aaiphatic hydrocarbons: Job Exposure Matrix, *Am. J. Ind. Med.* 26: 171-183 (1994).

<sup>8</sup> Norman, WC, Flawed estimates of methylene chloride exposures, *Am. J. Ind. Med.* 30: 504-505 (1996).

exposure matrix was that it had exactly reversed the exposure probabilities, so that workers were shown to be widely exposed to carbon tetrachloride, for example, decades after it had ceased being used. The authors acknowledged this mistake, and also acknowledged that in the absence of any direct exposure information, any findings must be interpreted cautiously (Gomez, 1996).<sup>9</sup>

In any event, a recently published comprehensive study of chlorinated solvents and brain cancer found no association between exposure to any of six chlorinated solvents, including methylene chloride, and glioma risk (Ruder *et al.*, 2013).<sup>10</sup> This study specifically referenced Heineman *et al.* (1994), among others, as follows: “Three consecutive case-control studies of glioma and other cause deaths used occupational information from death certificates, next-of-kin interview and job-exposure matrices to estimate solvent exposure with the strongest association for methylene chloride and risk of glioma with increasing probability of exposure and with increasing duration of exposure in high-exposed jobs.” “The primary hypothesis was that at least one of these chlorinated solvents would be associated with increased glioma risk.” The authors concluded, however, that:

- “In our study of exposure to six chlorinated solvents and glioma, we did not find a higher risk of glioma among solvent-exposed participants”
- “Our results suggest that exposure to chlorinated solvents does not increase the risk of glioma”
- “Study strengths include the large number of histologically confirmed gliomas and the use of population-based controls. Another strength was the estimation of workplace exposure determinants by industrial hygienists blinded to the case-control status of participants, with documented published literature to rigorously estimate intensity. . . . Most of the earlier studies of solvent exposure and brain cancer had greater limitations. Only one previous study included interviews with cases and controls. In the others, occupational information was obtained entirely from cases, from proxies [reference to Heineman *et al.*] or was based on a single occupation on a death certificate.”

In conclusion, the absence of associations in well-defined cohorts having experienced high exposures suggests that the carcinogenic hazard of methylene chloride to humans is extremely low or non-existent, as summarized in the review by Dell *et al.*:

“No strong or consistent finding for any site of cancer was apparent despite several studies of large occupational cohorts of workers potentially exposed to high concentrations of methylene chloride. Sporadic and weak associations were reported for cancers of the pancreas, liver and biliary passages, breast, and brain. Although these studies collectively cannot rule out the possibility of any cancer

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<sup>9</sup> Gomez MR, Exposure determinants needed to improve the assessment of exposure, *Am. J Ind. Med.* 29: 569-570 (1996).

<sup>10</sup> Ruder AM, Yiin JH, Waters MA, *et al.*, The upper midwest health study: gliomas and occupational exposure to chlorinated solvents, *Occup. Environ. Med.* 70: 73-80 (2013).

risk associated with methylene chloride exposure, they do support a conclusion of no substantive cancer risk.”<sup>11</sup>

B. The two-year mouse drinking water bioassays do not show an increase in liver tumors in the male mice.

EPA used a two-year drinking water study in mice on methylene chloride (Serota *et al.*, 1986)<sup>12</sup> to calculate an oral slope factor for cancer based on its reinterpretation of the results to indicate an increased incidence of liver tumors in male mice. This is unconvincing for several reasons. First, the EPA IRIS Assessment erroneously concludes that the drinking water bioassays were positive, based on the Hazelton laboratory’s statistical analysis. Both the study authors and reviewers (including EPA in its earlier assessments) have always considered these studies negative. The Hazelton report states that the incidence of hepatocellular adenomas and carcinomas in treated male mice was slightly higher than controls. It goes on to state, however, that the increase was not dose-related or statistically significant when compared to concurrent controls.

Furthermore, the incidence of the lesions in the treated males was well within the historical range of control values both at Hazelton and in the literature. As no treatment-related effects were noted for any of the other endpoints examined, the authors concluded that methylene chloride did not induce a carcinogenic response in male mice, the same conclusion reached for female mice and for rats of both sexes. The liver tumor incidence in this study was 19%, 26%, 30%, 32%, and 28% for the 0, 60, 125, 185, and 250 mg/kg-day methylene chloride dose groups. The range and mean of historical control liver tumor incidences was range 5 - 40%, mean 17.8% for the laboratory. The range of liver tumors observed in the NTP studies in control B6C3F<sub>1</sub> mice at the time of the methylene chloride study reached an even higher level (range 7 - 58%, mean 32%). EPA has adjusted the p-value for statistical significance from that used in the original study report and pairwise comparisons show that the incidences of liver tumors in the top three dose levels could be considered statistically significantly different from that of the controls. However, this cannot overcome the broader factors in the interpretation.

EPA also points to the “marginally increased trend test (p=0.058)” – this is not statistically significant despite the normal propensity for the Cochran-Armitage trend test to show statistical significance. In addition, FDA guidance for interpretation of rodent bioassay trend test analyses of common tumors (> 1% incidence) calls for use of p = 0.005 to establish statistical significance in order to avoid excessive false positive findings (FDA, 2001).<sup>13</sup> Thus, the pattern of liver tumor incidence in male mice does not show a credible dose-related pattern and the incidences for methylene chloride-dosed mice lies comfortably within the historical

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<sup>11</sup> Dell, LD, Mundt, KA, McDonald, M, Tritschler II, JP, Mundt, DJ, Critical review of the epidemiology literature on the potential cancer Risks of methylene chloride, *Int. Arch. Occup. Environ. Health* 72: 429-442 (1999).

<sup>12</sup> Serota, DG, Thakur, AK, Ulland, BM, Kirschman, JC, Brown, NM, Coors, RH, and Morgareidge, K, A two-year drinking water study of dichloromethane in rodents. II. Mice, *Fd. Chem. Toxicol.* 24: 959-963 (1986).

<sup>13</sup> FDA, Guidance for industry: statistical aspects of the design, analysis, and interpretation of chronic rodent carcinogenicity studies of pharmaceuticals, draft guidance, Center for Drug Evaluation and Research, Food and Drug Administration, U.S. Department of Health and Human Services (May 2001).

control range for the laboratory. For these reasons, we accept the interpretation of the original investigators and find that methylene chloride was not shown to induce mouse liver tumors in this study.

C. The tumors seen in the two-year inhalation bioassays are not quantitatively relevant to humans.

In the NTP two-year mouse inhalation bioassay on methylene chloride (NTP, 1986),<sup>14</sup> liver and lung tumors were seen in mice exposed to 2,000 and 4,000 ppm; lower exposure concentrations were not tested. A more recent study by Aiso *et al.* (2014)<sup>15</sup> reported liver and lung tumors in mice at 1,000, 2,000, and 4,000 ppm methylene chloride. It is important to note that the tumorigenic responses of methylene chloride in these bioassays were at exposure concentrations that are clearly above metabolic saturation of the oxidative pathway of methylene chloride, which occurs between 200 and 500 ppm in both animals and humans (AEGL, 2009).<sup>16</sup> Because of the lower affinity of the enzymes involved in the glutathione conjugation pathway for methylene chloride metabolism relative to the oxidative metabolism mediated by CYP2E1, the glutathione-pathway largely functions only under conditions of saturated oxidative metabolism. Thus, the mode of action for the mouse-specific tumors involving the glutathione conjugation pathway at very high methylene chloride exposures ( $\geq 1,000$  ppm) is not quantitatively relevant to the substantially lower human occupational and general population exposures to methylene chloride (EPA, 2018).<sup>17</sup> This problem with extrapolating toxicological data from animal studies with supra-saturating doses is pointed out by both EPA and OECD as an important consideration in the dose selection of the chronic animal bioassays. At these supra-saturating doses, the toxicokinetics become non-linear and there may be secondary high dose-specific mode(s) of action (*e.g.*, glutathione conjugate metabolism in the case of methylene chloride). Under these conditions, the results are not quantitatively relevant to realistic human exposures.<sup>18</sup>

D. Recent genomics study suggests a non-genotoxic MOA for liver and lung tumors in methylene chloride-exposed mice.

The IRIS assessment concluded that the mouse liver and lung tumors in the cancer bioassays occurred through a mutagenic mode-of-action (MOA), which is thought to involve the

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<sup>14</sup> NTP (National Toxicology Program), Toxicology and Carcinogenesis Studies of dichloromethane (Methylene Chloride) (CAS No. 75-09-2) in F344/N Rats and B6C3F<sub>1</sub> mice (Inhalation Studies), NTP-TR-306 (1986).

<sup>15</sup> Aiso, S., Take, M., Kasai, T., Senoh, H., Umeda, Y., Matsumoto, M., and Fukushima, S., Inhalation carcinogenicity of dichloromethane in rats and mice, *Inhal. Toxicol.* 26: 435-451 (2014).

<sup>16</sup> AEGL, Methylene chloride, interim acute exposure guideline levels (AEGLs), for NAS/COT Subcommittee for AEGLs (2009).

<sup>17</sup> EPA, Problem formulation of the risk evaluation for methylene chloride (dichloromethane, DCM), EPA Document# EPA 740-R1-7016, (2018).

<sup>18</sup> EPA, Guidelines for Carcinogen Risk Assessment, EPA/630/P-03/001F (2005). OECD, Guidance Document 116 on the Conduct and Design of Chronic Toxicity and Carcinogenicity Studies, Supporting Test Guidelines 451, 452 453, 2<sup>nd</sup> Edition, Series on Testing and Assessment No. 116 (2012). Bus, J.S., "The dose makes the poison": key implications for mode of action (mechanistic) research in a 21<sup>st</sup> century toxicology paradigm, *Curr. Opinion Toxicol.* 3: 87-91 (2007).

glutathione conjugation of methylene chloride to S-(chloromethyl)-glutathione by the GST-T1 isoenzyme. Recently published data suggest that a non-genotoxic MOA is much more likely. Andersen *et al.* (2017)<sup>19</sup> used reactome ontologies and bioinformatic tools to evaluate and visualize the pattern of genomic responses in the liver and lung of female B6C3F<sub>1</sub> mice following inhalation exposure to methylene chloride vapor for 13 weeks (6 hours/day, 5 days/week). The exposure concentrations were 0, 100, 500, 2,000, 3,000, and 4,000 ppm methylene chloride. A physiologically-based pharmacokinetic (PBPK) model for methylene chloride in the mouse, initially developed by Andersen *et al.* (1994)<sup>20</sup> and which includes both the conjugation and oxidation pathways, was modified to simulate the rates of methylene chloride oxidation to carbon monoxide (CO) in lung and liver and the time course of carboxyhemoglobin (HbCO) in blood.

If a genotoxic MOA through S-(chloromethyl)-glutathione is involved in methylene chloride toxicity and tumorigenicity in mice, then the predicted concentration-response of genes involved in processes expected with a genotoxic MOA would show little activity until the oxidation metabolic pathway becomes saturated at above 500 ppm and the glutathione conjugation pathway correspondingly increases in activity. However, a very different concentration-response was observed involving a very different group of genes. There were alterations of large numbers of genes at 100 ppm with maximal changes in the numbers at 500 or 2,000 ppm, mostly related to cellular metabolism and circadian clock. In contrast, there were no changes in gene expression in liver and lung in response to oxidative stress, DNA-damage/repair, glutathione synthesis, and little evidence of cell proliferation expected to be associated with formation of a DNA- and protein-reactive metabolite.

At the higher concentrations of methylene chloride, there was a consistent change in the gene expression of key components of the core circadian clock circuitry in both the liver and lung. Diurnal regulation of metabolism at the tissue and cellular level are linked to these components of the circadian clock.<sup>21</sup> The dose-response of the responses of the circadian-related genes seen in this study also coincide with the dose-response of liver and lung tumors seen in the mouse carcinogenicity studies.

These findings suggest that mouse liver and lung tumors from methylene chloride exposure do not occur from events expected for genotoxic carcinogens, but from a non-genotoxic MOA that involves hypoxia from increased levels of carboxyhemoglobin and tissue carbon monoxide. In light of these new findings, a threshold approach should be used to estimate cancer risk for methylene chloride.

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<sup>19</sup> Andersen, M.E., Black, M.B., Campbell, J.L., Pendse, S.N., Clewell, III, H.J., Pottenger, L.H., Bus, J.S., Dodd, D.E., Kemp, D.C., and McMullen, P.D. Combining transcriptomics and PBPK modeling indicates a primary role of hypoxia and altered circadian signaling in dichloromethane carcinogenicity in mouse lung and liver, *Toxicol. Appl. Pharmacol.* 332: 149-158 (2017).

<sup>20</sup> Andersen, M.E., Clewell, III, H.J., Mahle, D.A., and Gearhart, J.M., Gas uptake studies of deuterium isotope effects on dichloromethane metabolism in female B6C3F<sub>1</sub> mice in vivo, *Toxicol. Appl. Pharmacol.* 128: 158-165 (1994).

<sup>21</sup> Kosaka, A. and Bass, J., A sense of time: how molecular clocks organize metabolism, *Trend Endocrinol. Metab.* 18: 4-11 (2007).



### III. Miscellaneous

A. Assessments for worker and consumer exposure should utilize all industry provided and publicly available information.

The problem formulation document states that EPA will evaluate worker exposures to methylene chloride in the TSCA risk evaluation from data that are publicly available, *i.e.*, monitoring data from government agencies such as OSHA and NIOSH and from the published literature. It is recognized that these data may be from limited conditions of use or from out-of-date use/exposure scenarios. Thus, HSIA is submitting worker air monitoring data from methylene chloride manufacturing facilities and from facilities that use methylene chloride in their manufacturing processes (attached as Attachments 1 and 2). We encourage EPA to utilize all available industry provided and publicly available information in its analysis of the exposure assessment in the risk evaluation.

B. Methylene chloride is subject to transportation regulations by the Department of Transportation (DOT) and the Pipeline and Hazardous Materials Safety Administration (PHMSA).

Appendix A.1 of the problem formulation document lists the federal laws and regulations to which methylene chloride is subject. There are also specific transportation regulatory requirements for methylene chloride by the DOT and PHMSA; these regulations need to be added to the list of Federal Laws and Regulations in Appendix A.1. The DOT regulations provide instructions on how methylene chloride is to be transported by air, highway, rail or water. It defines the operational measures to ensure the health and safety of workers, as well as to ensure that no product is allowed to be released into the air, soil or water. PHMSA has the responsibility to maintain the hazardous material regulations.

### Conclusion

We hope that these comments will be useful to EPA as it develops the risk evaluation for methylene chloride.

Respectfully submitted,

*Faye Graul*

Faye Graul  
Executive Director

Attachments

### Attachment 1

Exposure monitoring data of workers at methylene chloride manufacturing facilities are presented in the tables below. Full shift data are listed in Tables I and III; task samples are listed in Tables II and IV.

**Table I. Worker Exposure Data (Full Shift Samples) from a Methylene Chloride Manufacturing Facility (Company A)**

<b>Exposure Group</b>	<b>Approx. Frequency/ Duration</b>	<b>Task Description</b>	<b>Sample Date</b>	<b>Sample Duration (minutes)</b>	<b>Methylene chloride (ppm)</b>
Lab technician/R&D	Full-shift	Analytical work	09/22/17	390	0.0002
Lab technician/R&D	Full-shift	Analytical work	09/27/17	390	0.0002
Lab technician/R&D	Full-shift	Analytical work	09/15/17	420	0.009
Board operator	Full-shift	Analytical work	02/22/17	430	Not detected $\leq$ 0.003
Board operator	Full-shift	General 8-hour exposure	02/22/17	430	Not detected $\leq$ 0.003
Quality assurance	Full-shift	Analytical work	02/22/17	430	0.729
Outside operator	Full-shift	Analytical work	08/22/17	430	Not detected $\leq$ 0.003
Outside operator	Full-shift	General 8-hour exposure	08/22/17	430	Not detected $\leq$ 0.003
Lab technician/R&D	Full-shift	Analytical work	09/13/17	435	0.0005
Lab technician/R&D	Full-shift	Analytical work	09/13/17	435	0.0001
Lab technician	Full-shift	General 8-hour exposure	07/25/17	480	Not detected $\leq$ 0.11
Lab technician	Full-shift	General 8-hour exposure	07/25/17	480	Not detected $\leq$ 0.11

Logical distributor operator	Full-shift	General 8-hour exposure	09/12/17	480	0.92
Logical distributor operator	Full-shift	General 8-hour exposure	09/12/17	480	0.65
Logical distributor operator	Full-shift	General 8-hour exposure	09/12/17	480	0.2
Lab technician/R&D	Full-shift	Analytical work	09/27/17	480	0.0002
Logical distributor operator	Full-shift	General 8-hour exposure	10/05/17	480	Not detected $\leq$ 0.11
Logical distributor operator	Full-shift	General 8-hour exposure	10/05/17	480	Not detected $\leq$ 0.11
Logical distributor operator	Full-shift	General 8-hour exposure	10/05/17	480	Not detected $\leq$ 0.11
Lab technician	Full-shift	General 8-hour exposure	10/16/17	480	Not detected $\leq$ 0.11
Lab technician	Full-shift	General 8-hour exposure	10/17/17	480	Not detected $\leq$ 0.11
Lab technician	Full-shift	General 8-hour exposure	11/16/17	480	Not detected $\leq$ 0.11
Lab technician	Full-shift	General 8-hour exposure	11/16/17	480	Not detected $\leq$ 0.11
Lab technician	Full-shift	General 8-hour exposure	11/27/17	480	Not detected $\leq$ 0.093
Lab technician	Full-shift	General 8-hour exposure	03/22/17	485	0.14
Operator	Full-shift	General 12-hour exposure	04/25/18	495	Not detected $\leq$ 0.11
Operator	Full-shift	General 12-hour exposure	04/25/18	506	Not detected $\leq$ 0.12
Lab technician	Full-shift	General 8-hour exposure	03/27/17	540	Not detected $\leq$ 0.098
Lab technician	Full-shift	General 8-hour exposure	03/28/17	540	Not detected $\leq$ 0.098

Lab technician	Full-shift	General 8-hour exposure	04/04/17	540	Not detected $\leq$ 0.098
Lab technician	Full-shift	General 8-hour exposure	04/04/17	540	Not detected $\leq$ 0.15
Lab technician	Full-shift	General 8-hour exposure	04/06/17	540	Not detected $\leq$ 0.098
Lab technician	Full-shift	General 8-hour exposure	11/27/17	570	Not detected $\leq$ 0.093
Operator	Full-shift	General 12-hour exposure	04/26/18	660	Not detected $\leq$ 0.11
Operator	Full-shift	General 12-hour exposure	04/26/18	660	Not detected $\leq$ 0.11
Process technician	Full-shift	General 12-hour exposure	11/13/17	720	Not detected $\leq$ 0.074
Process technician	Full-shift	General 12-hour exposure	11/13/17	720	Not detected $\leq$ 0.074
Process technician	Full-shift	General 12-hour exposure	11/14/17	720	Not detected $\leq$ 0.074
Process technician	Full-shift	General 12-hour exposure	11/14/17	720	Not detected $\leq$ 0.074
Process technician	Full-shift	General 12-hour exposure	11/30/17	720	0.17
Process technician	Full-shift	General 12-hour exposure	12/04/17	720	Not detected $\leq$ 0.074
Operator	Full-shift	General 12-hour exposure	06/12/18	720	Not detected $\leq$ 0.11
Operator	Full-shift	General 12-hour exposure	06/14/18	720	Not detected $\leq$ 0.11

**Table II. Worker Exposure Data (Task Samples) from a Methylene Chloride Manufacturing Facility (Company A)**

<b>Exposure Group</b>	<b>Task description</b>	<b>Sample Date</b>	<b>Sample Duration (minutes)</b>	<b>Methylene chloride (ppm)</b>
Distribution lab operator	Lab - analysis	05/04/18	15	Not detected $\leq$ 3.5
Distribution lab operator	Lab - analysis	05/16/18	15	Not detected $\leq$ 3.5
Distribution lab operator	Lab - analysis	05/18/18	15	Not detected $\leq$ 3.5
Distribution lab operator	Lab - analysis	05/21/18	15	Not detected $\leq$ 3.5
Outside operator	Catch samples - other	08/15/17	17	Not detected $\leq$ 3.1
Logistics distribution operator	Loading/unloading – sampling and disconnect loading hose	09/11/17	17	86
Outside operator	Lab – analysis	06/06/18	17	Not detected $\leq$ 3.1
Outside operator	Catch samples – other	08/14/17	19	Not detected $\leq$ 2.8
Outside operator	Catch samples - other	08/16/17	19	Not detected $\leq$ 2.8
Logistics distribution operator	Loading/unloading – sampling and connect loading hose	09/11/17	20	Not detected $\leq$ 2.7
Outside operator	Lab - analysis	05/23/18	22	Not detected $\leq$ 2.4
Logistics distribution operator	Loading/unloading – sampling and connect loading hose	09/12/17	35	Not detected $\leq$ 1.5
Logistics distribution operator	Loading/unloading – sampling and connect loading hose	09/11/17	50	Not detected $\leq$ 1.1
Logistics distribution operator	Loading/unloading – sampling and disconnect loading hose	09/11/17	51	4.6
Logistics distribution operator	Loading/unloading – sampling and disconnect loading hose	09/11/17	54	1.9
Machinist	Line and equipment opening	09/21/17	55	Not detected $\leq$ 0.97

**Table III. Worker Exposure Data (Full Shift Samples) from a Methylene Chloride Manufacturing Facility (Company B)**

<b>Exposure Group</b>	<b>Approximate Frequency/ Duration</b>	<b>Task Description</b>	<b>Sample Date</b>	<b>Sample Duration (minutes)</b>	<b>Methylene chloride (ppm)</b>
Tank Area	Full-Shift	Washed & drained an acid line. Loaded 2 acid cars.training, hooked up 2 railcars and hooked up a solvent trailer to air.	8/16/05	600	0.23
Tank Area	Full-Shift	Loaded a methylene chloride trailer, then loaded 2 acid trailers, training the rest of the day.	8/17/05	600	7.9
Tank Area	Full-Shift	Performed inventory on tanks and cars, performed sump inspections, buttoned up 1 HCl railcar, loaded a methylene trailer, computer training.	8/18/05	720	0.18
Tank Area	Full-Shift	Loaded and sampled 2 methyl railcars, 1 methyl trailer, 2 chloroform railcars and 1 carbon tetrachloride railcar. Unloaded 2 methanol railcars and unhooked a spent sulfuric railcar.	8/18/05	480	≥0.78
Tank Area	Full-Shift	Loaded a spent sulfuric railcar, loaded and sampled a methylene railcar, a methyl trailer, prepped for what needed loaded next week, and unloaded 2 methanol cars.	8/19/05	480	≥0.13
Tank Area	Full-Shift	Loaded 1 methyl chloride trailer, 2 chloroform cars, and unloaded a methanol trailer.	8/31/05	480	0.27
Control Lab	Full-Shift	Shot 20 GC samples, retrieved a jar of carbon tetrachloride from CLM2, and helped hook up a cylinder of methyl chloride to VCRU.	5/23/06	480	0.37
Control Lab	Full-Shift	Routine lab samples - 2 methylene, 5 chloroform, 2 carbon tetrachloride, 5 methyl chloride, 6 crude gas, 1 sulfuric and 2 mallinckrodt samples, and washed solvent bottles.	5/23/06	480	1
Control Lab	Full-Shift	Shot 14 methyl shots on GCs, paperwork, shot 6 GC shots, and went to CLM2 to pick up an empty cylinder from the previous day.	5/24/06	480	0.34

Control Lab	Full-Shift	Shot 12 samples on the GCs, some carbon tetrachloride, some chloroform and some methylene; performed 20 wet tests on methyl chloride.	5/24/06	480	0.6
Control Lab	Full-Shift	Worked on aquastar analyzer, shot 2 methylene, 3 chloroform and 4 carbon tet samples, 2 crudes and 3 methyls on GCs.	5/25/06	480	0.62
Control Lab	Full-Shift	Paperwork, shot 12 methyl shots, and 1 GC shot.	5/25/06	480	0.3
Tank Area	Full-Shift	Loaded and sampled a methyl tank car and a methyl trailer; aired out 1 each of chloroform, carbon tet, and methylene railcars to go to tank car repair; Unloaded a methanol railcar.	6/2/06	600	≥0.13
Tank Area	Full-Shift	Aired and loaded a methylene and a chloroform trailer; sampled methylene trailer 9 times and chloroform once.	6/2/06	720	3.11
Tank Area	Full-Shift	Aired, loaded and sampled 1 methylene trailer; started filling 1 acid railcar; paperwork.	6/28/06	720	0.49
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	12/5/06	720	≥0.041
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	12/5/06	720	≥0.041
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	12/5/06	720	0.549
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	12/6/06	600	≥0.041
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	12/6/06	720	0.322
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	12/6/06	720	0.742
Tank Area	Full-Shift	Resampled a methylene chloride trailer.	3/19/07	720	≥0.15

Tank Area	Full-Shift	Loaded and sampled 2 chloroform railcars and 1 methyl railcar. Drained a methylene line to prep for maintenance. Unloaded a methanol car and hooked up a methyl car to sniff.	3/19/07	480	0.98
Tank Area	Full-Shift	Loaded and sampled a chloroform and a carbon tetrachloride trailer.	3/21/07	720	0.19
Tank Area	Full-Shift	Loaded and sampled 9 methyl chloride tank cars and a chloroform railcar; hooked up 3 chloroform cars to sniff; unhooked a methylene railcar and unhooked 1 methanol railcar.	3/22/07	720	0.16
Tank Area	Full-Shift	Sniff tested ST-8 for maintenance and loaded a methyl trailer and sampled.	3/22/07	480	≥0.18
Tank Area	Full-Shift	Loaded and sampled a methylene chloride trailer.	3/22/07	720	1.3
Control Lab	Full-Shift	Performed environmental sampling - composited the deepwell samples, shot 4 trichlor samples, 1 carbon tet, 7 methylene and 1 chloroform. Shot 2 methyl chloride samples. Made a purge and trap standard using the organic mix.	5/7/07	480	0.26
Control Lab	Full-Shift	GC person at the control lab - shot 3 methyls and did wet tests. Shot and performed wet tests on 4 chloroform, 1 carbon tet and 3 methylene samples. Dumped 7 solvent jugs into the solvent for recovery tote	5/7/07	600	1.1
Control Lab	Full-Shift	Shot 12 methyl chloride samples, picked up 1 methylene chloride sample at CLM2 and shot it on the GC; ran 5 purge and trap samples; weighed out chloroform, methyl chloride, and methylene chloride to make a bottoms standard and shot it 6 times.	5/8/07	480	0.4
Control Lab	Full-Shift	Shot 17 methyl chloride shots, 1 methylene chloride, 1 chloroform, 1 carbon tetrachloride, and 2 purge and trap shots.	5/9/07	480	≥0.17
Control Lab	Full-Shift	Shot and ran wet tests on 6 chloroform, 2 methylene chloride, 2 carbon tetrachloride and 3 methyl chloride samples.	5/9/07	720	0.32



Control Lab	Full-Shift	Shot and ran wet tests on 3 chloroform, 2 carbon tetrachloride, 1 methylene, and 1 methyl chloride.	5/10/17	720	1.1
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	6/13/07	600	$\geq 0.059$
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	6/13/07	720	$\geq 0.15$
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	6/13/07	720	$\geq 0.15$
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	6/19/07	720	$\geq 0.12$
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	6/19/07	720	$\geq 0.13$
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	6/19/07	720	$\geq 0.29$
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	6/21/07	720	$\geq 0.12$
CLM2 Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	12/20/07	720	0.28
CLM2 Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	12/20/07	720	0.48
Control Lab	Full-Shift	Performed GC shots on 4 methylene chloride, 2 chloroform, 2 carbon tet and 3 bottoms GC shots; performed wet tests on methylene, chloroform, and carbon tet samples; performed analysis on a special shipment sample; ran 2 plant methyl samples and 1 shipment methyl samples.	2/26/08	720	2.2

Control Lab	Full-Shift	Performed UV/Vis and IR on a chloroform shipment; shot 2 methylene, 2 carbon tet, and 4 chloroform samples; shot a methyl chloride sample and performed wet tests on it.	2/27/08	720	0.31
Control Lab	Full-Shift	Performed GC shots on 3 methylene chloride, 2 chloroform, 2 carbon tet samples; performed GC shots and wet tests on 2 methyl chloride shipments; completed analysis on a special sample.	2/28/08	720	0.62
Drum Fill Warehouse	Full-Shift	Loaded and sampled 1 methyl trailer; loaded and sampled 2 chloroform railcars; unloaded 1 methanol railcar.	4/1/08	480	$\geq 0.14$
Drum Fill Warehouse	Full-Shift	Loaded and sampled 3 chloroform railcars; loaded and sampled a methyl chloride car; hooked up another methyl car to prep for loading; loaded a methyl trailer and sampled it; unloaded a methanol railcar.	4/2/08	480	$\geq 0.11$
Drum Fill Warehouse	Full-Shift	Loaded and sampled a carbon tetrachloride railcar; loaded and sampled an NF chloroform railcar.	4/2/08	720	0.24
Drum Fill Warehouse	Full-Shift	Loaded and sampled 2 chloroform railcars, loaded and sampled 1 methyl railcar, loaded and sampled 1 methyl trailer; offloaded 2 methanol cars.	4/17/08	720	$\geq 0.1$
Drum Fill Warehouse	Full-Shift	Loaded and sampled 3 methylene chloride trailers; sampled 1 trailer 10 times, one 2 times and the last one 1 time.	4/17/08	720	6
Tank Area	Full-Shift	Loaded acid railcars and helped prep caustic railcars for loading.	5/8/08	720	$\geq 0.1$
Drum Fill Warehouse	Full-Shift	Loaded and sampled 1 methyl chloride railcar, 1 methyl chloride trailer; loaded and sampled a chloroform railcar, unloaded a methanol railcar; loaded 12 drums of chloroform.	5/21/08	480	$\geq 0.24$
CLM2 Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	7/30/08	720	$\geq 0.011$
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample	7/30/08	720	$\geq 0.099$

		collection			
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	7/30/08	720	$\geq 0.099$
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	7/30/08	480	$\geq 0.14$
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	7/31/08	480	$\geq 0.14$
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	7/31/08	720	0.23
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	8/1/08	720	$\geq 0.1$
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	8/1/08	720	$\geq 0.1$
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	8/1/08	480	0.29
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	2/4/09	720	$\geq 0.11$
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	2/4/09	480	$\geq 0.17$
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	2/4/09	720	0.32
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	2/5/09	720	$\geq 0.11$
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	2/5/09	480	0.16
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	2/5/09	720	$\geq 0.16$
Control Lab	Full-Shift	Shot 3 carbon tet, 2 chloroform, and 4 methylene samples; ran 4 colors; ran 1 methyl process sample.	5/5/09	600	2
Control Lab	Full-Shift	Shot a T-503 bottoms sample.	5/6/09	600	$\geq 0.13$

Control Lab	Full-Shift	Shot 2 methylene, 4 chloroform, 3 carbon tet and 2 methyl; ran water and acidity on 4 samples; ran chlorides and halogens on 2 samples.	5/12/09	720	0.26
Drum Fill Warehouse	Full-Shift	Loaded 1 methyl chloride trailer, offloaded a methanol railcar; shipped a chloroform order.	11/3/09	480	0.048
Drum Fill Warehouse	Full-Shift	Vented a methyl railcar to VCRU; shipped a drum of chloroform.	11/3/09	480	≥0.076
Tank Area	Full-Shift	No solvent work performed.	11/3/09	720	0.17
Tank Area	Full-Shift	Prepped a solvent trailer for loading.	11/4/09	720	≥0.1
Drum Fill Warehouse	Full-Shift	Sampled TK11, sampled 1 chloroform drum; filled 40 chloroform drums.	11/5/09	480	≥0.079
Tank Area	Full-Shift	No solvent work performed.	11/5/09	720	0.19
Drum Fill Warehouse	Full-Shift	Prepared some drums to ship.	2/25/10	480	≥0.075
Drum Fill Warehouse	Full-Shift	Loaded and sampled 2 chloroform and 1 methylene railcar. Hooked up 1 methyl, 2 chloroform, and 1 methylene railcar. Sampled 1 chloroform and 1 methylene railcar.	2/25/10	480	1.3
Drum Fill Warehouse	Full-Shift	Hooked up a methyl railcar; unloaded and unhooked 2 methanol railcars; hooked up 2 methanol railcars; hooked up, sampled, and unhooked 1 carbon tet railcar and 2 chloroform railcars.	2/26/10	480	0.94
Tank Area	Full-Shift	Loaded 1 methylene chloride trailer; sampled methylene.	3/12/10	720	2.2
Tank Area	Full-Shift	No solvent work performed.	3/15/10	720	≥0.084
Tank Area	Full-Shift	Loaded methylene trailer and 1 chloroform trailer.	5/7/10	720	0.25
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	7/29/10	720	≥0.055
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	7/29/10	720	≥0.12
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	10/7/10	480	0.48

Control Lab	Full-Shift	Ran routine organic samples, wet tests, and GC work. Ran 3 each carbon tet, chloroform, and methylene chloride. Ran methyl sample on GC. Also ran special tests on a special sample.	10/12/10	720	0.44
Drum Fill Warehouse	Full-Shift	Drumming chloroform most of shift; drummed 40 chloroform drums, sampled 1 drum, and dumped excess to waste solvents drum.	10/12/10	480	1.4
Drum Fill Warehouse	Full-Shift	Unloaded 2 methanol railcars, topped off a methylene railcar, and vented 1 each methylene and chloroform cars; shipped 2 drum orders.	10/12/10	480	1.7
Control Lab	Full-Shift	Collected and analyzed routine solvent samples. Dumped waste jugs. Dumped retain samples into waste jugs in lab hood.	10/13/10	720	1.4
Drum Fill Warehouse	Full-Shift	Loaded/filled 40 drums of chloroform.	10/14/10	480	$\geq 0.11$
Tank Area	Full-Shift	Loaded a methyl trailer and a chloroform trailer.	11/8/10	720	$\geq 0.071$
Drum Fill Warehouse	Full-Shift	Drummed 40 drums of chloroform, helped on 2 chloroform cars, 1 methanol car, 1 methyl car and sampled drums of chloroform.	12/1/10	480	$\geq 0.11$
Drum Fill Warehouse	Full-Shift	Filled 24 drums of carbon tetrachloride.	12/21/10	480	$\geq 0.13$
Control Lab	Full-Shift	Performed GC shots and wet tests on the following samples: 7 methylene, 4 carbon tet, 4 chloroform and 3 methyl chloride.	1/19/11	720	0.57
Control Lab	Full-Shift	Shot 5 methylene samples, 5 chloroform, 4 carbon tets, 1 crude and 3 D502 samples; performed wet tests on 6 methylene, 6 chloroform, 3 carbon tets and a crude sample; performed 27 methyl GC shots and washed a few sample bottles.	1/20/11	720	0.4
Drum Fill Warehouse	Full-Shift	Loaded a methyl chloride railcar and sampled it. Unloaded and disconnected a methanol railcar. Loaded, sampled, and disconnected a methyl chloride ISO container.	5/3/11	480	$\geq 0.079$

Tank Area	Full-Shift	Aired a methylene chloride trailer.	5/3/11	720	0.19
Drum Fill Warehouse	Full-Shift	Loaded and sampled a methyl railcar and an ISO container. Loaded 2 carbon tet railcars and sampled 1. Loaded and sampled 1 methylene chloride railcar. Unloaded 2 methanol railcars and unhooked 1.	5/10/11	480	1.1
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	7/14/11	720	0.12
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	7/14/11	720	0.55
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	7/14/11	720	0.6
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	7/19/11	480	0.13
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	7/19/11	720	0.13
CLM2 Methyl Technician	Full-Shift	Performed 2 reading rounds, performed 1 sample round and changed out the D515 filter screen.	7/19/11	720	0.68
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	7/20/11	480	0.54
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	8/2/11	480	3
Drum Fill Warehouse	Full-Shift	Drummed 40 drums of carbon tetrachloride and collected 4 samples from drums.	11/30/11	480	2.1
Control Lab	Full-Shift	Analyzed methylene chloride, chloroform, and carbon tetrachloride samples. Ran UV/Vis analysis and completed GC and wet tests.	3/28/12	720	0.75
Control Lab	Full-Shift	GC shots and wet tests on methylene chloride, chloroform, carbon tet, and methyl chloride.	3/29/12	660	0.18

Drum Fill Warehouse	Full-Shift	Unloaded 1 methanol railcar; loaded and sampled 1 chloroform railcar; loaded and sampled 1 methyl chloride trailer; hooked up a methyl chloride trailer to air; hooked up methyl railcar to vent; hooked up 3 solvent railcars to vent.	4/2/12	480	0.71
Drum Fill Warehouse	Full-Shift	Sampled methyl chloride railcar; evacuated lines and disconnected methyl railcar; unloaded a methanol railcar; unloaded 2 chloroform railcars and sampled one; unloaded 1 carbon tetrachloride railcar and sampled it.	4/3/12	480	0.21
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	4/10/12	720	0.076
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	4/10/12	720	≥0.076
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	4/10/12	720	0.093
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	4/10/12	480	≥0.11
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	4/11/12	720	≥0.091
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	4/11/12	720	≥0.091
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	4/11/12	720	≥0.092
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	4/11/12	480	≥0.12
Tank Area	Full-Shift	Loaded a methylene trailer.	8/28/12	720	2.2
Tank Area	Full-Shift	Loaded a methylene trailer, sampled it, and drained the filters.	8/29/12	720	4.4
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	5/28/13	480	0.17

CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	5/28/13	720	0.6
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	5/28/13	720	3.7
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	5/29/13	720	0.087
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	5/29/13	720	0.089
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	5/29/13	480	0.2
Control Lab	Full-Shift	Special samples - UV/Vis ran; routine samples - 4 bottoms samples, 5 carbon tetrachloride samples, 2 chloroform samples, 1 methylene sample; ran 1 chloroform shipment.	6/10/13	720	≥0.08
Control Lab	Full-Shift	Special chloroform sample; methyl routine samples, methyl shipment; chloroform, methylene, and carbon tet tower samples and bottoms samples; chloroform check tank; carbon tetrachloride	6/11/13	720	≥0.078
Drum Fill Warehouse	Full-Shift	Hooked up and offloaded a methanol railcar; hooked up and loaded a methyl trailer; hooked up and loaded a carbon tet railcar; sampled both railcars that were loaded and then worked on the methyl evac rack.	11/13/13	480	≥0.11
Drum Fill Warehouse	Full-Shift	Offloaded a methanol railcar; loaded a methylene railcar; sampled methylene railcar; sealed methylene railcar; hooked up a carbon tet railcar to air; hooked up a methylene railcar to air.	11/14/13	480	2.8
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	5/27/14	720	0.076



CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	5/27/14	720	0.11
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	5/28/14	720	0.046
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	5/28/14	720	0.26
Tank Area	Full-Shift	Loaded 2 methylene trailers and drained the filters into a bucket.	6/15/15	720	12
Tank Area	Full-Shift	Sampled a trailer in the AM, then loaded a methylene trailer, and drained the filters.	6/17/15	720	0.057
Control Lab	Full-Shift	5 methyl samples, 2 methylene samples, 4 chloroform samples, 2 carbon tet samples, 3 bottoms samples, PV-530 and D502.	2/24/16	720	0.17
Drum Fill Warehouse	Full-Shift	Loaded 1 methylene and 1 chloroform trailer, 1 methyl trailer and offloaded a methanol railcar.	3/15/16	480	0.43
Drum Fill Warehouse	Full-Shift	Loaded 1 chloroform railcar and 1 methyl railcar; offloaded 1 methanol railcar.	3/16/16	480	0.15
Control Lab	Full-Shift	3 bottoms samples, 1 methyl process sample, 1 methyl shipment, 9 methylene samples, 6 chloroform samples, 6 carbon tetrachloride samples, 2 cooling tower water samples.	3/16/16	720	0.42
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	6/7/16	480	≥0.11
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	6/7/16	720	0.14
CLM2 Methyl Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	6/7/16	720	0.14
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	6/8/16	480	≥0.24
CLM2 Thermal Technician	Full-Shift	Routine rounds/filter and trap changes/equipment preparation/sample collection	6/8/16	720	2.1
Shipping Day Technician	Full-Shift	Load product/locomotive and rail activities	6/5/12	480	≥0.068

EDC Outside Equipment Technician	Full-Shift	Maintenance preparation/sample collection/perform rounds	4/12/12	720	≥0.074
EDC Outside Equipment Technician	Full-Shift	Maintenance preparation/sample collection/perform rounds	6/5/12	720	≥0.074
EDC Outside Equipment Technician	Full-Shift	Maintenance preparation/sample collection/perform rounds	10/11/12	720	≥0.075
EDC Outside Equipment Technician	Full-Shift	Maintenance preparation/sample collection/perform rounds	11/27/12	720	≥0.075
Analyzer Technician	Full-Shift	Perform maintenance on instrumentation	11/10/08	480	≥0.077
EDC Outside Equipment Technician	Full-Shift	Maintenance preparation/sample collection/perform rounds	11/8/12	720	≥0.077
Analyzer Technician	Full-Shift	Perform maintenance on instrumentation	11/5/08	480	≥0.078
Instrument Technician	Full-Shift	Perform maintenance on instrumentation	11/5/08	480	≥0.078
Instrument Technician	Full-Shift	Perform maintenance on instrumentation	11/10/08	480	≥0.078
Lab Day Technician	Full-Shift	Full-Shift - ran organic samples, doing RCL and wet test analysis. Dumped days process retains under hood.	4/14/08	480	≥0.084
Analyzer Technician	Full-Shift	Perform maintenance on instrumentation	11/4/08	480	≥0.087
Instrument Technician	Full-Shift	Perform maintenance on instrumentation	11/4/08	480	≥0.087
Electrician	Full-Shift	Full-Shift - worked on Electrical Systems on EDC reactors and compressors.	12/4/06	480	≥0.088
Electrician	Full-Shift	Full-Shift - worked all day installing heaters on the perc reactor.	11/5/08	480	≥0.089
Electrician	Full-Shift	Full-Shift - worked on monitor on F-1 deck, worked in the 230 yard in the CL2 unit.	12/5/06	480	≥0.09
Instrument Technician	Full-Shift	Perform maintenance on instrumentation	12/4/06	480	≥0.09
Analyzer Technician	Full-Shift	Perform maintenance on instrumentation	12/4/06	480	≥0.091
Analyzer Technician	Full-Shift	Perform maintenance on instrumentation	12/5/06	480	≥0.092
Instrument Technician	Full-Shift	Perform maintenance on instrumentation	12/6/06	480	≥0.092
Methanes Distillation Technician	Full-Shift	Full-Shift - made process rounds, collected process samples and check tank samples, worked the CL2 loading rack.	11/12/07	720	≥0.092

Methanes Hydrochlor Technician	Full-Shift	Full-Shift - made rounds, swapped unit check tanks, prepped jobs for maintenance and moved drums.	10/23/08	720	0.093
Analyzer Technician	Full-Shift	Perform maintenance on instrumentation	12/6/07	480	≥0.093
Instrument Technician	Full-Shift	Perform maintenance on instrumentation	12/5/06	480	≥0.093
Electrician	Full-Shift	Full-Shift - worked in the chlorine unit on electrical problems.	12/6/06	480	≥0.094
Lab Shift Technician	Full-Shift	Full-Shift - helped run organic samples. Dumped organic sample retains.	4/10/08	720	≥0.094
Methanes Hydrochlor Technician	Full-Shift	Full-Shift - made unit rounds, ran a hotwork in hydrochlor. Lined up E505 to Perc, blocked in E505 and lined up D520 to Perc. Prepped T511 for maintenance.	11/16/06	720	≥0.094
Methanes Hydrochlor Technician	Full-Shift	Full-Shift - made unit rounds, caught a ST 521B sample and prepped P-519B for maintenance.	11/27/06	720	0.095
Analyzer Technician	Full-Shift	Perform maintenance on instrumentation - worked on analyzers in the chlorine diaphragm unit and in shop.	10/1/07	480	≥0.095
Lab Day Technician	Full-Shift	Full-Shift - ran organic samples; ran wets and RCLs.	4/10/08	480	≥0.095
Methanes Day Technician	Full-Shift	Full-Shift - prepped and gave to maintenance PSV's on ST500, 501, 502, CP542 and P573A. Loaded methyl chloride truck, stopped loading methyl chloride tank car on west spot, sample a new rental tank.	10/23/08	480	≥0.095
EDC Outside Equipment Technician	Full-Shift	Maintenance preparation/sample collection/perform rounds	10/1/07	720	≥0.097
Electrician	Full-Shift	Full-Shift - worked electrical problems in the caustic unit and in the chlorine unit.	11/10/08	480	≥0.097
Instrument Technician	Full-Shift	Perform maintenance on instrumentation	10/2/07	480	≥0.097
Lab Shift Technician	Full-Shift	Full-Shift - ran organic samples, made unit rounds, dump retains from organic samples.	3/7/06	720	≥0.097
Methanes Day Technician	Full-Shift	Full-Shift - gave maintenance the PSVs on CP542 and off loaded a methyl chloride tank car on the east gate.	10/22/08	480	≥0.097
Lab Day Technician	Full-Shift	Full-Shift - helped run organic sample rounds	3/8/06	480	≥0.098

		and worked on lab instruments.			
Lab Day Technician	Full-Shift	Full-Shift - worked the 8 hr day job loading tank cars. Loaded perc and carbon tetrachloride.	4/30/08	480	$\geq 0.098$
Lab Shift Technician	Full-Shift	Full-Shift - worked in the organic section of the lab running samples all day. Made one round into the plant to pick up samples.	3/8/06	720	$\geq 0.098$
Electrician	Full-Shift	Full-Shift - worked on electrical systems in MCI unit and worked in the old MCFII unit.	10/3/07	480	$\geq 0.099$
Electrician	Full-Shift	Full-Shift - worked in the utilities F1 area, worked in the 5CP unit and in the electrical shop.	11/4/08	480	$\geq 0.099$
Instrument Technician	Full-Shift	Perform maintenance on instrumentation	10/1/07	480	$\geq 0.099$
Shipping Day Technician	Full-Shift	Load product/locomotive and rail activities	4/29/08	480	$\geq 0.099$
Shipping Shift Technician	Full-Shift	Load/unload raw materials and product/sample collection	5/5/07	720	$\geq 0.099$
Shipping Shift Technician	Full-Shift	Load/unload raw materials and product/sample collection	5/8/07	720	$\geq 0.099$
Analyzer Technician	Full-Shift	Perform maintenance on instrumentation	10/2/07	480	$\geq 0.1$
Analyzer Technician	Full-Shift	Perform maintenance on instrumentation	10/3/07	480	$\geq 0.1$
Instrument Technician	Full-Shift	Perform maintenance on instrumentation	10/3/07	480	$\geq 0.1$
Lab Day Technician	Full-Shift	Full-Shift - made and shot standards.	3/7/06	480	$\geq 0.1$
Lab Day Technician	Full-Shift	Full-Shift - ran organic samples and dumped sample retains.	4/11/08	480	$\geq 0.1$
Lab Day Technician	Full-Shift	Full-Shift - helped run organic samples most of the day. Helped with caustic samples. Dumped organic retains.	4/11/08	480	$\geq 0.1$
Lab Shift Technician	Full-Shift	Full-Shift - made rounds into the plant to pick up samples and analyzed standard organic samples.	3/9/06	720	$\geq 0.1$
Lab Shift Technician	Full-Shift	Full-Shift - worked in the environmental lab	3/9/06	720	$\geq 0.1$

		and dumped lab retains.			
Methanes Hydrochlor Technician	Full-Shift	Full-Shift - made rounds.	11/14/06	720	≥0.1
Shipping Day Technician	Full-Shift	Load product/locomotive and rail activities	5/1/08	480	≥0.1
Shipping Shift Technician	Full-Shift	Load/unload raw materials and product/sample collection	5/10/07	720	≥0.1
Lab Shift Technician	Full-Shift	Full-Shift - helped run organic samples and dumped retains.	4/14/08	720	0.11
Methanes Hydrochlor Technician	Full-Shift	Full-Shift - made standard unit rounds. Shut down T516, pumped one check tank to storage and walked jobs with maintenance.	10/22/08	720	0.11
Administration II (Process Supervisor)	Full-Shift	Full-Shift - routine supervision duties.	6/14/16	480	≥0.11
Methanes Day Technician	Full-Shift	Full-Shift - loaded two methyl chloride tank cars and loaded one methyl chloride tank truck. Disconnected all 3.	11/14/06	480	≥0.11
Methanes Day Technician	Full-Shift	Full-Shift - loaded two methyl chloride tank cars and loaded one methyl chloride tank truck. Disconnected all 3.	11/8/07	480	≥0.11
Shipping Day Technician	Full-Shift	Load product/locomotive and rail activities	4/6/06	480	≥0.11
Shipping Shift Technician	Full-Shift	Load/unload raw materials and product/sample collection	4/5/06	720	≥0.11
Shipping Shift Technician	Full-Shift	Load/unload raw materials and product/sample collection	4/5/06	720	≥0.11
Lab Shift Technician	Full-Shift	Full-Shift - made one round in plant to pick up samples. Ran organic samples all day.	5/21/07	720	≥0.12
Methanes Day Technician	Full-Shift	Full-Shift - loaded two methyl chloride tank cars and loaded one methyl chloride tank truck. Disconnected all 3.	11/16/06	480	≥0.12
Methanes Day Technician	Full-Shift	Full-Shift - loaded two methyl chloride tank cars and loaded one methyl chloride tank truck. Disconnected all 3.	11/27/06	480	≥0.12
Methanes Distillation Technician	Full-Shift	Full-Shift - made rounds, caught samples and prepped T511 for maintenance.	10/22/08	720	0.13
Methanes Distillation Technician	Full-Shift	Full-Shift - made process sample rounds, caught samples, cleaned up in unit and moved waste drums.	10/23/08	720	0.13

Methanes Hydrochlor Technician	Full-Shift	Full-Shift - made rounds, collected scheduled samples and worked with maintenance.	11/8/07	720	0.13
Lab Shift Technician	Full-Shift	Full-Shift - made one round into the plant to pick up samples. Ran organic samples all day.	5/22/07	720	≥0.13
Lab Shift Technician	Full-Shift	Full-Shift - jMade round in plant to pick up samples. Ran routine organic process samples. Dumped sample retains.	5/23/07	720	≥0.13
Methanes Day Technician	Full-Shift	Full-Shift - Loaded 3 methyl chloride tank trucks and on tank car. Caught product quality samples.	11/12/07	480	0.14
Lab Day Technician	Full-Shift	Full-Shift - Ran samples	5/21/07	480	≥0.14
Methanes Hydrochlor Technician	Full-Shift	Full-Shift - Made process rounds, collected process samples. Swaped control valves and permitted maintenance.	11/12/07	720	0.15
Lab Day Technician	Full-Shift	Full-Shift - Worked in the environmental lab and helped in the inorganic area.	5/22/07	480	≥0.15
Shipping Shift Technician	Full-Shift	Load/unload raw materials and product/sample collection	4/6/06	720	0.17
Methanes Hydrochlor Technician	Full-Shift	Full-Shift - Loaded on methyl chloride tank car. Disconnected tank cars and collected methyl chloride samples.	10/21/08	720	0.26
Methanes Day Technician	Full-Shift	Full-Shift - Loaded one methyl chloride tank car. Disconnected tank cars and collected methyl chloride samples.	11/9/07	480	0.27
Methanes Day Technician	Full-Shift	Full-Shift - Blocked tank car on the west methyl chloride loading rack, prepped PSV558-2 for maintenance, hooked up methyl tank truck, prepped PSV573A for maintenance, loaded tank truck, disconnected East/West methyl tank car spots and disconnect truck.	10/2/08	480	0.28
Methanes Distillation Technician	Full-Shift	Full-Shift - Made rounds through unit and collected scheduled samples.	11/8/07	720	0.29
Shipping Shift Technician	Full-Shift	Load/unload raw materials and product/sample collection	4/4/06	720	0.3
Shipping Shift Technician	Full-Shift	Load/unload raw materials and product/sample collection	4/6/06	720	0.3

Methanes Distillation Technician	Full-Shift	Full-Shift - made unit rounds, caught scheduled samples, collected check tank samples and pump check tanks to storage.	10/21/08	720	0.37
Shipping Shift Technician	Full-Shift	Load/unload raw materials and product/sample collection	4/4/06	720	0.37
Methanes Hydrochlor Technician	Full-Shift	Full-Shift - made unit rounds. Collected scheduled process samples and samples on 521 tanks. Got drums ready for the waste yard.	11/9/07	720	0.43
Methanes Distillation Technician	Full-Shift	Full-Shift - prepped equipment for maintenance. No open lines involved. Made 2 unit rounds and caught scheduled samples.	11/16/06	720	0.61
Methanes Distillation Technician	Full-Shift	Full-Shift - Made unit rounds. Topped out check tanks and stabilized tanks. Collect check tank samples and process samples.	11/9/07	720	0.67
Methanes Distillation Technician	Full-Shift	Full-Shift - made rounds. Sampled D554, D517C, D519C, and D517B.	11/14/06	720	0.76
Methanes Distillation Technician	Full-Shift	Full-Shift - made unit rounds, caught samples D505, T504-OH, and T505-OH. Helped day tech with methyl chloride tank cars, put the mole sieve in service and regenerated the cis-beds.	11/27/06	720	0.78
Shipping Day Technician	Full-Shift	Load product/locomotive and rail activities	5/10/07	480	0.96
Electrician	Full-Shift	Full-Shift - worked in the membrane chopper room and on the top of TK1801.	10/2/07	480	≥0.99
Shipping Shift Technician	Full-Shift	Load/unload raw materials and product/sample collection	5/14/07	720	1.2
VCRU Technician	Full-Shift	Transfer waste/Filter Changes/Trap Changes	6/8/16	480	3
Administration II (Process Supervisor)	Full-Shift	Full-Shift - routine supervision duties.	9/15/16	480	≥0.11
Shipping Day Technician	Full-Shift	Full-Shift - Loaded tank cars all day off loaded one Carbon Tetrachloride tank car. Loaded perchloroethylene tank car. Dried one methylene chloride tank car.	4/4/06	480	3.3

**Table IV. Worker Exposure Data (Task Samples) from a Methylene Chloride Manufacturing Facility (Company B)**

Exposure Group	Task Name	Approximate Frequency/Duration	Task Description	Sample Date	Sample Duration (minutes)	Methylene chloride (ppm)
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	Change D530 Filters	12/6/06	15	≥0.082
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	Change D530 Filters	12/6/06	15	>0.082
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	Change D530 Filters	12/6/06	15	≥0.088
VCRU Technician	Sample Collection	Varies / ≤ 15	Sample D517, stabilized D518	12/12/06	15	≥0.086
CLM2 Thermal Technician	Sample Collection	STEL	Sample Round	12/12/06	15	2.68
Control Lab Technician	Special Samples	Varies / ≤ 15	Special Samples	5/8/07	15	3.4
Drum Fill Loader	Sample Collection	Bi-weekly / 5 - 10	Sample Methylene Chloride Drum	6/28/08	15	1.8
Drum Fill Loader	Sample Collection	Bi-weekly / 5 - 10	Sample Methylene Chloride Drum	6/28/08	15	2
Drum Fill Loader	Sample Collection	Bi-weekly / 5 - 10	Sample Methylene Chloride Drum	6/28/08	15	4.2
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample rounds	7/31/08	15	1.2
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample rounds	8/4/08	15	6
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	Change D530 Filters	2/4/09	15	≥0.17
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	Change D530 Filters	2/5/09	15	0.16
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	Change D530 Filters	6/24/09	15	0.88
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	8/25/10	15	≥0.63
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	8/25/10	15	7.9



VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	12/22/10	15	0.75
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	12/22/10	15	0.94
Tank Area	Sample Collection	STEL	Sample Collection	5/4/11	15	49
VCRU Technician	Special Samples	Varies / $\leq 15$	Special Samples	8/2/11	15	17
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample rounds	10/17/11	15	1
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample rounds	10/18/11	15	1.3
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample rounds	10/19/11	15	2
Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	11/14/11	15	62
Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	11/14/11	15	86
Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	11/28/11	15	44
Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	11/29/11	15	30
Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	12/1/11	15	13
Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Dumping Jugs	12/1/11	15	23
Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Dumping Jugs	12/13/11	15	36
Drum Fill Loader	Sample Collection	Bi-weekly / 5 - 10	Sample Methylene Chloride Drum	12/15/11	15	36
Drum Fill Loader	Sample Collection	Bi-weekly / 5 - 10	Sample Methylene Chloride Drum	12/15/11	15	38
Drum Fill Loader	Sample Collection	Bi-weekly / 5 - 10	Sample Methylene Chloride Drum	12/15/11	15	42
Drum Fill Loader	Sample Collection	Bi-weekly / 5 - 10	Sample Methylene Chloride Drum	12/15/11	15	46

Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Dumping Jugs	12/16/11	15	40
Tank Area	Sample Collection	STEL	Sample Collection	12/17/11	15	6.1
Tank Area	Sample Collection	STEL	Sample Collection	12/19/11	15	32
Drum Fill Loader	Sample Collection	Bi-weekly / 5 - 10	Sample Methylene Chloride Drum	12/22/11	15	21
Drum Fill Loader	Sample Collection	Bi-weekly / 5 - 10	Sample Methylene Chloride Drum	12/22/11	15	25
Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Dumping Jugs	4/2/12	15	26
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	4/11/12	15	$\geq 0.12$
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	5/28/13	15	$\geq 1.8$
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	5/29/13	15	3.5
Tank Area	Sample Collection	STEL	Sample Collection	6/10/13	15	18
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	6/26/13	15	1.6
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	6/27/13	15	2.4
Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	7/24/13	15	13
Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Dumping Jugs	8/15/13	15	52
Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	8/19/13	15	29
Tank Area	Sample Collection	STEL	Sample Collection	8/20/13	15	5.1
Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Dumping Jugs	12/4/13	15	25
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	3/20/14	15	7.1

Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	5/27/14	15	≥0.61
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	6/4/14	15	0.69
Control Lab Technician	Dumping Jugs	Varies / ≤ 15	Dumping Jugs	6/16/14	15	140
Control Lab Technician	Dumping Jugs	Varies / ≤ 15	Dumping Jugs	6/25/14	15	53
Drum Fill Loader	Sample Collection	Periodically / ≤ 15	Sample Methylene Chloride Railcar	6/26/14	15	30
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	10/22/14	15	0.78
Control Lab Technician	Dumping Jugs	Varies / ≤ 15	Dumping Jugs	1/12/15	15	57
Drum Fill Loader	Sample Collection	Periodically / ≤ 15	Sample Methylene Chloride Railcar	1/27/15	15	5.3
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	1/28/15	15	≥0.49
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	2/25/15	15	4.4
Control Lab Technician	Dumping Jugs	Varies / ≤ 15	Dumping Jugs	4/17/15	15	36
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	5/28/15	15	3
Drum Fill Loader	Sample Collection	Periodically / ≤ 15	Sample Methylene Chloride Railcar	6/16/15	15	53
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	7/21/15	15	2.7
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	7/22/15	15	3.3
Drum Fill Loader	Sample Collection	Periodically / ≤ 15	Sample Methylene Chloride Railcar	8/12/15	15	5.2
Control Lab Technician	Dumping Jugs	Varies / ≤ 15	Dumping Jugs	8/17/15	15	73

Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	11/17/15	15	6.9
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	11/19/15	15	$\geq 0.38$
Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Dumping Jugs	11/20/15	15	12
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	12/2/15	15	$\geq 0.45$
Tank Area	Sample Collection	STEL	Sample Collection	2/2/16	15	17
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	3/15/16	15	$\geq 0.45$
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	3/15/16	15	35
Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	3/15/16	15	7.1
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	3/16/16	15	0.93
Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Dumping Jugs	3/31/16	15	37
Tank Area	Sample Collection	STEL	Sample Collection	5/4/16	15	3.4
Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	5/19/16	15	12
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	6/8/16	15	1.3
Control Lab Technician	Special Samples	Varies / $\leq 15$	Purged sample line into waste jug; filled 2 sample bottles, then drained sample line into waste jug.	6/28/16	17	$\geq 0.36$
Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Lab tech had jugs loaded onto a cart. he pushed the cart outside, dumped 7 jugs into the solvent for recovery tote, put empty jugs back on the cart and rolled it back into the lab.	7/11/16	15	5.4
Tank Area	Sample	STEL	Sample Collection	7/13/16	15	2.9

	Collection					
Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	8/9/16	15	$\geq 0.58$
Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	8/9/16	15	12
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Collected 0600 samples - T503 bottoms, T503 reflux, T504 bottoms, T505 bottoms, T505 after, T506 after, Trap.	8/9/16	17	9.2
Solvent Loader	Special Samples	Periodically / $\leq 15$	Connected air line to blow the load line out. disconnected load hose. connected air line to pressure up railcar. connected sampling apparatus to railcar. started purging sample line into a waste bucket. filled sample bottle and rinsed it. dumped that into a waste bucket. filled sample bottle and capped it. disconnected sampling apparatus. closed air line and finished disconnecting railcar and sealed it up.	9/8/16	15	2.6
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	Drained filter casing into a waste bucket. removed filter casing lid. scraped excess carbon into filter. pulled filter from casing and put it over a waste bucket. transferred to D530 filter satellite drum. placed a new filter in the casing and re-bolted the lid on. repeated this process for the 2nd filter casing.	9/21/16	15	2.6
Methanes Distillation Technician	Sample Collection	Monthly / 5 - 10	Collected process sample from DR-520	8/19/15	15	1
Methanes Distillation Technician	Sample Collection	Daily / 5 - 10	Collected process sample from DR-517. Open bleed sampling station.	9/20/16	15	$\geq 1.1$
Methanes Distillation Technician	Sample Collection	Daily / 5 - 10	Collected process sample from DR-503.	9/23/15	15	$\geq 1.1$

Methanes Distillation Technician	Sample Collection	Daily / 5 - 10	Collected process sample from DR-503.	10/21/15	15	≥1.1
Methanes Distillation Technician	Sample Collection	Monthly / 5 - 10	Collected process sample from DR-520. Open bleed sampling station.	6/24/15	15	≥1.2
Methanes Distillation Technician	Sample Collection	Daily / 5 - 10	Collected process sample from DR-517.	7/22/15	15	≥1.2
Methanes Distillation Technician	Sample Collection	Daily / 5 - 10	Collected process sample from DR-517. Closed loop sampling station.	9/23/15	15	≥1.2
Methanes Hydrochlor Technician	Sample Collection	Daily / 5 - 10	Collected process sample from DR-503.	7/22/15	15	≥1.2
Methanes Distillation Technician	Sample Collection	Daily / 5 - 10	Collected process sample from T-504 OH.	9/27/16	15	1.4
Methanes Distillation Technician	Sample Collection	Daily / 5 - 10	Collected process sample from DR-520.	9/27/16	15	1.4
Methanes Distillation Technician	Sample Collection	Daily / 5 - 10	Collected process sample from DR-503.	8/19/15	15	1.9
Methanes Distillation Technician	Sample Collection	Daily / 5 - 10	Collected process sample from T-504 OH.	8/19/15	15	2.5
Methanes Distillation Technician	Sample Collection	Monthly / 5 - 10	Collected process sample from DR-520.	7/22/15	15	3.3
Control Lab Technician	Special Samples	Varies / ≤ 15	Took sample bottles to Chlorine plant to sample trailer. went with chlorine plant operator to trailer. filled 2 sample bottles, after purging sample line into a waste jug. took samples and waste jug back to lab. dumped contents of waste jug into solvent for recovery tote. placed sample bottles on magnetic stirrer.	9/28/16	15	1.4
Control Lab Technician	Dumping jugs	Varies / ≤ 15	Screwed on the funnel for the solvent for recovery tote. Dumped 7 jugs into the tote. closed the funnel. unscrewed funnel from tote and capped the tote.	9/28/16	15	6.4

Drum Fill Loader	Sample Collection	Bi-weekly / 5 - 10	Sample Methylene Chloride Drum	11/16/16	15	4.7
Drum Fill Loader	Sample Collection	Bi-weekly / 5 - 10	Sample Methylene Chloride Drum	11/16/16	15	14
Drum Fill Loader	Sample Collection	Periodically / $\leq 15$	Sample Methylene Chloride Railcar	11/16/16	15	14
Solvent Loader	Special Samples	Bi-weekly / 5 - 10	Opened drum. inserted tube into drum. filled sample bottle and capped it. Sealed drum back up.	11/16/16	15	4.2
Solvent Loader	Special Samples	Bi-weekly / 5 - 10	Opened drum. inserted sample tube into drum. filled sample bottle, then sealed drum.	11/22/16	15	0.93
Solvent Loader	Special Samples	Periodically / $\leq 15$	Connected sampling apparatus to railcar. turned on air to pressure up railcar. purged sample line into a waste bucket. filled sample bottle, rinsed it into a waste bucket. filled sample bottle again and capped it. disconnected sampling apparatus and sealed up railcar.	12/1/16	17	5.5
Control Lab Technician	Special Samples	Varies / $\leq 15$	Sampled pre-cooler trailer, with the assistance of the chlorine plant operator. purged sample line into a waste jug, then filled 2 sample bottles. purged excess from sample line into waste jug and then took jug back to lab and put into the solvent for recovery tote.	12/2/16	15	4.1
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	12/28/16	15	1.8
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	12/28/16	15	3

VCRU Technician	D530 Filter Change	Weekly / 30 - 60	Blocked in filter. Drained filter casing into waste jugs from bleed valves. removed filter casing lid. removed carbon and filter from filter casing. put a new filter in. poured carbon tet from waste buckets into the filter casing. replaced the lid of the filter casing. repeated this process for 2nd filter.	12/28/16	27	12
Control Lab Technician	Special Samples	Varies / $\leq 15$	Special Samples	3/21/17	15	3
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	3/22/17	16	2.4
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	3/22/17	22	7.5
Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Dumping Jugs	3/27/17	15	7.7
Solvent Loader	Special Samples	Frequently / 5 - 10	Special Samples	3/28/17	16	2.4
Solvent Loader	Special Samples	Frequently / 5 - 10	Special Samples	6/6/17	15	9.4
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	6/7/17	15	0.51
Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Dumping Jugs	6/7/17	15	1.1
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	6/7/17	17	56
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	8/3/17	22	2.1
Control Lab Technician	Special Samples	Varies / $\leq 15$	Special Samples	8/3/17	15	1.4
Solvent Loader	Special Samples	Frequently / 5 - 10	Special Samples	9/22/17	16	0.46
Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Dumping Jugs	9/25/17	15	2.8



VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	10/11/17	15	14
Solvent Loader	Special Samples	Frequently / 5 - 10	Special Samples	12/6/17	15	0.92
Control Lab Technician	Special Samples	Varies / $\leq 15$	Special Samples	12/7/17	18	$\geq 0.3$
VCRU Technician	D530 Filter Change	Weekly / 30 - 60	D530 Filter Change	12/13/17	21	0.89
Control Lab Technician	Special Samples	Varies / $\leq 15$	Special Samples	12/16/17	15	1.9
Chloromethanes II Thermal Technician	Sample Collection	Frequently / 5 - 10	Sample Collection	12/20/17	17	2.4
Control Lab Technician	Dumping Jugs	Varies / $\leq 15$	Dumping Jugs	12/20/17	15	6.4
Solvent Loader	Special Samples	Frequently / 5 - 10	Special Samples	12/20/17	15	1.6
Solvent Loader	Special Samples	Frequently / 5 - 10	Special Samples	12/20/17	15	0.96

## Attachment 2

Exposure data of workers from facilities that use methylene chloride are presented in the tables below. Table I lists worker exposure data from a facility that uses methylene chloride as a feedstock in the production of fluorochemicals. Tables II and III lists worker exposure data from a facility that uses methylene chloride as a carrier solvent in plastic materials and resin manufacturing (polycarbonates).

**Table I. Methylene Chloride Worker Exposure Data from a Fluorochemicals Manufacturing Facility (Company C)**

Exposure Group	Task description	Comments	Sample Date	Sample Duration (minutes)	Methylene Chloride (ppm)
Maintenance	Removal of tube bundle 3A-249 previously containing methylene chloride	PPE: Respirator worn (3M Tyvek supplied air hood); guardian acid jacket	06/15/17	-	0.067
Maintenance	Insulation removal from piping previously containing methylene chloride	PPE: Respirator worn (3M Tyvek supplied air hood); guardian acid jacket	06/15/17	-	0.068
Maintenance	Starting methylene chloride compressor unit	PPE: Hyflex 11-600 gloves	06/15/17	-	< detection limit
Chemical operator	Prep of methylene chloride cooler pumps for maintenance 3A-617 and 3A-616	PPE: guardian acid jacket	06/15/17	-	< detection limit
Chemical operator	Prep of methylene chloride cooler pumps for maintenance 3A-617 and 3A-616	PPE: guardian acid jacket and Ansell Scorpio 08-352 gloves	06/15/17	-	4
Chemical operator	Sampling of methylene chloride system RS-510	PPE: guardian acid jacket and Ansell Scorpio 08-352 gloves	06/15/17	-	1.5
Chemical operator	Normal plant operations	PPE: guardian acid jacket and Ansell Scorpio 08-352 gloves	06/15/17	-	< detection limit
Laboratory technician	Normal laboratory operations	Safety Professionals, Inc. sampling pumps	09/30/15	420	< 0.35
Laboratory technician	Normal laboratory operations	Safety Professionals, Inc. sampling pumps	09/30/15	639	< 2.56
Maintenance	Normal plant operations	Methylene chloride sampling badge, modified OSHA 7 method	04/13/10	450	0.29

Chemical operator	Normal plant operations	ATC IH services, sampling pumps, Modified OSHA 59 method.	03/11/10	654	< 0.47
Chemical operator	Normal plant operations	ATC IH services, sampling pumps, Modified OSHA 59 method.	03/11/10	649	< 0.47
Chemical operator	Normal plant operations	ATC IH services, sampling pumps, Modified OSHA 59 method.	03/11/10	638	< 0.48
Chemical operator	Normal plant operations	Respirator worn (3M Tyvek supplied air hood	03/05/10	241	2.5
Chemical operator	Normal plant operations	AT Labs vapor badge.	03/05/10	384	0.89
Chemical operator	Area 1 <sup>st</sup> floor area 3	Area sample. AT Labs vapor badge.	03/05/10	416	0.096
Chemical operator	Area 2 <sup>nd</sup> floor CR	Area sample. AT Labs vapor badge.	03/05/10	472	0.57
Chemical operator	Area 3 <sup>rd</sup> floor RS-510	Area sample. AT Labs vapor badge.	03/05/10	470	0.36
Chemical operator	Area Door W-4	Area sample. AT Labs vapor badge.	03/05/10	487	ND

**Table II. Methylene chloride Worker Exposure Data (Full Shift Samples) from a Plastics Material and Resin Manufacturing Facility (Company D)**

Exposure Group	Application	Sampling Date	Sample Duration (minutes)	Methylene chloride (ppm)	
				Total	TWA*
Production technician	Plastics material and resin manufacturing	2015	478	1.00113	1.50170
Production technician	Plastics material and resin manufacturing	2015	491	1.00054	1.50082
Production technician	Plastics material and resin manufacturing	2015	479	4.90244	7.35366
Production technician	Plastics material and resin manufacturing	2015	486	6.12571	9.18857
Production technician	Plastics material and resin manufacturing	2015	480	0.93366	1.40049
Production technician	Plastics material and resin manufacturing	2014	551	1.39235	2.08852
Production technician	Plastics material and resin manufacturing	2014	534	0.71122	1.06684
Production technician	Plastics material and resin manufacturing	2014	539	0.70463	1.05694
Production technician	Plastics material and resin manufacturing	2014	547	1.33310	1.99965
Production technician	Plastics material and resin manufacturing	2014	539	0.74691	1.12036
Production technician	Plastics material and resin manufacturing	2014	539	0.70463	1.05694
Production technician	Plastics material and resin manufacturing	2014	527	2.86828	4.30241
Production technician	Plastics material and resin manufacturing	2014	553	25.74086	38.61128
Production technician	Plastics material and resin manufacturing	2014	555	3.13416	4.70124
Production technician	Plastics material and resin manufacturing	2014	550	1.47775	2.21662
Production technician	Plastics material and resin manufacturing	2014	538	3.89678	5.84516

Production technician	Plastics material and resin manufacturing	2014	538	2.18841	3.28261
Production technician	Plastics material and resin manufacturing	2014	544	2.45749	3.68624
Production technician	Plastics material and resin manufacturing	2014	552	0.97701	1.46551
Production technician	Plastics material and resin manufacturing	2014	547	3.29109	4.93663

\*Time-weight average. Airborne concentration of methylene chloride is averaged over the sampling period, taking into account the average levels of the substance and the time spent in a particular area or a particular task.

**Table III. Methylene chloride Worker Exposure Data (Short-term Samples) from a Plastics Material and Resin Manufacturing Facility (Company D)**

Exposure Group	Application	Sampling Date	Sample Duration (minutes)	Results (ppm)
Operator	Plastics material and resin manufacturing	2015	13	29.38
Operator	Plastics material and resin manufacturing	2015	18	21.17
Operator	Plastics material and resin manufacturing	2015	14	27.16
Operator	Plastics material and resin manufacturing	2015	20	18.94
Operator	Plastics material and resin manufacturing	2015	20	18.94
Operator	Plastics material and resin manufacturing	2015	22	17.34
Operator	Plastics material and resin manufacturing	2015	10	37.88
Operator	Plastics material and resin manufacturing	2015	20	18.94
Operator	Plastics material and resin manufacturing	2015	13	29.38

Operator	Plastics material and resin manufacturing	2015	8	47.98
Operator	Plastics material and resin manufacturing	2015	12	31.99
Operator	Plastics material and resin manufacturing	2015	15	23.99
Product technician	Plastics material and resin manufacturing	2015	11	34.52
Product technician	Plastics material and resin manufacturing	2015	19	19.99
Product technician	Plastics material and resin manufacturing	2015	16	23.74
Product technician	Plastics material and resin manufacturing	2015	21	18.09
Product technician	Plastics material and resin manufacturing	2014	15	25.32
Product technician	Plastics material and resin manufacturing	2014	16	23.74
Product technician	Plastics material and resin manufacturing	2014	13	29.21
Product technician	Plastics material and resin manufacturing	2014	12	31.65
Product technician	Plastics material and resin manufacturing	2014	26	14.61