



Byproducts Assessment for 1,2-Dichloroethane

Technical Support Document for the Risk Evaluation

CASRN 107-06-2



April 2026

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KEY ABBREVIATIONS AND ACRONYMS

7Q10	Lowest 7-day average flow that occurs (on average) once every 10 years
30Q5	Lowest 30-day average flow that occurs (on average) once every 5 years
AC	Acute concentration
AAC	Annual Average Air Concentration ($\mu\text{g}/\text{m}^3$)
AAD	Acute absorbed dose
AADR	Acute absorbed dose rate
ADAF	Age dependent adjustment factor
ADC	Average daily concentration
ADC _{intermediate}	Intermediate average daily concentration
ADD	Average daily dose
ADR	Acute dose rate
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
APF	Assigned protection factor
BLS	Bureau of Labor Statistics (U.S.)
CASRN	Chemical Abstracts Service Registry Number
CDR	Chemical Data Reporting
CFR	Code of Federal Regulations
ChV	Chronic value
CI	Confidence interval

COC	Concentration of concern
COU	Condition of use
CAD	Chronic absorbed dose
CSF	Cancer slope factor
DEVL	Dermal Exposure to Volatile Liquids Model
DMR	Discharge Monitoring Report
ECETOC TRA	Ecotoxicology and Toxicology of Chemicals Targeted Risk Assessment
ECx	Effect concentration at which x% of test organisms exhibit an effect
EHS	Environment, health, and safety
EPA	Environmental Protection Agency (U.S.)
HC05	Hazardous concentration for 5% of species
HEC	Human equivalent concentration
HED	Human equivalent dose
HEM	Human Exposure Model
IAD	Intermediate absorbed dose
IIOAC	Integrated Indoor-Outdoor Air Calculator
ISO	International Standard Organization
IUR	Inhalation Unit Risk
LADC	Lifetime average daily concentration
LCAD	Lifetime chronic absorbed dose
LCx	Lethal concentration at which x% of test organisms die
LDAR	Leak Detection and Repair
LOEL	Lowest-observed-effect level
NAICS	North American Industry Classification System
MLD	Million liters per day
MOE	Margin of exposure
NAICS	North American Industry Classification System
NEI	National Emissions Inventory
NIOSH	National Institute for Occupational Safety and Health
NPDES	National Pollutant Discharge Elimination System
OCSPP	Office of Chemical Safety and Pollution Prevention (EPA)
OEL	Occupational exposure limit
OES	Occupational exposure scenario
ONU	Occupational non-user
OPPT	Office of Pollution Prevention and Toxics (EPA)
OSHA	Occupational Safety and Health Administration (U.S.)
PBZ	Personal breathing zone
POD	Point of departure
POTW	Publicly owned treatment works
PPE	Personal protective equipment
PV	Production volume
RQ	Risk quotient
SAR	Supplied-air respirator
SCBA	Self-contained breathing apparatus
SEG	Similar exposure group
SOP	Standard operating procedure
SSD	Species sensitivity distribution
STEL	Short-term exposure limit
TRI	Toxics Release Inventory

TRV	Toxicity Reference Value
TSCA	Toxic Substances Control Act
TSD	Technical support document
TWA	Time-weighted average
U.S.	United States
WWT	Wastewater treatment

SUMMARY

This technical support document (TSD) provides details on releases, exposure, and associated risks of the five assessed byproducts produced during the manufacture of 1,2-dichloroethane and supports the *Risk Evaluation for 1,2-Dichloroethane* (also called the “1,2-dichloroethane risk evaluation” or “risk evaluation”) ([U.S. EPA, 2026k](#)). The production of chlorinated solvents 1,1-dichloroethane (CASRN 75-34-3), trichloroethylene (CASRN 79-01-6), perchloroethylene (CASRN 127-18-4), methylene chloride (CASRN 75-09-2), and carbon tetrachloride (CASRN 56-23-5) as byproducts during the manufacture of 1,2-dichloroethane are included in the risk evaluation. It does not include the manufacture of [1,1,2-trichloroethane](#) (CASRN 79-00-5) and [trans-1,2-dichloroethylene](#) (CASRN 156-60-5) byproducts because those exposures will be assessed in separate Toxic Substances Control Act (TSCA) risk evaluations. In this TSD and the 1,2-dichloroethane risk evaluation, the five byproducts that the U.S. Environmental Protection Agency (EPA or the Agency) is evaluating are collectively referred to as “the byproducts.” This TSD utilizes existing and previously peer-reviewed information when assessing these byproducts. Although the risk estimates of the assessed byproducts are provided in this TSD, environmental and human health risk characterizations are detailed in Sections 4.3 and 5.3 of the 1,2-dichloroethane risk evaluation ([U.S. EPA, 2026k](#)).

Approach

EPA used existing and previously peer-reviewed methodologies and assumptions to estimate inhalation and dermal occupational exposures associated with each byproduct (Section 4.1.1). For acute, intermediate, and chronic inhalation exposures, personal breathing zone (PBZ) monitoring data obtained through test orders were used.¹ Specifically for 1,1-dichloroethane, the Agency used inhalation monitoring data submitted in response to a test order that measured 1,1-dichloroethane inhalation exposures during 1,2-dichloroethane manufacturing. For the other four assessed byproducts—trichloroethylene, perchloroethylene, methylene chloride, and carbon tetrachloride—EPA applied surrogate inhalation monitoring data from the 1,2-dichloroethane test order. This approach follows the methodology outlined in the *Risk Evaluation for 1,2-Dichloroethane* ([U.S. EPA, 2026k](#)). Dermal exposures were modeled using the Dermal Exposure to Volatile Liquids Model, consistent with the *Risk Evaluation for 1,1-Dichloroethane* ([U.S. EPA, 2025a](#)) and based on values and assumptions from previously published chemical-specific risk evaluations (listed in Section 1.2). EPA assessed dermal exposures to unpurified 1,2-dichloroethane (considered a low-end exposure estimate due to lower concentrations of the byproducts in the process stream) as well as light- and heavy-end liquid streams (considered a high-end exposure estimate due to higher concentrations of the byproducts in the process stream). These concentration estimates were provided by the Vinyl Institute (see Table 4-9). The exposure estimates were then used to assess occupational risk for each of the assessed byproducts (see Section 6.1).

¹ TSCA section 4(a)(2)(A)(i) allows the EPA to impose testing requirements via “rule, order, or consent agreement” whenever new information “is necessary” in order to perform a risk evaluation (15 U.S.C. 2603(a)(2)(A)(i)). The Agency issued a test order for 1,2-dichloroethane on January 14, 2021; see https://www.epa.gov/sites/default/files/2021-01/documents/tsca_section_4a2_order_for_12-dichloroethane_on_ecotoxicity_and_occupational_exposure_0.pdf (accessed October 21, 2025)([Stantec ChemRisk, 2024](#)). EPA also received inhalation monitoring data from the test order submission for 1,1-dichloroethane manufactured as a byproduct in the manufacture of 1,2-dichloroethane ([Stantec ChemRisk, 2023](#)).

EPA used 1,2-dichloroethane reported release data obtained from the Toxic Release Inventory (TRI)² and Discharge Monitoring Report (DMR) databases, in conjunction with concentrations of byproducts in the 1,2-dichloroethane product streams provided by industry in several public comments, to quantitatively estimate the environmental releases for each assessed byproduct for the 1,2-dichloroethane Manufacturing condition of use (COU) under TSCA (Section 2.1.2). To determine expected exposures and associated risks from byproducts to the general population, estimated environmental releases for each assessed byproduct were compared to reported releases for the Manufacturing COU in the previously published chemical-specific risk evaluations as well as the *Draft TSCA Screening Level Approach for Assessing Ambient Air and Water Exposures to Fenceline Communities*³ and fenceline TSD for each chemical (also collectively called the “fenceline analyses”; see Section 1.2 for a list of the support documents). To further refine this assessment, EPA also used these estimated environmental releases of byproducts (Section 2.1.2) to model inhalation exposures to the general population residing in the vicinity of 1,2-dichloroethane manufacturing facilities using the Human Exposure Model (HEM).

Through the National Pollutant Discharge Elimination System (NPDES), EPA identified one facility that manufactures and releases 1,2-dichloroethane and assessed byproducts as evidence of possible concurrent byproduct formation and release. The Agency assessed each of the estimated byproduct chemical releases, assuming the same percentages within the purified process stream also occur in the facility’s wastewater prior to treatment. Wastewater treatment efficiency for each byproduct was applied before estimating the amount of byproducts discharge to the receiving water body. The estimated byproduct concentrations in the receiving water body were used to assess aquatic species (environmental) exposures. In addition, byproduct concentrations in the receiving water body were used to estimate general population exposures through ingestion of fish caught in the receiving water body as well as incidental oral and dermal exposures through swimming in the same water body. EPA conducted a screening assessment for drinking water exposures and confirmed that exposures to infants drinking water in formula did not result in risks below the benchmark range of 1×10^{-6} to 1×10^{-4} .

Risk to terrestrial species was assessed based on the prior risk evaluations for the byproducts and the physical and chemical and fate properties of each chemical.

Conclusions

Estimated releases of each of the assessed chlorinated solvent byproducts are significantly lower compared to their reported releases for the Manufacturing COU in the corresponding final risk evaluations and fenceline analyses. As shown in Table S-1, all inhalation or dermal risk estimates were above Agency non-cancer benchmarks and below Agency cancer estimates for 1,1-dichloroethane, perchloroethylene, or methylene chloride for workers and occupational non-users (ONUs⁴). Trichloroethylene presents chronic, non-cancer inhalation risk for operators and laboratory technicians at high-end exposures. Carbon tetrachloride presents chronic, non-cancer inhalation risk below applicable benchmarks for operators at both central tendency and high-end exposures, as well as for

² In response to public comments, EPA updated TRI release data from 2021 to 2024 for the final risk evaluation, including the TRI release information used in this byproducts assessment. EPA used NEI data in combination with CDR, TRI, and DMR data to determine the number of facilities and the operating days for the 1,2-Dichloroethane Manufacturing COU, as discussed in Section 2.1.1. However, EPA did not consider NEI data to estimate exposures and associated risks when evaluating byproducts; the Agency used TRI and DMR releases to quantitatively estimate the environmental releases for each assessed byproduct for the 1,2-Dichloroethane Manufacturing COU and the associated exposures and associated risks.

³ Available at https://www.epa.gov/system/files/documents/2022-01/draft-fenceline-report_sacc.pdf (accessed April 24, 2026).

⁴ ONUs do not directly handle chemicals but may be indirectly exposed to them in the workplace as part of their employment.

maintenance technicians, laboratory technicians, and ONUs at high-end exposures. Carbon tetrachloride presents chronic, cancer inhalation risk above benchmarks for operators, maintenance technicians, laboratory technicians, and ONUs at central tendency and high-end exposures, and for logistics technicians at high-end exposures. For dermal exposures, carbon tetrachloride presents cancer risk for workers at central tendency exposures. As described in Section 4.1.1.1 (and Footnote 4), because ONUs do not directly handle chemicals they are expected to have lower dermal exposures through contact with liquids or solids. No occupational risks were identified for other byproduct chemicals (Section 6.1.1).

Table S-1. Summary of Risk Estimates for Byproducts for Workers and ONUs

Summary of Risk Estimates for Byproducts for Workers and ONUs		
Byproduct	Inhalation	Dermal
Acute, non-cancer exposure estimates		
1,1-Dichloroethane	All risk estimates above benchmark, indicating no unreasonable risk	
Trichloroethylene		
Perchloroethylene		
Methylene chloride		
Carbon tetrachloride		
Intermediate, non-cancer		
1,1-Dichloroethane	All risk estimates above benchmark, indicating no unreasonable risk	
Trichloroethylene		
Perchloroethylene		
Methylene chloride		
Carbon tetrachloride		
Chronic, non-cancer		
1,1-Dichloroethane	All risk estimates above benchmark, indicating no unreasonable risk	All risk estimates above benchmark, indicating no unreasonable risk
Trichloroethylene	High-end worker estimates (operator and laboratory technician SEGs) below benchmarks	
Perchloroethylene	All risk estimates above benchmark, indicating no unreasonable risk	
Methylene chloride	All risk estimates above benchmark, indicating no unreasonable risk	
Carbon tetrachloride	Central tendency and high-end worker risk estimates (operator SEG) below benchmarks	
Chronic, cancer		
1,1-Dichloroethane	All risk estimates below cancer benchmark, indicating no unreasonable risk	
Trichloroethylene		
Perchloroethylene		
Methylene chloride		
Carbon tetrachloride	Central tendency and high-end worker (operator, maintenance technician, laboratory technician SEGs) and ONU risk estimates below benchmarks	Central tendency estimates below benchmarks; high-end not assessed
ONU = occupational non-user; SEG = similar exposure group		

No non-cancer margin of exposure (MOE) estimates below benchmark and no cancer estimates above benchmark are expected for the general population from releases to air, water, and land from the assessed byproducts, as discussed in Section 6.2. Exposure is not expected to exceed hazard benchmarks for aquatic or terrestrial species from releases to air, water, and land from the assessed byproducts, as discussed in Section 3.3.

1 INTRODUCTION

1.1 Overview

1,2-Dichloroethane (CASRN 107-06-2) is a high-priority chemical undergoing risk evaluation under Toxic Substances Control Act (TSCA) for existing chemicals as amended by the 2016 Frank R. Lautenberg Chemical Safety for the 21st Century Act. Also known as ethylene dichloride, the chlorinated solvent 1,2-dichloroethane is a colorless, oily liquid with a chloroform-like odor. It is soluble in water and is miscible in most organic solvents. 1,2-Dichloroethane is a volatile, synthetic chemical that is used primarily in the synthesis of vinyl chloride. It is included in the TSCA Inventory reported under the Chemical Data Reporting (CDR) rule and has a total, non-confidential production volume (PV) in the United States between 30 to 40 billion pounds (lb) annually per the 2020 CDR reporting period ([U.S. EPA, 2026k](#)).

For the 1,2-dichloroethane risk evaluation, the Domestic manufacture COU addresses manufacturing or production of 1,2-dichloroethane within the United States, including manufacturing of 1,2-dichloroethane as a byproduct. The Domestic manufacture COU covers both intentional manufacturing of 1,2-dichloroethane and unintentional manufacturing where 1,2-dichloroethane is produced as a byproduct during another chemical process (see *Release Assessment for 1,2-Dichloroethane* ([U.S. EPA, 2026f](#))). At a typical manufacturing facility, 1,2-dichloroethane can be manufactured by the vapor- or liquid-phase chlorination of ethylene.

Byproducts can also be formed during the manufacture of 1,2-dichloroethane. For the purposes of the 1,2-dichloroethane risk evaluation, these chlorinated solvent byproducts include 1,1-dichloroethane (CASRN 75-34-3), trichloroethylene (CASRN 79-01-6), perchloroethylene (CASRN 127-18-4), methylene chloride (CASRN 75-09-2), and carbon tetrachloride (CASRN 56-23-5) manufactured during the 1,2-dichloroethane Manufacturing COU. Note that the risk evaluation does not include the manufacture of 1,1,2-trichloroethane (CASRN 79-00-5) and *trans*-1,2-dichloroethylene (CASRN 156-60-5). Although these chemicals are also byproducts produced during the manufacture of 1,2-dichloroethane, EPA has decided that those exposures will be assessed in forthcoming, separate risk evaluations for 1,1,2-trichloroethane and *trans*-1,2-dichloroethylene, respectively.⁵ In this TSD and the 1,2-dichloroethane risk evaluation, the five byproducts EPA evaluated are collectively referred to as “the byproducts.” In this TSD, the Domestic manufacture COU is the only COU addressing production of byproducts.

EPA previously announced in the *Final Scope of the Risk Evaluation for 1,2-Dichloroethane; CASRN 107-06-2* (also referred to as the “final scope document” or “final scope”) ([U.S. EPA, 2020f](#))—and in several of the finalized risk evaluations for the byproducts—that risks from the manufacture of these other chemicals as byproducts during the manufacture of 1,2-dichloroethane will be assessed as part of the 1,2-dichloroethane risk evaluation. This TSD presents the analysis of these byproducts.

1.2 Byproducts Assessment Scope

This TSD evaluates exposures and associated risks to the assessed byproducts to (1) workers via inhalation and dermal routes; (2) the general population residing in the vicinity of 1,2-dichloroethane manufacturing facilities, via inhalation, oral, and dermal routes; and (3) aquatic and terrestrial ecological receptors. This TSD uses physical and chemical properties and fate data, environmental and human

⁵ Hazards values for both chemicals are still under review and will be part of the forthcoming, separate draft risk evaluations.

health hazard data, as well as data such as releases from the following EPA risk evaluations and related documents:

- *Chemistry, Fate, and Transport Assessment for 1,2-Dichloroethane* ([U.S. EPA, 2026d](#))
- *Release Assessment for 1,2-Dichloroethane* ([U.S. EPA, 2026f](#))
- *Risk Evaluation for 1,1-Dichloroethane* ([U.S. EPA, 2025a](#))
- *Risk Evaluation for Carbon Tetrachloride* ([U.S. EPA, 2020g](#))
- *Risk Evaluation for Methylene Chloride* ([U.S. EPA, 2020h](#))
- *Risk Evaluation for Perchloroethylene* ([U.S. EPA, 2020i](#))
- *Risk Evaluation for Trichloroethylene* ([U.S. EPA, 2020j](#))
- *Carbon Tetrachloride: Fenceline Technical Support – Ambient Air Pathway* ([U.S. EPA, 2022a](#))
- *Carbon Tetrachloride: Fenceline Technical Support – Water Pathway* ([U.S. EPA, 2022b](#))
- *Methylene Chloride: TRI Release Data Sensitivity Analysis* ([U.S. EPA, 2022d](#))
- *Methylene Chloride: Fenceline Technical Support – Water Pathway* ([U.S. EPA, 2022c](#))
- *Perchloroethylene: Fenceline Technical Support – Air Pathway* ([U.S. EPA, 2022e](#))
- *Perchloroethylene: Fenceline Technical Support – Water Pathway* ([U.S. EPA, 2022f](#))
- *Trichloroethylene (TCE): Fenceline Technical Support – Ambient Air Pathway* ([U.S. EPA, 2022g](#))
- *Trichloroethylene: Fenceline Technical Support – Water Pathway* ([U.S. EPA, 2022h](#)).

In this TSD, EPA quantitatively estimates environmental releases to air and water associated with the assessed byproducts and compares these estimates to the reported release ranges for the Manufacturing COU in the previously published fenceline analyses (see preceding list). The Agency acknowledges that releases of assessed byproducts evaluated herein were excluded from the scopes of the final risk evaluations for these byproducts themselves and that not all 1,2-dichloroethane manufacturing facilities were included in the fenceline modeling. Among the fenceline TSDs, only *Carbon Tetrachloride: Fenceline Technical Support – Ambient Air Pathway* ([U.S. EPA, 2022a](#)) reports ambient air releases explicitly labeled as “byproducts”; however, it is unclear whether these reported releases are solely from the 1,2-dichloroethane Manufacturing COU as there may be other chemical processes that produce carbon tetrachloride as a byproduct. In this TSD, EPA did a refined full analysis using HEM and the estimated exposure and associated risks aligned with fenceline results for facilities reporting releases of carbon tetrachloride as a byproduct.

1.2.1 1,2-Dichloroethane Manufacturing COU Process Description

1,2-Dichloroethane may be produced by the vapor-phase chlorination of ethylene (oxychlorination) or by the liquid-phase chlorination of ethylene (direct chlorination) ([Reed, 2000](#); [Carroll et al., 1998](#); [NTP, 1991](#); [UNEP, 1988](#); [NIOSH, 1976](#)). In practice, both methods are often applied in tandem in manufacturing facilities as part of an integrated balanced process ([Stantec ChemRisk, 2024](#)).

The process begins with the reaction feedstocks, oxygen, ethylene and chlorine transferred to the reactor (see Figure 1-1). Reaction to form 1,2-dichloroethane occurs via either the oxychlorination or direct chlorination processes. In addition to producing the product 1,2-dichloroethane, several chemicals are also formed as byproducts, primarily during the oxychlorination process ([EPA-HQ-OPPT-2018-0421-0027](#)). The 1,2-dichloroethane reaction product is then purified by removing the byproducts from the finished 1,2-dichloroethane product via a separation process using different boiling points of the chemicals (distillation). There are three liquid product streams generated from the purification process: (1) the purified 1,2-dichloroethane product stream, (2) the “light-ends” byproducts stream, and (3) the “heavy-ends” byproducts stream. The purified 1,2-dichloroethane product stream, close to 100% 1,2-dichloroethane, is then transferred to storage and from there distributed in commerce or processed as a

reactant most often to produce vinyl chloride. Trace amounts of the byproducts can still be present within the purified 1,2-dichloroethane product stream and final 1,2-dichloroethane products ([EPA-HQ-OPPT-2018-0421-0027](#); [EPA-HQ-OPPT-2018-0427-0026](#)). See Table 1-1 for more details on stream concentrations. Light-ends liquid streams are the more volatile fractions in the mixture. Heavy-ends liquid streams are the less volatile, higher boiling point fractions. The percentage of byproducts found in both the light- and heavy-ends liquid streams might vary depending on the specific configuration of the oxychlorination unit, including differences in the catalyst type, operating pressures and temperatures, air or oxygen feed, and purification tower design ([EPA-HQ-OPPT-2018-0421-0027](#)).

Once separated from purified 1,2-dichloroethane, most facilities process the light- and heavy-ends liquid byproduct streams as a reactant to produce hydrochloric acid (HCl) in HCl furnaces or dispose of the byproduct streams, including in an incinerator or thermal oxidizer. EPA notes that any processing of the byproducts streams is not addressed in this TSD. The byproduct streams may also be processed as reactants in co-located perchloroethylene units, disposed of by thermal oxidation, or processed as reactants in the Catoxid process to manufacture anhydrous HCl, which is processed as a feedstock for the oxychlorination process. If co-located with another organochloride production unit, heavy-ends may be processed as a feedstock in units designed to produce commercial 1,1,2-trichloroethane. 1,2-Dichloroethane and vinyl chloride manufacturing processes often occur in integrated facilities designed with balanced processes that allow for efficient recovery and further processing of byproducts.

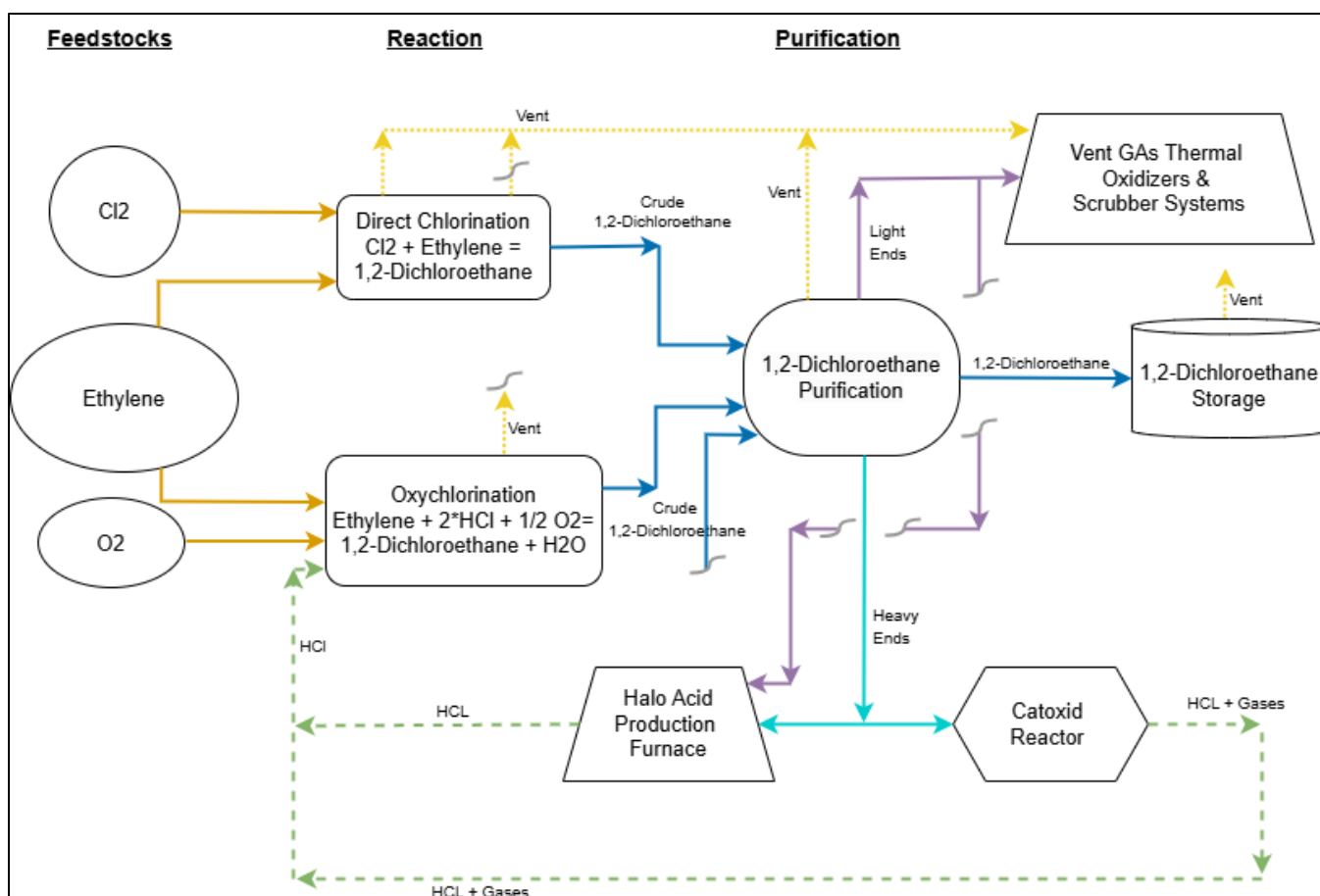


Figure 1-1. 1,2-Dichloroethane Combined Vinyl Chloride Process Diagram

Source: Adapted from data provided by the Vinyl Institute ([EPA-HQ-OPPT-2018-0427-0024](#)).

The reaction process produces water that is separated from the product stream. Water may also be used in scrubbers for treatment of stack air releases. During the direct chlorination process, unpurified 1,2-dichloroethane from the reactor is washed with water and caustic soda (sodium hydroxide; NaOH) to remove dissolved HCl and chlorine gas (Cl₂) before being transferred to in-process storage. This waste wash water can be then sent to a wastewater stripper. Wastewater is sent to wastewater treatment before discharge. Air streams vented from various process equipment are connected through piping to thermal oxidizers for combustion which can be a source of stack air emissions. Fugitive emissions are monitored and controlled through a facility's LDAR (Leak Detection and Repair) program. If leaks are detected, steps are initiated to isolate the source of the leak and make repairs.

The 1,2-dichloroethane manufacturing process, including the five assessed byproducts, is a continuous process, operating 24 hours a day, 7 days per week. The plants operate in 12-hour work shifts. Exposure groups identified in the 1,1-dichloroethane and 1,2-dichloroethane Test Order Summary Reports ([Stantec ChemRisk, 2024, 2023](#)) include operators/process technicians, maintenance technicians, logistic/distribution technicians, and laboratory technicians. Although task frequency may vary, tasks performed daily include collecting samples, routine maintenance, container transfers, railcar loading and offloading, and sample analysis.

1.2.2 Estimated Byproducts Production Volumes Resulting from Manufacturing of 1,2-Dichloroethane

The production volume for each of the assessed byproducts resulting from 1,2-dichloroethane manufacturing is estimated based on the reported production volume of 1,2-dichloroethane and the weight percent of the byproduct in the non-purified 1,2-dichloroethane product stream provided by industry.

1,2-Dichloroethane had a reported CDR, non-confidential, total PV in 2019 between 30 and 40 billion pounds (lb). Vinyl Institute reported that approximately 1.25 lb of mixed chlorinated organic liquid byproducts are unintentionally produced per 100 lb of 1,2-dichloroethane manufactured. Roughly one-fourth are produced as light-ends and three-fourths as heavy-ends, in addition to a small amount of some non-condensable gases ([EPA-HQ-OPPT-2018-0421-0027](#)). As noted above, actual composition (weight %) of byproducts in product streams for a given 1,2-dichloroethane manufacturing process will vary by facility. EPA used information provided from the Vinyl Institute in several public comments ([EPA-HQ-OPPT-2018-0421-0027](#); [EPA-HQ-OPPT-2016-0732-0013](#); [EPA-HQ-OPPT-2019-0500-0101](#)) to estimate the maximum weight percent of each byproduct in various product streams to use in the draft risk evaluation (Table 1-1). The information in Table 1-1 was used to evaluate exposures to byproducts for the Manufacturing COU and represents maximum concentrations of byproducts that would be found in any 1,2-dichloroethane manufacturing facility. 1,1,2-Trichloroethane and *trans*-1,2-dichloroethylene are not assessed in the risk evaluation but are included in Table 1-1 for context; that is, to show 100% total of all chemicals within a product stream.

Table 1-1. Maximum Weight Percent of Byproducts in Product Streams During the Manufacture of 1,2-Dichloroethane

Chemical	Percent Non-Purified Product Stream	Percent Purified Product Stream	Percent Heavy-Ends Liquid ^c	Percent Light-Ends Liquid ^c
1,2-Dichloroethane	98.94	100	27.7	30.7
1,1-Dichloroethane	0.291	0.1	21	30
1,1,2-Trichloroethane ^a	0.472	0.02	50	0.1
<i>trans</i> -1,2-Dichloroethylene ^a	0.028	0.1	0	9

Chemical	Percent Non-Purified Product Stream	Percent Purified Product Stream	Percent Heavy-Ends Liquid ^c	Percent Light-Ends Liquid ^c
Trichloroethylene	0.0035	0 ^b	0.23	0.0999 ^d
Perchloroethylene	0.015	0 ^b	1.1	0
Methylene chloride	0.0999 ^e	0 ^b	0	0 ^d
Carbon tetrachloride	0.15	0 ^b	0	30

^a 1,1,2-Trichloroethane and *trans*-1,2-dichloroethylene are not assessed in this TSD or the risk evaluation but are included in the table to show 100% total of all chemicals within a product stream.

^b No information provided; assumed 0.

^c For heavy- and light-liquid ends, the highest concentration of byproduct reported was applied with the remaining percent assumed to be 1,2-dichloroethane. Light-ends liquid streams are the more volatile fractions in the mixture, typically derived from the initial stages of refining process and known for their lower boiling points. Heavy-ends liquid streams are the less volatile, higher boiling point fractions obtained towards the later stages of the refining process.

^d 0.0999% assumed when “ppm levels”/“quantities” was reported.

EPA assumed approximately 1.25 lb of byproducts are produced per 100 lb of 1,2-dichloroethane (data provided by the Vinyl Institute) ([EPA-HQ-OPPT-2018-0421-0027](#)). Using this information, and the 1,2-dichloroethane production volume reported as 30 to 40 billion lb, the Agency estimated that 375 to 500 million lb of byproducts are produced each year. Using percent weights of byproducts for the non-purified product stream shown in Table 1-1, as well as the annual byproducts production volume range of 375 to 500 million lb, EPA estimated the annual production volume range for each evaluated byproduct shown in Table 1-2.

Table 1-2. Estimated Annual Production Volume Range of Each Byproduct^a

Chemical	Percent Non-Purified Product Stream	Lower-End Production Volume ^b (Million lb/yr)	Higher-End Production Volume ^b (Million lb/yr)
1,1-Dichloroethane	0.291	88.2	118
Trichloroethylene	0.0035	1.06	1.41
Perchloroethylene	0.015	4.55	6.06
Methylene chloride	0.0999 ^c	30.3	40.4
Carbon tetrachloride	0.15	45.5	60.6

^a Annual production volumes estimated using percent weights of byproducts for the non-purified product stream provided by industry (also shown in Table 1-1) and the annual 1,2-dichloroethane PV range of 30–40 billion lb.

^b Lower- and higher-end PVs assume 1,2-dichloroethane PV of 30 and 40 billion lb per year, respectively.

^c 0.0999% assumed when “ppm levels”/“quantities” reported.

The Vinyl Institute stated that not all facilities manufacturing 1,2-dichloroethane produce all these byproducts and that some facilities are more efficient than others due to different methods of handling byproducts production (e.g., some may dispose of or break down all the byproducts while others have them distilled; [EPA-HQ-OPPT-2018-0427-0068](#)). Other facilities may not normally produce byproducts at all due to the sole use of the direct chlorination process during 1,2-dichloroethane manufacture. However, because the information provided by the Vinyl Institute did not identify individual facilities where byproduct production differs or how it differs, in this TSD, EPA assumed all of the 1,2-dichloroethane production volume contributes to the production of byproducts.

2 RELEASES AND CONCENTRATIONS OF THE BYPRODUCTS IN THE ENVIRONMENT

2.1 Environmental Releases

2.1.1 Number of Facilities

As mentioned previously, for this assessment, EPA assumed all facilities that manufacture 1,2-dichloroethane produced the assessed byproducts. In the 2020 CDR (*i.e.*, 2016–2019 reporting period), 17 sites reported the manufacture of 1,2-dichloroethane (Table 2-1). EPA reviewed the 2024 CDR and did not identify any additional manufacturing facilities. Facilities reported annual production volumes ranging from approximately 53,000 (*e.g.*, when manufactured as a byproduct) to 6 billion lb (*e.g.*, when manufactured as a product) with a total production volume of 30 billion to less than 40 billion lb nationwide ([U.S. EPA, 2020a](#)).⁶

Table 2-1. Facilities with 1,2-Dichloroethane Manufacturing Releases Reported in 2020 CDR

Name	Location
Westlake Vinyls, Inc.	Calvert City, KY
Axiall, LLC	Westlake, LA
Axiall, LLC	Plaquemine, LA
Blue Cube Operations, LLC	Plaquemine, LA
Buckman Laboratories, Inc.	Cadet, MO
Eagle US 2, LLC	Westlake, LA
Formosa Plastics Corporation	Baton Rouge, LA
Formosa Plastics Corporation	Point Comfort, TX
Geon Oxy Vinyl	Laporte, TX
Lanxess Corporation	North Charleston, SC
Occidental Chemical Corporation	Convent, LA
Occidental Chemical Corporation	Geismar, LA
Olin Blue Cube	Freeport, TX
Oxy Vinyls LP	Deer Park, TX
OxyChem Ingleside Plant	Gregory, TX
Shintech	Plaquemine, LA
Westlake Vinyls Company, LP	Geismar, LA
Source: (U.S. EPA, 2020a)	

⁶ A preliminary review of the 2024 CDR data indicates that the reported total production volume is within the same range as that reported in 2020.

EPA identified release data for all 17 sites reporting to 2020 and 2024 CDR (Table 2-1) in TRI (2015–2024), DMR (2015–2024), and National NEI (2014, 2017, and 2020). EPA also identified 25 additional manufacturing sites that were not present in the CDR database but reported to either TRI, NEI or DMR. Their absence from the CDR was likely due to the facility production volumes of 1,2-dichloroethane being below the CDR reporting threshold of 25,000 lb. In total, EPA identified 42 manufacturing sites. See *Number of Sites for 1,2-Dichloroethane* ([U.S. EPA, 2026i](#)) for a list of all facilities mapped to manufacturing that reported to CDR, TRI, DMR, and/or NEI, from 2015 to 2024.

Since 1,2-dichloroethane is a large-production volume commodity chemical, the Agency assumes 350 days per year of operation as discussed in Section 2.3.2 of the *Environmental Release Assessment for 1,2-Dichloroethane* ([U.S. EPA, 2026f](#)). This assumes that (1) the plant runs 7 days per week and 50 weeks per year (with 2 weeks down for facility planned period of non-production to perform maintenance, inspection, repair, and upgrade activities); and (2) the plant is always producing the chemical. This assumption of 350 days per year of operation for the 1,2-dichloroethane Manufacturing COU is consistent with information provided by the Vinyl Institute and in NEI. In the Test Order Summary Report, manufacturers of 1,2-dichloroethane reported operating between 360 and 365 days per year, and sites identified as manufacturers in NEI reported 364 to 365 days per year of operation ([Stantec ChemRisk, 2024](#)).

2.1.2 Environmental Release Assessment

2.1.2.1 Environmental Release Assessment Methodology

EPA obtained reported releases of 1,2-dichloroethane from manufacturing facilities from the 2015 to 2024 DMR and TRI as well as the 2014, 2017, and 2020 NEI. The 50th and 95th percentiles of reported releases were calculated to obtain the central tendency and high-end, respectively. Table 2-2 provides a summary of reported releases of 1,2-dichloroethane to surface water and ambient air (fugitive and stack releases). For more information about the methodology of estimating these releases, see Section 2.3 of the *Environmental Release Assessment for 1,2-Dichloroethane* ([U.S. EPA, 2026f](#)).

Next, EPA assumed that the concentrations of the byproduct chemicals in the releases were equal to their concentrations in the non-purified 1,2-dichloroethane product stream (these concentrations are presented in Table 1-1). With this assumption in mind, the Agency estimated the releases of each byproduct chemical from each 1,2-dichloroethane manufacturing facility by multiplying the 1,2-dichloroethane releases summarized in Table 2-2 with the “Percent Non-Purified Product Stream” concentrations in Table 1-1. For the water pathway, EPA refined this assumption using chemical-specific wastewater treatment efficiency (see *Byproducts Releases for 1,2-Dichloroethane* ([U.S. EPA, 2026b](#)) for all calculations).

Although release databases such as TRI, NEI, and DMR may report releases of the byproduct chemicals from 1,2-dichloroethane manufacturing facilities, these reported releases could not be used for this assessment. At many of these facilities, multiple processes are occurring unrelated to the manufacture of 1,2-dichloroethane that might result in the production of the byproduct chemicals. Even in cases when it can be determined that the chemical is present on-site as a byproduct, it could not be confirmed whether the reported releases are solely from the 1,2-dichloroethane manufacturing portion of the facility. For these reasons, the Agency chose to estimate releases using the 1,2-dichloroethane releases and concentration data as described at the beginning of this section.

Table 2-2. Summary of Reported Environmental Releases from 1,2-Dichloroethane Manufacturing Facilities^a

Environmental Media	Number of Facilities ^b	Yearly Release (kg/yr)		Number of Release Days	Daily Release (kg/site-day)		Source(s)
		Central Tendency	High-End		Central Tendency	High-End	
Surface water	70	1.4	190	350	3.9E-03	0.54	2015–2024 TRI/DMR
Landfill	18	6.8	621		1.9E-02	18	2015–2024 TRI
Fugitive air	22	3,510	1.7E04		10	48	2015–2024 TRI
Stack air	23	1,088	1.2E04		3.1	35	2015–2024 TRI
Fugitive air	21	2,655	1.0E04		7.6	29	2014, 2017, and 2020 NEI
Stack air	23	833	6,192		2.4	18	2014, 2017, and 2020 NEI

DMR = Discharge Monitoring Report; NEI = National Emissions Inventory; TRI = Toxic Release Inventory
^a EPA used 2015–2024 DMR and TRI reported releases as well as 2014, 2017, and 2020 NEI manufacturing reported releases for 1,2-dichloroethane to calculate the 50th and 95th percentiles of releases to obtain the central tendency and high-end, respectively. The full inputs and results are presented in the *Environmental Release Assessment for 1,2-Dichloroethane* ([U.S. EPA, 2026f](#)).
^b A single facility may release to multiple environmental media or may be listed in both NEI and TRI air releases.

2.1.2.2 Sources of Environmental Releases

EPA collected 1,2-dichloroethane facility reported release data from TRI, NEI, and DMR databases. As discussed in Section 1.2.1, potential sources of water releases from 1,2-dichloroethane manufacturing include equipment and transport container cleaning, aqueous wastes from scrubbers and decanters, reaction water, process water from washing intermediate products, and trace water accumulated in storage tanks. Wastewater is generated during the direct chlorination process where unpurified 1,2-dichloroethane from the reactor is washed with water and caustic soda (NaOH) to remove dissolved HCl and chlorine gas (Cl₂) before being transferred to in-process storage. Additional wastewater is produced during the oxychlorination process for manufacturing 1,2-dichloroethane where it is separated from the product stream during distillation. Potential sources of air emissions include both stack and fugitive releases from process vents during operations; vapor displacement during transfer operations, emissions from storage vessels, piping, and equipment leaks (e.g., from pumps, valves, connectors, sampling ports, compressors, pressure relief devices); as well as from wastewater handling ([EPA-HQ-OPPT-2018-0427](#)).

2.1.2.3 Environmental Release Assessment Results

Central tendency and high-end releases for each assessed byproduct were both estimated using the method summarized in Section 2.1.2.1 and are provided in Table 2-3. The central tendency and high-end values were obtained by calculating the 50th and 95th percentiles, respectively, of the resulting releases for each byproduct across the 1,2-dichloroethane manufacturing facilities. For more information on release estimates see the *Byproducts Releases for 1,2-Dichloroethane* ([U.S. EPA, 2026b](#)).

Table 2-3. Summary of Estimated Environmental Releases of Byproducts from 1,2-Dichloroethane Manufacturing Facilities^a

Chemical/ Byproduct	No. Facilities ^b	Annual Release (kg/site-yr)		Type of Discharge, ^c Air Emission, ^d or Transfer for Disposal ^e	Daily Release (kg/site-day)	
		Central Tendency	High- End		Central Tendency	High- End
1,1-Dichloroethane	70	4.6E-03	0.55	Surface water (2015–2024 TRI/DMR)	1.3E-05	1.6E-03
	2	2.0E-02	0.23	POTW (2015–2024 TRI)	5.8E-05	6.5E-04
	6	0.67	0.98	WWT (2015–2024 TRI)	1.9E-03	2.8E-03
	18	4.4E-02	4.0	Landfill (2015–2024 TRI)	1.2E-04	1.1E-02
	23	3.2	36	Stack air (2015–2024 TRI)	9.2E-03	0.10
	22	12	50	Fugitive air (2015–2024 TRI)	3.3E-02	0.14
	23	6.9E-03	5.1E-02	Stack air (2014, 2017, and 2020 NEI)	8.6	30
	21	8.6	30	Fugitive air (2014, 2017, and 2020 NEI)	2.5E-02	8.4E-02
Trichloroethylene	70	5.6E-05	6.7E-03	Surface water (2015–2024 TRI/DMR)	1.6E-07	1.9E-05
	2	2.5E-04	2.7E-03	POTW (2015–2024 TRI)	7.0E-07	7.8E-06
	6	8.1E-03	1.2E-02	WWT (2015–2024 TRI)	2.3E-05	3.4E-05
	18	5.3E-04	4.8E-02	Landfill (2015–2024 TRI)	1.5E-06	1.4E-04
	23	3.9E-02	0.43	Stack air (2015–2024 TRI)	1.1E-04	1.2E-03
	22	0.14	0.60	Fugitive air (2015–2024 TRI)	4.0E-04	1.7E-03
	23	2.9E-02	0.22	Stack air (2014, 2017, and 2020 NEI)	8.3E-05	6.2E-04
	21	0.10	0.35	Fugitive air (2014, 2017, and 2020 NEI)	3.0E-04	1.0E-03
Perchloroethylene	70	2.4E-04	2.9E-02	Surface water (2015–2024 TRI/DMR)	6.8E-07	8.2E-05
	2	1.1E-03	1.2E-02	POTW (2015–2024 TRI)	3.0E-06	3.4E-05
	6	3.5E-02	5.1E-02	WWT (2015–2024 TRI)	9.9E-05	1.4E-04
	18	2.3E-03	0.21	Landfill (2015–2024 TRI)	6.4E-06	5.9E-04
	23	0.17	1.9	Stack air (2015–2024 TRI)	4.7E-04	5.3E-03
	22	0.60	2.6	Fugitive air (2015–2024 TRI)	1.7E-03	7.3E-03
	23	0.12	0.93	Stack air (2014, 2017, and 2020 NEI)	3.6E-04	2.7E-03
	21	0.45	1.5	Fugitive air (2014, 2017, and 2020 NEI)	1.3E-03	4.3E-03

Chemical/ Byproduct	No. Facilities ^b	Annual Release (kg/site-yr)		Type of Discharge, ^c Air Emission, ^d or Transfer for Disposal ^e	Daily Release (kg/site-day)	
		Central Tendency	High- End		Central Tendency	High- End
Methylene chloride	70	1.6E-03	0.19	Surface water (2015–2024 TRI/DMR)	4.6E-06	5.4E-04
	2	7.0E-03	7.8E-02	POTW (2015–2024 TRI)	2.0E-05	2.2E-04
	6	0.23	0.34	WWT (2015–2024 TRI)	6.6E-04	9.6E-04
	18	1.5E-02	1.4	Landfill (2015–2024 TRI)	4.3E-05	3.9E-03
	23	1.1	12	Stack air (2015–2024 TRI)	3.2E-03	3.5E-02
	22	4.0	17	Fugitive air (2015–2024 TRI)	1.1E-02	4.9E-02
	23	0.83	6.2	Stack air (2014, 2017, and 2020 NEI)	2.4E-03	1.8E-02
	21	3.0	10	Fugitive air (2014, 2017, and 2020 NEI)	8.5E-03	2.9E-02
Carbon tetrachloride	70	2.4E-03	0.29	Surface water (2015–2024 TRI/DMR)	6.8E-06	8.2E-04
	2	1.1E-02	0.12	POTW (2015–2024 TRI)	3.0E-05	3.4E-04
	6	0.35	0.51	WWT (2015–2024 TRI)	9.9E-04	1.4E-03
	18	2.3E-02	2.1	Landfill (2015–2024 TRI)	6.4E-05	5.9E-03
	23	1.7	19	Stack air (2015–2024 TRI)	4.9E-03	5.3E-02
	22	6.0	26	Fugitive air (2015–2024 TRI)	1.7E-02	7.3E-02
	23	1.2	9.3	Stack air (2014, 2017, and 2020 NEI)	3.6E-03	2.7E-02
	21	4.5	15	Fugitive air (2014, 2017, and 2020 NEI)	1.3E-02	4.3E-02

DMR = Discharge Monitoring Report; NEI = National Emissions Inventory; POTW = publicly owned treatment works; TRI = Toxic Release Inventory; WWT = wastewater treatment

^a Daily and annual releases were estimated using facility-reported releases of 1,2-dichloroethane Manufacturing COU (Table 2-2) and concentrations of byproducts provided by industry (Table 1-1) (see Section 2.1.2.1). EPA used 2015–2024 DMR and TRI reported releases as well as 2014, 2017, and 2020 NEI manufacturing reported releases for 1,2-dichloroethane to estimate the releases per facility of each byproduct. The 50th and 95th percentiles of byproduct releases were then calculated to obtain the central tendency and high-end, respectively. The full inputs and results are presented in the *Byproducts Releases for 1,2-Dichloroethane* (U.S. EPA, 2026b).

^b Not all facilities reported releases for all 10 years.

^c Includes water discharges to surface water, indirect discharge to POTWs, or non-POTW WWT.

^d Includes air emissions via fugitive air or stack air.

^e Includes transfer to surface impoundment, land application, or landfills.

2.1.3 Release Comparison

Table 2-4 shows reported releases for the Manufacturing COU in the final risk evaluations and fenceline analyses for each byproduct chemical. EPA acknowledges that (1) releases of assessed byproducts due to the manufacture of 1,2-dichloroethane were excluded from the scopes of their respective final risk evaluations, and (2) not all 1,2-dichloroethane manufacturing facilities were included in the fenceline modeling because the fenceline modeling only would have included those facilities that reported the respective chemical. Among the fenceline TSDs, only *Carbon Tetrachloride: Fenceline Technical Support – Ambient Air Pathway* (U.S. EPA, 2022a) reports air releases explicitly labeled as

“byproducts”; however, it is unclear whether these reported air releases are solely from the 1,2-dichloroethane manufacturing process (other co-located manufacturing processes at a given site may also result in carbon tetrachloride air releases, as observed from EPA’s review of facilities’ operating permits).

As expected, releases presented in individual chemical risk evaluations for the Manufacturing COU (Table 2-4) are higher when compared to estimated releases of the chemical produced as a byproduct (Table 2-3). For example, central tendency surface water releases are between two and five orders of magnitude greater when the chemical is manufactured intentionally as opposed to when manufactured as a byproduct of 1,2-dichloroethane manufacturing. For central tendency fugitive air releases from TRI, the range of release discrepancies varied, with byproducts releases and manufacturing releases ranging from being similar to differing by three orders of magnitude. Across all but one of the assessed byproducts (1,1-dichloroethane), the estimated releases for these chemicals when produced as a byproduct were lower.

Table 2-4. Annual Release of Chemicals from Their Manufacturing COU

Chemical	Estimated Release for Manufacturing (kg/site-yr) ^a		Estimated Fenceline Release for Manufacturing (kg/site-yr) ^a		Type of Discharge or Air Emission	Reference
	Central Tendency	High-End	Central Tendency	High-End		
1,1-Dichloroethane	1.6	1,299	N/A ^b	N/A ^b	Surface water	U.S. EPA (2025a)
	8.4	2,184	N/A ^b	N/A ^b	Fugitive air (TRI)	
	34	74	N/A ^b	N/A ^b	Fugitive air (NEI)	
	45	499	N/A ^b	N/A ^b	Stack air (TRI)	
	33		N/A ^b		Stack air (NEI)	
Trichloroethylene	15	345	15	345	Surface water or POTW	U.S. EPA (2022h)
	–		448	7,070	Fugitive air (TRI)	U.S. EPA (2022g)
	–		9	966	Stack air (TRI)	
Perchloroethylene	5.1	17	5.1	17	Surface water or POTW	U.S. EPA (2022f)
	–		45	7,184	Fugitive air (TRI)	U.S. EPA (2022e)
	–		14	3,677	Stack air (TRI)	
Methylene chloride	1.0	59	1.0	59	Surface water or POTW	U.S. EPA (2022c)
	–		244	2,268	Fugitive air (TRI)	U.S. EPA (2022d)
	–		1,671	5,044	Stack air (TRI)	
Carbon tetrachloride	–	115 ^c	–	115 ^c	Surface water or POTW	U.S. EPA (2022b)
	–		116	1,944	Fugitive air (TRI)	U.S. EPA (2022a)
	–		143	11,793	Stack air (TRI)	

Chemical	Estimated Release for Manufacturing (kg/site-yr) ^a		Estimated Fenceline Release for Manufacturing (kg/site-yr) ^a		Type of Discharge or Air Emission	Reference
	Central Tendency	High-End	Central Tendency	High-End		

NEI = National Emissions Inventory; POTW = publicly owned treatment works; TRI = Toxic Release Inventory
^a The 50th and 95th percentiles of releases were calculated to obtain the central tendency and high-end, respectively.
^b N/A = Not applicable. A separate fenceline analysis was conducted only for the first 10 risk evaluations, addressing a prior decision to not assess certain exposure pathways (including, but not limited to, ambient air and ambient surface water) in the risk evaluation. For 1,1-dichloroethane, this TSD utilizes release data from the *Risk Evaluation for 1,1-Dichloroethane* ([U.S. EPA, 2025a](#)).
^c There are only 2 releases identified for the Manufacturing COU (0.23 and 115 kg/site-yr) for carbon tetrachloride. The 115 kg/site-yr release is presented here as the high-end value.

2.1.4 Weight of Scientific Evidence for Environmental Releases

EPA develops a conclusion on the weight of scientific evidence supporting the environmental release estimates based on the strengths, limitations, and uncertainties associated with the environmental release estimates. The conclusion is summarized using the following confidence descriptors: robust, moderate, slight, or indeterminate. EPA considers factors that increase or decrease the strength of the evidence supporting the release estimate—including quality of the data/information, applicability of the release data to the COU (including considerations of temporal relevance, locational relevance), and the representativeness of the estimate for the whole industry.

To assess the environmental releases of the byproducts from the manufacturing of 1,2-dichloroethane, EPA started by considering the releases of 1,2-dichloroethane from the Manufacturing COU.⁷ For the 1,2-dichloroethane Manufacturing COU, EPA relied on facility-specific release information to water and air as reported in TRI, NPDES permitted water releases as reported in DMR, and ambient air releases as reported in NEI.

Water releases for 1,2-dichloroethane are assessed using reported releases from the 2015 to 2024 TRI and DMR. The primary strength of TRI data is that TRI compiles the best readily available facility-specific reported release data. DMR data are facility-specific reported monitoring and release data per NPDES permit requirements. The primary limitation is uncertainty in the accuracy of reported releases. Based on other reporting databases (e.g., CDR, NEI), there are six additional manufacturing sites that report releases to other media but do not report releases to water.

Air releases for 1,2-dichloroethane are assessed using reported releases from 2015 to 2024 TRI and 2014, 2017, and 2020 NEI. A strength of NEI data is that it captures additional sources that are not included in TRI due to reporting thresholds. Factors that decrease the overall confidence for these releases include the uncertainty in the accuracy of reported releases and the limitations in representativeness to all sites because TRI and NEI might not capture all relevant sites. Based on other reporting databases like CDR and DMR, there are 17 additional manufacturing sites that report releases to other media but do not report releases to air. Additionally, EPA made assumptions on the number of operating days to estimate daily releases.

⁷ In response to public comments (see Section 2.2), EPA notes that this risk evaluation only assesses the risk presented by TCE produced as a byproduct during the manufacturing of 1,2-dichloroethane—not the processing and nearly all disposal of the byproduct TCE.

In conclusion, though there is uncertainty of whether the databases capture all sites releasing to each medium, the 1,2-dichloroethane Manufacturing COU release data are rated high in systematic review and provide releases directly from a wide number of manufacturing facilities. Based on this information, EPA has concluded that the weight of scientific evidence for the 1,2-dichloroethane Manufacturing COU release data are moderate-to-robust and provides a plausible estimate of releases in consideration of the strengths and limitations of reasonably available data (see the *Environmental Release Assessment for 1,2-Dichloroethane* ([U.S. EPA, 2026f](#))).

There is uncertainty in estimating releases of the assessed byproducts using the releases of 1,2-dichloroethane. Although each 1,2-dichloroethane manufacturing facility typically produces these byproducts, the quantities generated can vary due to differences in the manufacturing process. This assessment assumed that the byproducts are produced at each facility in the concentrations provided in Table 1-1. The strength of this approach is that these concentrations are provided by industry and represent actual concentrations that are known to occur within 1,2-dichloroethane manufacturing facilities. Furthermore, the estimated releases of each of the assessed byproducts are significantly lower when compared to their reported releases for the Manufacturing COU in the corresponding final risk evaluations and fenceline analyses.

Based on this information, EPA has concluded that the weight of scientific evidence for the release estimates of the byproducts produced during the 1,2-dichloroethane manufacturing process is moderate and provides a plausible estimate of releases in consideration of the strengths and limitations of reasonably available data.

2.2 Concentrations of Byproducts in the Environment

2.2.1 Ambient Air Pathway

2.2.1.1 Comparison of Ambient Air Releases in Fenceline Analyses to Releases Calculated in this Assessment/TSD

In this TSD, EPA compared the range of releases used in the fenceline analyses to byproduct releases calculated by multiplying the 1,2-dichloroethane releases from Manufacturing COU (Table 2-2) by the respective weight fraction in the non-purified product stream (Table 1-1). Table 2-5 shows the range of modeled releases in this TSD and the fenceline analysis for each byproduct (note that 1,1-dichloroethane was not assessed in a fenceline analysis). The maximum fenceline releases were higher than estimated maximum byproduct releases; however, the releases from the fenceline analyses for the Manufacturing COU are not necessarily directly comparable to those used in this TSD because not every facility manufacturing the assessed byproducts was modeled in the fenceline analyses. Therefore, the Agency also used estimated environmental releases of byproducts (Section 2.1.2) to model inhalation exposures to the general population residing in the vicinity of 1,2-dichloroethane manufacturing facilities to further refine this assessment.

For 1,1-dichloroethane, EPA compared releases calculated in this TSD to those used in the *Risk Evaluation for 1,1-Dichloroethane* ([U.S. EPA, 2025a](#)). The median facility releases for manufacturing facilities from the years analyzed in the 1,1-dichloroethane risk evaluation, 2015 to 2020, ranged from 1.96 to 4,550 lb/year. The range of releases calculated in this TSD vary from 1.6×10^{-6} to 283 lb/year and is because each facility within the Manufacturing COU reporting its releases that can vary due to differences in manufacturing processes and air emission controls.

Table 2-5. Range of Releases Used for Modeling of Ambient Air Concentrations in Fenceline Analyses for the Manufacturing COU and the Byproducts Assessment

Chemical/ Byproduct ^a	Range of Facility Releases Reported in Fenceline Analyses ^b (lb/year)	Range of Facility Releases of Byproducts Estimated in this TSD ^c (lb/year)
Trichloroethylene	0.25–24,500	1.1E–06 to 4.2
Perchloroethylene	0.79–66,000	4.5E–07 to 18
Methylene chloride	2.0E–02 to 37,100	3.0E–06 to 119
Carbon tetrachloride	2–44,733	4.5E–06 to 180

^a 1,1-Dichloroethane was not assessed in the fenceline analysis.

^b Minimum and maximum releases as reported by facilities to TRI for the years 2015–2024.

^c Releases were calculated by multiplying the maximum TRI reported releases of 1,2-dichloroethane for each facility for the reporting years of 2015–2024 from the Manufacturing COU by the associated percentage in Table 1-1.

2.2.1.2 Ambient Air Concentrations Modeled by HEM

As stated previously, because the facilities covered by the Manufacturing COU in the fenceline analyses do not align with all of the 1,2-dichloroethane manufacturing facilities that release the assessed byproducts, EPA conducted additional modeling using HEM5.0. EPA estimated ambient air concentrations of each byproduct using the highest reported release from TRI for the years 2015 to 2024 for each individual facility in the Manufacturing COU using HEM Version 5.0 ([HEM5.0](#); accessed October 22, 2025). HEM5.0 also provides a more refined population analysis than the previous Integrated Indoor-Outdoor Air Calculator ([IIOAC](#); accessed October 22, 2025) and American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) modeling used for fenceline analyses and uses facility-specific input data (*i.e.*, land use and meteorological data). Additionally, the comparison of releases performed in Section 2.2.1.1 provides a line of evidence that the releases used as inputs to HEM5.0 in this analysis are not a gross overestimation relative to the previously modeled Manufacturing COU releases. For more information on the HEM5.0 method, see the *Environmental Media Assessment for 1,2-Dichloroethane* ([U.S. EPA, 2026e](#)) and *General Population Exposure Assessment for 1,2-Dichloroethane* ([U.S. EPA, 2026g](#)).

As shown in Table 2-6 and Table 2-7, the highest chronic (hourly concentrations averaged over a year) and acute (hourly concentrations averaged over a day) modeled concentrations for each facility occurred at either 10, 30, or 100 m from the modeled release location. Concentrations were modeled up to 50,000 m from the releasing facility. Across all facilities and byproducts, 1,1-dichloroethane had the highest modeled chronic concentration of 7.87 µg/m³, which occurred 10 m from the modeled release location at a facility in Louisiana (TRI ID 70669PPGNDCOLUM). The modeled highest acute concentration across all facilities and byproducts was 1,1-dichloroethane at a concentration of 28.1 µg/m³, which occurred at 30 m from the modeled release location at a facility in Kentucky (TRI ID 42029WSTLK2468I).

The concentrations presented in Table 2-6 and Table 2-7 present the highest modeled concentrations without regard for whether populations live at the modeled locations. Therefore, to estimate exposures and risks more representative of human populations, EPA used ambient air concentrations modeled at census block centroids (Section 6.2.1).

Table 2-6. Highest Modeled Chronic Ambient Air Concentrations for Each Byproduct Using 1,2-Dichloroethane^a 2015–2024 TRI^b Data at Each 1,2-Dichloroethane Manufacturing Facility Using HEM5.0 at Any Distance

TRI Facility ID	Distance (m)	Chronic Ambient Air Concentration (µg/m ³) ^c				
		1,1-Dichloroethane	Trichloroethylene	Perchloroethylene	Methylene Chloride	Carbon Tetrachloride
29415LBRGH2151K	10	1.25E-02	1.51E-04	6.45E-04	4.30E-03	6.45E-03
41129CLGNCUSROU	10	2.66E-04	3.21E-06	1.37E-05	9.15E-05	1.37E-04
42029PNNWLALTON	100	4.01E-07	4.83E-09	2.07E-08	1.38E-07	2.07E-07
42029WSTLK2468I	30	7.80	9.39E-02	0.40	2.68	4.02
52761MNSNTWIGGI	10	6.27E-02	7.54E-04	3.23E-03	2.15E-02	3.23E-02
63630BCKMNHIGHW	10	0.15	1.85E-03	7.92E-03	5.27E-02	7.92E-02
70669GRGGL1600V	10	6.73	8.10E-02	0.35	2.31	3.47
70669PPGNDCOLUM	10	7.87	9.47E-02	0.41	2.70	4.06
70723CCDNTHIGHW	10	0.53	6.32E-03	2.71E-02	0.18	0.27
70734BRDNLOUIS	10	1.99	2.40E-02	0.10	0.68	1.03
70734VLCNMASHLA	10	2.79	3.35E-02	0.14	0.96	1.44
70764LLMNXHWHY40	10	4.34	5.22E-02	0.22	1.49	2.24
70765GRGGLHIGHW	10	1.20	1.44E-02	6.18E-02	0.41	0.62
70765THDWCHIGHW	100	1.03E-04	1.23E-06	5.29E-06	3.52E-05	5.29E-05
7076WBLCBP21255	10	0.88	1.06E-02	4.53E-02	0.30	0.45
7076WDDPSP21255	10	0.00	0.00	0.00	0.00	0.00
70805FRMSPGULFS	10	4.41	5.31E-02	0.23	1.51	2.27
70805LLDSGCORNE	100	7.14E-05	8.59E-07	3.68E-06	2.45E-05	3.68E-05
77501THYLC1000N	10	1.43E-03	1.73E-05	7.40E-05	4.93E-04	7.40E-04
77536CCDNTTIDAL	10	1.14	1.37E-02	5.88E-02	0.39	0.59
7754WBLCBP231NB	10	1.91	2.29E-02	9.82E-02	0.65	0.98
77571LPRTC2400M	10	1.80	2.16E-02	9.27E-02	0.62	0.93
77978FRMSPPOBOX	10	1.46	1.76E-02	7.54E-02	0.50	0.75
78359CCDNTHWHY36	10	1.38	1.66E-02	7.11E-02	0.47	0.71

HEM5.0 = Human Exposure Model Version 5; TRI = Toxics Release Inventory

^a Release amounts of each byproduct calculated by multiplying the 1,2-dichloroethane release by the respective fraction in the non-purified product stream (see Table 1-1). Releases modeled using HEM5.0 to estimate the ambient air concentrations shown in this table.

^b For each facility the maximum total (fugitive + stack) annual reported release reported to TRI from 2015–2024 was used for HEM5.0 modeling.

^c Reported concentrations are the sum of the concentrations resulting from stack and fugitive emissions.

Table 2-7. Highest Modeled Acute Ambient Air Concentrations for Each Byproduct Using 1,2-Dichloroethane^a 2015–2024 TRI^b Data at Each 1,2-Dichloroethane Manufacturing Facility Using HEM5.0 at Any Distance

TRI Facility ID	Distance (m)	Acute Ambient Air Concentration ($\mu\text{g}/\text{m}^3$) ^c				
		1,1-Dichloroethane	Trichloroethylene	Perchloroethylene	Methylene Chloride	Carbon Tetrachloride
29415LBRGH2151K	100	5.63E-02	6.77E-04	2.90E-03	1.93E-02	2.90E-02
41129CLGNCUSROU	100	7.31E-04	8.79E-06	3.77E-05	2.51E-04	3.77E-04
42029PNNWLALTON	100	1.97E-06	2.37E-08	1.01E-07	6.75E-07	1.01E-06
42029WSTLK2468I	30	28.1	0.34	1.45	9.66	14.5
52761MNSNTWIGGI	30	0.21	2.52E-03	1.08E-02	7.19E-02	0.11
63630BCKMNHIGHW	30	0.29	3.46E-03	1.48E-02	9.88E-02	0.15
70669GRGGL1600V	30	19.1	0.23	0.99	6.56	9.85
70669PPGNDCOLUM	30	22.3	0.27	1.15	7.67	11.5
70723CCDNTHIGHW	30	1.77	2.13E-02	9.14E-02	0.61	0.91
70734BRDNCLOUIS	30	5.98	7.19E-02	0.31	2.05	3.08
70734VLCNMASHLA	30	8.36	0.10	0.43	2.87	4.31
70764LLMNXHWHY40	30	13	0.16	0.67	4.47	6.71
70765GRGGLHIGHW	30	3.60	4.33E-02	0.19	1.24	1.85
70765THDWCHIGHW	100	5.23E-04	6.29E-06	2.70E-05	1.80E-04	2.70E-04
7076WBLCBP21255	30	2.62	3.15E-02	0.14	0.90	1.35
70805FRMSPGULFS	30	0.00	0.00	0.00	0.00	0.00
70805LLDSGCORNE	30	13.1	0.16	0.68	4.54	6.82
77501THYLC1000N	30	3.64E-04	4.38E-06	1.88E-05	1.25E-04	1.88E-04
77536CCDNTTIDAL	30	4.04E-03	4.85E-05	2.08E-04	1.39E-03	2.08E-03
77541THDWCBUILD	30	3.21	3.86E-02	0.17	1.10	1.65
7754WBLCBP231NB	30	5.63	6.77E-02	0.29	1.93	2.90
77571LPRTC2400M	30	5.06	6.08E-02	0.26	1.74	2.61
77978FRMSPPOBOX	30	3.79	4.55E-02	0.20	1.30	1.95
78359CCDNTHWHY36	30	2.94	3.54E-02	0.15	1.01	1.52

HEM5.0 = Human Exposure Model Version 5; TRI = Toxics Release Inventory

^a Release amounts of each byproduct calculated by multiplying the 1,2-dichloroethane release by the respective fraction in the non-purified product stream (Table 1-1). Releases modeled using HEM5.0 to estimate the ambient air concentrations shown in this table.

^b For each facility the maximum total (fugitive + stack) annual reported release reported to TRI from 2015–2024 was used for HEM5.0 modeling.

^c Reported concentrations are the sum of the concentrations resulting from stack and fugitive emissions.

2.2.2 Surface Water Pathway

Byproducts are anticipated to be released to surface waters together with 1,2-dichloroethane via presence in effluent from the Manufacturing COU (see Section 2.1.2.3). EPA assessed each of the estimated byproduct chemical releases assuming the same percentages within the non-purified process stream (Table 1-1) also occur and are applied relative to 1,2-dichloroethane releases accounting also for wastewater treatment efficiency. The Agency also compared these estimated releases to the releases in each byproduct's corresponding risk evaluation. In the risk evaluation, EPA relied on facility-reported releases of each byproduct chemical as required under the NPDES permits. For purposes of the comparison in this TSD, EPA could only compare these releases per facility since the receiving water body flows are unique to each facility location and result in site-specific surface water concentrations.

EPA reviewed all facilities manufacturing and releasing 1,2-dichloroethane and identified only one facility, the Eagle US 2 LLC - Lake Charles Complex facility (Eagle US 2), that under the Manufacturing COU released 1,2-dichloroethane and reported releases of each of the assessed byproducts via DMR from 2015 through 2024. Across these 9 years, 2021 was the highest year of release for this facility in a year that was not dominated by a storm event and was the basis for the 1,2-dichloroethane and byproduct surface water concentration estimates (see *Environmental Media Assessment for 1,2-Dichloroethane*). In addition, the assessed byproducts' published risk evaluations considered releases from this same facility, allowing for a direct comparison between the calculated byproducts releases in this TSD and those reported in DMR for 2016 in the risk evaluations. Lastly, the Eagle US 2 facility releases to Bayou D'Inde resulted in the highest 1,2-dichloroethane surface water concentrations within the Manufacturing COU. Therefore, the Eagle US 2 surface water concentrations represent the high-end of possible environmental and general population exposures for 1,2-dichloroethane from the Manufacturing COU as well as possible high-end exposures associated with the assessed byproducts.

Using the EPA Pollutant Loading Tool, carbon tetrachloride was inconsistently released year-to-year from the Eagle US 2 facility and in the years investigated in the carbon tetrachloride risk evaluation (years 2014–2018), no releases of carbon tetrachloride were detected. EPA, however, did confirm that the Eagle US 2 facility has an NPDES permit that requires carbon tetrachloride monitoring in effluent and has reported levels of carbon tetrachloride releases in 2021 and 2023 through the permitting system.

For the Eagle US 2 facility, the amounts released as byproducts were compared with those reported releases in the corresponding chemical final risk evaluations. EPA first adjusted the estimated byproduct released to consider differences in physical and chemical properties affecting wastewater treatment and removal. In adjusting the amounts removed in the influent based on each chemical's removal, a more representative amount is estimated in the effluent. Table 2-8 presents each chemical's physical and chemical properties as well as the estimated wastewater removal rates using EPI Suite™ ([U.S. EPA, 2012](#)).

Table 2-8. Chemical Physical and Chemical Properties^a

Chemical/ Byproduct	Solubility (mg/L)	Vapor Pressure (mmHg at 25 °C)	Log K _{oc}	WWT Removal (%)
1,2-Dichloroethane	8,600	78.9	1.3–1.77	39.6
1,1-Dichloroethane	5,040	228	1.48	50
Trichloroethylene	1,280	73.72	1.8–2.1	81
Perchloroethylene	13	435	1.4	57
Methylene chloride	206	18.5	2.95	88
Carbon tetrachloride	793	115	1.69–2.16	92
K _{OC} = organic carbon: water partition coefficient; WWT = wastewater treatment ^a All listed parameter values except for 1,2-dichloroethane are from published chemical risk evaluations (Section 1.2).				

EPA calculated the amount of 1,2-dichloroethane in influent based on the removal rate of 1,2-dichloroethane from the wastewater stream. The 2021 1,2-dichloroethane DMR reported annual releases of 8,358 kg from the Eagle US 2 facility were divided by the 1,2-dichloroethane-specific removal rate of 0.396 ($8,358 \div [1 - 0.396]$) or 13,837.75 kg/yr of 1,2-dichloroethane in influent. The amount of byproduct chemicals in the influent resulting from the manufacture of 1,2-dichloroethane were assumed to be in the same proportion as in the non-purified process stream and estimated based on the purified process stream percentages (see Table 1-1 and Table 2-9). For example, given that the byproduct constitutes 0.291% of the total process stream ($13,837.75 \div 0.9894 = 13,986$ kg) (Table 2-9), the estimated amount of 1,1-dichloroethane in the influent is calculated in Equation 2-1.

Equation 2-1.

$$13,986 \text{ kg/yr} \times 0.291\% = 40.7 \text{ kg}$$

The byproduct chemicals then undergo wastewater treatment and the amount of each chemical's removal from the influent is dependent on the corresponding wastewater removal rate (see Table 2-9). For 1,1-dichloroethane, the 50% removal from wastewater treatment results in 20.35 kg/yr released. The same calculations were applied to the remaining four byproducts.

EPA reviewed the corresponding published chemical risk evaluation for each of the assessed byproducts. In addition to the Eagle US 2 facility reporting manufacturing and releases of 1,2-dichloroethane, it also reported releases for each of the evaluated byproducts in their individual chemical risk evaluation. EPA was not able to discern at the point of discharge whether the total amount released of the individual chemicals is from its manufacture or as a byproduct from 1,2-dichloroethane manufacture or a combination of the two processes. The latter was assumed likely because byproduct chemicals are reported in wastewater discharges from this facility as is 1,2-dichloroethane so that the Agency could compare the calculated amount of byproduct chemicals released per day (based on 350 days of release per year) based on the percentages as the process stream (see Table 1-1 and Table 2-9) to the amount of chemical released (per day) reported in the corresponding risk evaluations from the Eagle US 2 facility (see Table 2-10). The estimated releases of byproducts are less than the amount released of each individual chemical as reported in the corresponding risk evaluations.

Table 2-9. Estimated 1,2-Dichloroethane and Byproduct Surface Water Releases from Eagle US 2 Manufacturing Facility Releases Adjusted for Chemical-Specific Wastewater Treatment Removal

Chemical/Byproduct	Percent Byproduct in Process Stream	Estimated Amount of Byproduct Chemical in Influent ^a (kg/yr)	Chemical-Specific WWT Removal ^b (%)	Effluent Releases of Byproduct Chemicals Based on Chemical-Specific Removal Rates ^c (kg/yr)
1,2-Dichloroethane	98.94	13,838	39.6	8,358
1,1-Dichloroethane	0.291	40.7	50	20.3
Trichloroethylene	0.0035	0.49	81	0.09
Perchloroethylene	0.015	2.1	88	0.25
Methylene chloride	0.0999 ^c	13.98	57	6.0
Carbon tetrachloride	0.15	20.98	92	1.68
Total process stream		13,986		

WWT = wastewater treatment

^a Annual release for 1,2-dichloroethane from the Eagle US 2 facility was reported in DMR per NPDES permit requirements. The amount of 1,2-dichloroethane prior to treatment (influent) was estimated as follows: (1,2-dichloroethane annual release) ÷ (1 - 1,2-dichloroethane WWT Removal). For example, 8,358 kg/yr ÷ (1 - 0.396) = 13,838 kg/yr amount 1,2-dichloroethane in influent.

Note: Byproduct chemical amounts in influent prior to wastewater treatment were estimated based on percent of chemical in the process stream as provided by Vinyl Institute. For example, to calculate 1,1-dichloroethane in influent: 13,986 kg/yr × 0.291% = 40.7 kg. To calculate the other byproduct chemical amounts in influent the following values were used: 0.0035% for trichloroethylene, 0.015% for perchloroethylene, 0.0999% for methylene chloride, and 0.15% for carbon tetrachloride (% byproduct in non-purified product stream submitted by the Vinyl Institute public comments ([EPA-HQ-OPPT-2018-0421-0027](#)); see also Table 1-1).

^b The wastewater treatment removal efficiency is specific per chemical and based on each chemical's physical and chemical properties (see Table 2-8).

^c Effluent releases = (estimated amount of chemical in influent) × (1 - chemical-specific WWT Removal). For example, 40.7 kg/yr × (1 - 0.5) = 20.3 kg/yr of 1,1-dichloroethane released in effluent.

EPA used the equation for free-flowing water bodies within E-FAST 2014 to estimate site-specific surface water concentrations for documented releases. Surface water concentrations are calculated using the following equation:

Equation 2-2. Calculation of Surface Water Concentrations

$$SWC = \frac{WWR \times CF1 \times \left(1 - \frac{WWT}{100}\right)}{SF \times CF2}$$

Where:

- SWC = Surface water concentration (parts per billion (ppb) or µg/L)
- WWR = Chemical release to wastewater (kg/day)
- WWT = Removal from wastewater treatment (%)
- SF = Estimated flow of the receiving stream (million liters/day [MLD])
- CF1 = Conversion factor (10⁹ µg/kg)
- CF2 = Conversion factor (10⁶ L/day/MLD)

For the receiving water body flow used to calculate the respective byproduct concentrations, EPA compared the Eagle2 facility plant flow to the receiving water body flow. The plant flow in 2021 was greater (875 million liters/day [MLD]) than that of the receiving water body (7Q10 = 4.05 MLD; 30Q5 = 7.09 MLD and the Harmonic Mean = 12.46 MLD) and was used to calculate each of the byproduct surface water concentrations.⁸

Table 2-10. Eagle US 2 Manufacturing Facility Releases – Comparison to Estimated Byproduct Surface Water Releases^a

Chemical/ Byproduct	Reported 2016 Daily Releases from Chemical Risk Evaluations ^b (kg/day)	Estimated 2016 Daily Byproduct Release (kg/day)	Estimated 2016 Byproduct Instream Concentrations (µg/L) ^c	Estimated 2021 Byproduct Instream Concentrations (µg/L) ^d
1,1-Dichloroethane	0.30	5.1E-02	12.71	6.67E-02
Trichloroethylene	0.14–1.27	2.3E-04	0.06	3.05E-04
Perchloroethylene	0.1	4.2E-03	1.04	8.26E-04
Methylene chloride	1.0E-03	2.3E-03	0.56	1.97E-02
Carbon tetrachloride	Not reported	4.2E-03	1.04 ^e	5.50E-03

^a Concentrations of byproducts in receiving water estimated based on relative percent of byproduct to 1,2-dichloroethane (based on 350 days of releases)
^b Surface water releases from Eagle US 2 facility are presented in each of the corresponding chemical risk evaluations.
^c General population risks were evaluated in the Supplemental Fenceline analysis and presented in the Fenceline memorandum. The Eagle US 2 facility daily estimated byproduct release (kg/day) is similar or significantly lower than that in the fenceline analyses. 2016 byproduct instream concentrations based on 7Q10 flow of 4.05 million liters/day (MLD) or harmonic mean flow of 12.46 MLD.
^d 2021 instream concentrations estimates are based on facility plant flow (875 MLD)
^e The carbon tetrachloride risk evaluation did not include discharges from Eagle US 2 facility.

Because the Eagle US 2 facility releases of 1,2-dichloroethane result in the highest 1,2-dichloroethane receiving water body concentrations, EPA considered this facility to be appropriate of representing high-end byproduct surface water exposures. Therefore, the Agency used the estimated byproduct surface water concentrations presented in Table 2-10 to assess both aquatic and general population exposures and any associated risks.

2.2.3 Weight of Scientific Evidence for Byproduct Environmental Concentrations

Releases from industrial facilities, either to surface waters or to ambient air, contribute to concentrations of the byproducts in the environment. The ability to locate releases by location reduces uncertainty in assumptions when selecting model input parameters that are typically informed by location (*e.g.*, meteorological data, land cover parameters for air modeling, flow data for water modeling).

Ambient Air

The largest source of uncertainty in the estimation of ambient air concentrations was in the releases used. Although the fenceline analyses reported releases of some of the chemicals at facilities that are also 1,2-dichloroethane manufacturing facilities, not every 1,2-dichloroethane manufacturing facility reported releases of every byproduct. The releases in the fenceline analyses also total releases of each

⁸ The 7Q10 is the lowest 7-day average flow that occurs (on average) once every 10 years; the 30Q5 is the lowest 30-day average flow that occurs (on average) once every 5 years.

chemical assessed and not just the releases associated with the chemical produced as a byproduct. Due to the uncertainties associated with the releases modeled in the fence line analyses, EPA estimated releases of individual byproducts by multiplying TRI-reported releases of 1,2-dichloroethane by the associated byproduct chemical concentrations in the non-purified product stream presented in Table 1-1, which has high-end estimates of the byproduct concentrations. Additionally, EPA did a comparison of the estimated releases in this TSD to the release amounts published in the fence line analyses as a line of evidence to demonstrate that the releases in this TSD are not an overestimation relative to the releases coming from the overall Manufacturing COU previously modeled (Table 2-5).

Additionally, EPA modeled ambient air concentrations for each byproduct using the highest reported release for each individual facility in the Manufacturing COU for the years of 2015 to 2024. The Agency conducted HEM5.0 modeling in the analysis as opposed to the IIOAC modeling used in the fence line analyses because HEM5.0 provides a more refined population analysis than the previous modeling and uses facility-specific release data (*i.e.*, land use and meteorological data). The use of HEM5.0 to estimate ambient air concentrations is well supported as it uses AERMOD, which is EPA's primary regulatory model for ambient air modeling and is peer reviewed as part of the regulatory model process described in Appendix W to 40 CFR part 51, as a compiled executable program. Based on the overall uncertainties described in this paragraph, EPA has moderate confidence in accuracy of the ambient air concentrations of the byproducts but has robust confidence that the concentrations represent high-end estimates.

Surface Water

EPA estimated surface water releases of 1,2-dichloroethane and the associated byproducts in effluent resulting from 1,2-dichloroethane manufacturing. The Agency has high confidence in the facility-reported NPDES permit discharge monitoring data presented in the individual byproduct chemical risk evaluations and in this TSD. However, EPA relied on the assumption that the percentages of byproducts in the non-purified process stream of 1,2-dichloroethane manufacturing, as provided by Vinyl Institute, are the same as in the effluent and also accounts for the chemical-specific wastewater treatment efficiency. The Agency does not have reasonably available data to verify this assumption through empirical monitoring. The comparison between current estimates and previously published data presented in Section 2.2 do not contradict the assumption that byproducts are found in lower or similar quantities as when manufactured intentionally.

EPA was unable to identify other facilities that reported manufacturing 1,2-dichloroethane releases as well as all of the assessed byproducts and is thus relying on the Eagle2 facility as representative of possible byproduct formation and releases. The Eagle US 2 facility releases of 1,2-dichloroethane from the Manufacturing COU also resulted in the highest 1,2-dichloroethane surface water concentrations across all 1,2-dichloroethane manufacturing facilities. Therefore, because the amounts of byproducts formed are a percentage of manufacturing releases of 1,2-dichloroethane, this facility also represents a plausible upper bound for potential byproduct stream concentrations.

3 ENVIRONMENTAL RISK ASSESSMENT

3.1 Environmental Exposure

EPA used 7Q10 flows to calculate 1,2-dichloroethane concentrations in surface water and to assess the aquatic concentrations resulting from the Manufacturing COU release estimates (Section 2.2.2). The highest 1,2-dichloroethane concentration for the Manufacturing COU associated with a 7Q10 flow and a 350-day facility operating days release was multiplied by the weight percent of each byproduct in the non-purified product stream to estimate the resulting surface water concentration for each byproduct. The resulting concentrations were compared to the most sensitive aquatic concentration of concern (COC) for each byproduct to derive a screening risk quotient (RQ) value.

Table 3-1. Aquatic Ecological Species Exposures to Estimated Byproduct Concentrations in Receiving Water Body

Chemical/ Byproduct	Daily release (kg/day)	Days of Release	Facility Plant Flow (MLD) ^a	Chemical Concentration in Receiving Water ^b (µg/L)
1,1-Dichloroethane	5.8E-02	350	875	6.67E-02
Trichloroethylene	2.6E-04	350	875	3.05E-04
Perchloroethylene	7.2E-04	350	875	8.26E-04
Methylene chloride	1.7E-02	350	875	1.97E-02
Carbon tetrachloride	4.8E-03	350	875	5.50E-03

MLD = million of liters per day
^a Eagle US 2 Manufacturing facility plant flow was compared to receiving water body (Bayou d'Inde) 7Q10 flow and was used to calculate instream chemical concentrations. 7Q10 (7 consecutive days of lowest flow over a 10-year period that represents the lowest flows across other flow metrics (e.g., 30Q5 and harmonic mean) and is commonly used when evaluating aquatic environments)
^b Estimated concentration in receiving water body (Bayou d'Inde).

Exposure to terrestrial species via soil is not expected based on the physical and chemical and fate properties of the byproducts. The byproducts are not expected to partition to or accumulate in soil and are not anticipated to be retained in biosolids (log K_{OC} : 1.4 to 2.83; Henry's Law constant: 3.3×10^{-3} atm-m³/mole to 2.8×10^{-2} atm-m³/mole; vapor pressure: 19 mmHg at 25 °C to 435 mmHg at 25 °C). The byproducts are not expected to bioaccumulate in tissues (bioconcentration factor [BCF]: 2.6–312). Inhalation and dermal exposures are expected to be secondary to oral ingestion based on EPA's Guidance for Ecological Soil Screening Levels ([U.S. EPA, 2005, 2003](#)).

3.2 Environmental Hazards

The environmental hazards and associated weight of scientific evidence for each byproduct are described in full in each respective risk evaluation (Table 3-2).

Table 3-2. EPA Risk Evaluations for Chemicals Relevant to the 1,2-Dichloroethane Byproducts Assessment

Chemical	U.S. EPA Risk Evaluation Reference
1,1-Dichloroethane	U.S. EPA (2025a)
Trichloroethylene	U.S. EPA (2020j)
Perchloroethylene	U.S. EPA (2020i)
Methylene chloride	U.S. EPA (2020h)
Carbon tetrachloride	U.S. EPA (2020g)

3.2.1 Environmental Hazard Thresholds

The aquatic COCs for each byproduct assessed in this TSD are presented below in Table 3-3. The terrestrial hazard thresholds for 1,1-dichloroethane, which is the only byproduct with terrestrial hazard thresholds and quantitatively assessed risk to terrestrial species in its risk evaluation, are presented in Table 3-4. If more than one COC was available for a given exposure duration, media, and chemical (e.g., acute aquatic exposure to methylene chloride), then only the lowest COC was selected for use in the initial screening byproducts assessment. There were alternative COCs available from the final risk evaluations for methylene chloride, perchloroethylene, and trichloroethylene. Refinement in COC selection was not necessary, as the byproducts did not proceed beyond initial screening.

Table 3-3. Environmental Hazard Thresholds for Aquatic Environmental Toxicity

Environmental Aquatic Toxicity	Assessment Factor	Acute to Chronic Ratio	COC (ppb) ^a	Assessment Medium	Hazard Confidence
1,1-Dichloroethane					
Acute aquatic exposure: lower 95% CI of HC05 from SSD ^b	N/A	N/A	8,931	Water column	Robust
Chronic aquatic exposure: based on aquatic invertebrate ChV	10	N/A	93	Water column	Robust
Aquatic plant exposure: based on algae ChV ^c	10	N/A	1,000	Water column	Moderate
Acute benthic exposure: lower 95% CI of HC05 from SSD ^b	N/A	N/A	8,931	Benthic pore water	Moderate
Chronic benthic exposure: based on benthic invertebrate EC10 ^d	10	N/A	6,800	Benthic pore water	Moderate
Chronic benthic exposure: based on benthic invertebrate ChV ^d	10	N/A	2,900	Sediment	Moderate
Trichloroethylene					
Acute aquatic exposure: based on HC05 from SSD	5	N/A	2,000	Water column	High
Chronic aquatic exposure: based on fish EC20	10	N/A	788	Water column	High
Aquatic plant exposure: based on algae ChV	10	N/A	3	Water column	High
Acute benthic exposure: based on HC05 from SSD	5	N/A	2,000	Benthic pore water	High
Chronic benthic exposure: based on invertebrate ChV	10	N/A	920	Benthic pore water	High
Perchloroethylene					

Environmental Aquatic Toxicity	Assessment Factor	Acute to Chronic Ratio	COC (ppb) ^a	Assessment Medium	Hazard Confidence
Acute aquatic exposure: based on aquatic invertebrate EC50	5	N/A	1,400	Water column	High
Chronic aquatic: based on aquatic invertebrate ChV	10	N/A	50	Water column	High
Aquatic plant exposure: based on algae EC50	10	N/A	360	Water column	Medium
Methylene chloride ^e					
Acute aquatic exposure: based on amphibian LC50 geometric mean	10	N/A	2,630	Water column	–
Chronic aquatic exposure: based on amphibian LC10 geometric mean	10	N/A	90	Water column	–
Aquatic plant exposure: based on algae EC50	10	N/A	3,310	Water column	–
Acute benthic exposure: based on aquatic invertebrate EC50 and LC50 geometric mean	5	N/A	36,000	Benthic pore water	–
Chronic benthic exposure: based on aquatic invertebrate ChV	10	10	1,800	Benthic pore water	–
Carbon tetrachloride					
Acute aquatic exposure: based on amphibian LC50	10	N/A	90	Water column	High
Chronic aquatic exposure: based on amphibian LC10	10	N/A	3	Water column	High
Aquatic plant exposure: based on algae EC10	10	N/A	7	Water column	High
Acute benthic exposure: based on benthic invertebrate LOEL	5	N/A	400	Benthic pore water	High
Chronic benthic exposure: based on benthic invertebrate LOEL	N/A	10	40	Benthic pore water	High
<p>CI = confidence interval; ChV = chronic value; COC = concentration of concern; EC10/20/50 = effect concentration at which 10, 20, or 50% of test organisms exhibit an effect; HC05 = hazardous concentration for 5% of species; LC10/50 = lethal concentration at which 10 or 50% of test organisms die; LOEL = lowest-observed-effect level; SSD = species sensitivity distribution</p> <p>^a COCs are described in more detail in each chemical's respective risk evaluation.</p> <p>^b Includes both 1,1-dichloroethane and analog 1,2-dichloropropane data.</p> <p>^c Based on analog 1,2-dichloropropane data.</p> <p>^d Based on analog 1,1,2-trichloroethane data.</p> <p>^e Confidence in hazard thresholds was not characterized as high, medium, or low for methylene chloride. Refer to Section 3.1.3 of the <i>Risk Evaluation for Methylene Chloride</i> (U.S. EPA, 2020h) for information regarding the hazard weight of scientific evidence.</p>					

Table 3-4. Environmental Hazard Thresholds for Terrestrial Environmental Toxicity

Environmental Terrestrial Toxicity	Hazard Value or Toxicity Reference Value (TRV) ^a	Assessment Medium	Hazard Confidence
1,1-Dichloroethane			
Mammal: TRV	1,189 mg/kg-bw/day	Dietary (trophic transfer)	Moderate
Terrestrial plant: based on <i>Populus x canadensis</i> EC50	802 mg/L	Soil pore water	Slight
^a Hazard thresholds are described in more detail in the <i>Risk Evaluation for 1,1-Dichloroethane</i> (U.S. EPA, 2025a)			

3.3 Environmental Risk Conclusions

3.3.1 Risk Conclusion for Aquatic Species

Surface water concentrations were calculated as described in Sections 2.2.2 and 3.1 and compared to the most sensitive aquatic COC for each byproduct. The resulting RQ values are less than 1 for all byproducts. Thus, no risk is expected from exposure of the byproducts to aquatic species.

Table 3-5. Aquatic Ecological Species Risk Screen for Estimated Byproduct Concentrations in Receiving Water Body

Chemical/Byproduct	Daily Release (kg/day)	Days of Release	Receiving Water Body (Bayou D'Inde) 7Q10 Flow (MLD ^a)	Chemical Concentration in Receiving Water ^b (µg/L)	Ecological Chronic Concentration of Concern (µg/L) ^c	Risk Screen (RQ > 1)
1,1-Dichloroethane	5.8E-02	350	875	6.7E-02	93	7.2E-04
Trichloroethylene	2.6E-04	350	875	3.1E-04	3	1.0E-04
Perchloroethylene	7.2E-04	350	875	8.3E-04	50	1.7E-05
Methylene chloride	1.7E-02	350	875	2.0E-02	90	2.2E-04
Carbon tetrachloride	4.8E-03	350	875	5.5E-03	3	1.8E-03
MLD = million liters per day; RQ = risk quotient						
^a Eagle US 2 Manufacturing facility receiving water body (Bayou d'Inde) 7Q10 flow (7 consecutive days of lowest flow over a 10-year period)						
^b Estimated concentration in receiving water body (Bayou d'Inde).						
^c Chemical-specific aquatic concentration of concern (COC; see also Table 3-3).						

3.3.2 Risk Conclusion for Terrestrial Species

No risk is expected from byproduct exposure to terrestrial species based on the previous risk evaluations. No risk was observed for terrestrial species in the 1,1-dichloroethane risk evaluation, which is the only risk evaluation of the byproduct chemicals that quantitatively assessed risk to terrestrial species. Trichloroethylene, perchloroethylene, methylene chloride, and carbon tetrachloride determined in their respective risk evaluations that there was no terrestrial exposure pathway based on the physical and chemical and fate properties of each chemical. Additionally, no risk is expected from the assessed byproducts as these chemicals possess similar physical chemical and fate properties to 1,1-dichloroethane and are volatile chemicals that are not expected to be bioaccumulative.

4 HUMAN HEALTH EXPOSURES ASSESSMENT

4.1.1 Occupational Exposure Assessment

The following subsections describe EPA's approach to assessing the occupational exposures to the byproducts produced during the manufacture of 1,2-dichloroethane and provide the results of the occupational exposure assessment. The Agency assessed exposures to workers via inhalation and dermal routes. For estimates based on inhalation monitoring data, the 50th percentile of the exposure data were used for the central tendency and the 95th percentile was used for the high-end estimate. For deterministic modeling, EPA selected values for the model input parameters for the central tendency and high-end exposure estimates. The full inputs and results are presented in the *Byproducts Risk Calculator for 1,2-Dichloroethane* ([U.S. EPA, 2026c](#)) and the *Byproducts Risk Calculator for 1,2-Dichloroethane with Adjusted Working Years* ([U.S. EPA, 2026m](#)).

4.1.1.1 Worker Activities

Workers are potentially exposed to the byproducts in similar ways to how they may be exposed to 1,2-dichloroethane during its manufacture. A final study report submitted to EPA by the Vinyl Institute ([Stantec ChemRisk, 2024](#)) described worker activities per similar exposure group (SEG) that occurred at 1,2-dichloroethane manufacturing sites during sampling that provided inhalation test order monitoring data. EPA assumed that the activities described by Vinyl Institute are applicable to 1,2-dichloroethane manufacturing facilities throughout the country, and workers may experience inhalation and dermal exposure to 1,2-dichloroethane during these tasks. The four SEGs included operators, logistics technicians, laboratory technicians, and maintenance technicians. Additionally, for each of these SEGs, the Vinyl Institute provided task-level SEG categories, with information on weekly task frequency, daily frequency range, and average task duration. Additional information on frequency and duration of the tasks described in the final study report was provided in follow-up communication from the Vinyl Institute ([EPA-HQ-OPPT-2018-0427-0181](#)).

Operators at facilities that manufacture 1,2-dichloroethane were reported to conduct process sample collection for quality assurance and control purposes, open process lines and equipment in preparation for maintenance activities, conduct process area walk-throughs, and monitor process equipment for leaks or abnormal activities. Standard operating procedures (SOPs) are in place on how to perform specific tasks such as purging process lines. The Vinyl Institute noted employee versatility among the operator SEG, where a single worker may conduct tasks relevant to several different SEGs. In some circumstances, particularly at smaller facilities, operators often assisted with loading and unloading tasks on a routine or as-needed basis.

Operators and process technicians were reported to perform closed loop sample collection tasks on a daily basis, with daily frequency ranges from 1 to 2 times per shift (high concentration) or 1 to 3 times per shift (low-to-moderate concentration) and open loop sample collection (low-to-moderate concentration) 1 to 2 times per shift. Maintenance preparation and other tasks with exposure potential were described as occurring on a daily to "as needed" basis. Daily frequency ranged from 1 to 2 times per shift to "as needed." Average task durations for described operator tasks ranged from 0.25 to 0.75 hours ([Stantec ChemRisk, 2024](#)). Additional information on average task frequency was provided by the Vinyl Institute in a follow up communication ([EPA-HQ-OPPT-2018-0427-0181](#)). For manufacturing, reported average task frequency was 200 days per year for sample collection (closed and open loop samples), 96 days per year for maintenance preparation, and 233 days per year for sample processing.

According to the final study report, routine daily tasks performed by logistics technicians during inhalation sampling included inspections, permitting, spotting for drivers, connecting and disconnecting

hoses during chemical transfers, purging hoses, filling storage tanks, and loading and offloading bulk chemicals into and from ships, tanker trucks, totes, railcars, or barges ([Stantec ChemRisk, 2024](#)). Logistics technicians at facilities that manufacture 1,2-dichloroethane loaded products into the process from rail cars and barges and unloaded 1,2-dichloroethane onto rail carts or totes in an “on-demand” basis (which may be weekly, monthly, or less frequently). Barge and Truck loading and offloading tasks were described as being performed on a daily basis, one to two times per shift, with an average task duration of 0.25 and 1 hour; railcar loading and offloading reportedly occurred on an as needed to daily basis. The daily frequency ranged from as needed to one time per shift, and with an average task duration of 0.75 hours. Reported average task frequency was 50 days per year for loading and offloading tasks (including railcar, truck, and barge loading tasks) ([EPA-HQ-OPPT-2018-0427-0181](#)).

Laboratory technicians at facilities that manufacture 1,2-dichloroethane handled samples and processed them for analysis under a fume hood. Typical tasks included processing samples collected from the field by other workers, and routine laboratory duties such as housekeeping, paperwork, and routine laboratory equipment maintenance. Sample processing tasks were reported to occur on a daily to monthly basis, with a daily frequency range of 1-5 times per shift and an average duration of 0.75 hours per task. Other tasks with exposure potential were reported to occur on a daily to twice-weekly basis, with a daily frequency of one to four times per shift and an average task duration of 0.25 hours per task. For manufacturing, reported average task frequency was 166 days per year for sample processing ([EPA-HQ-OPPT-2018-0427-0181](#)).

Maintenance technicians at facilities that manufacture 1,2-dichloroethane perform a wide variety of tasks. Because equipment is typically purged prior to maintenance activities, working with open equipment does not present as high of an exposure potential as may occur with other SEGs interacting with open process lines and equipment. Additionally, maintenance technicians may be assigned to multiple process areas, some of which were not associated with 1,2-dichloroethane manufacturing. Routine duties performed by maintenance technicians include rounds, permitting, air monitoring, and preparation for maintenance tasks that may include preparing and setting up equipment and personal protective equipment (PPE). They also conduct instrumentation checks as well as line breaks and equipment opening. Daily task frequency ranged from “as needed” to five times per shift, with an average task duration of 1 hour. Maintenance technicians were also reported to perform routine duties such as rounds, housekeeping, paperwork, and ordering parts. They also installed, adjusted, and deconstructed equipment as well as conducted line breaks and equipment opening for maintenance tasks. Maintenance technicians were reported to perform other tasks with exposure potential on a “random” basis, with an average task duration of four hours. For manufacturing, reported average task frequency was 128 days per year for line breaks and equipment opening and 75 days per year for electrical and instrumentation checks ([EPA-HQ-OPPT-2018-0427-0181](#)).

ONUs at facilities that manufacture 1,2-dichloroethane were maintenance supervisors, engineers, control board operators, project engineers and managers, senior process and technical advisors, maintenance coordinations, and environment, health, and safety (EHS) technicians. Routine tasks performed during sampling varied and included process area walk-throughs, equipment inspections, maintenance activity observations, logistics and maintenance trouble shooting, and indoor administrative and control room tasks. Because ONUs do not directly handle 1,2-dichloroethane, they are expected to have lower inhalation exposures and are not expected to have dermal exposures. Information on frequency and duration of tasks for ONUs was not provided.

Worker Demographic Data

Information on worker demographics, including length of service (years) of employees at a particular

facility, was received as part of the Vinyl Institute Consortium Test Order submission ([Stantec ChemRisk, 2024](#)) ([EPA-HQ-OPPT-2018-0427-0169](#); [EPA-HQ-OPPT-2018-0427-0181](#)). Demographic information for the overall workforce and by SEG was reported, including the mean and range of length of service in years. This information was collected from the same facilities that were included in the 1,2-dichloroethane inhalation monitoring study, and the length of service was aggregated across all sites that reported inhalation monitoring data. The overall mean length of service was reported as being calculated as a weighted average based on the number of workers per SEG reported by each site.

For manufacturing of 1,2-dichloroethane, the overall mean length of service across five facilities (n=494 workers) was reported as 8.9 years. Mean length of service varied by SEG, and the mean length of service by SEG ranged from 4.6 years (logistics technicians) to 15.6 years (laboratory technicians). Only one site reported a range for length of service (0–33 years).

4.1.1.2 Number of Workers

Because the production of byproducts occurs during the process that manufactures 1,2-dichloroethane, the number of workers who may be exposed to the byproducts is expected to be the same as the number of workers who may be exposed to 1,2-dichloroethane (Table 4-1). See the *Occupational Exposure Assessment for 1,2-Dichloroethane* ([U.S. EPA, 2026j](#)) for more details on these estimates.

Table 4-1. Estimated Number of Workers Potentially Exposed During 1,2-Dichloroethane Manufacturing

Estimated Number of Sites	NAICS Code	Exposed Workers per Site ^a	Exposed Occupational Non-Users per Site ^a
41	325199 – All Other Basic Organic Chemical Manufacturing	33	16
	325180 – Other Basic Inorganic Chemical Manufacturing		
	325110 – Petrochemical Manufacturing		
NAICS = North American Industry Classification System ^a Number of workers and occupational non-users (ONUs) per site calculated by dividing the exposed number of workers (1,353) or ONUs (656) by the number of establishments.			

4.1.1.3 Occupational Exposure Methodology

4.1.1.3.1 Inhalation Exposure

Based on the data available, EPA assessed inhalation exposure for byproducts using two approaches as previously used in the *Risk Evaluation for 1,1-Dichloroethane* and the *Risk Evaluation for 1,2-Dichloroethane* ([U.S. EPA, 2026k, 2025a](#)). An overview of both approaches is described below, and more detail is provided in subsequent sections of this TSD:

- *Approach 1:* When inhalation monitoring data were available for a byproduct produced during the 1,2-dichloroethane manufacturing process, the data were used directly. Only one byproduct, 1,1-dichloroethane, had such data from the 1,1-dichloroethane test order ([Stantec ChemRisk, 2023](#)), which measured 1,1-dichloroethane manufactured during 1,2-dichloroethane.
- *Approach 2:* When inhalation monitoring data were not available for a byproduct produced during the 1,2-dichloroethane manufacturing process, either from systematic review or from test orders (as was the case for trichloroethylene, perchloroethylene, methylene chloride, and carbon tetrachloride), EPA used surrogate data from 1,2-dichloroethane manufacturing. Inhalation

exposures were estimated by adjusting for vapor pressure and mole fractions to estimate individual byproduct exposures. Specifically, inhalation monitoring data for 1,2-dichloroethane for manufacturing, submitted by the Vinyl Institute ([Stantec ChemRisk, 2024](#)), were used as surrogate data for trichloroethylene, perchloroethylene, methylene chloride, and carbon tetrachloride.

Approach 1: Use of Directly Applicable Inhalation Monitoring Data

For 1,1-dichloroethane, *Approach 1* was utilized because occupational inhalation data were provided via a test order submission from the Vinyl Institute ([Stantec ChemRisk, 2023](#)). EPA identified 72 worker and 26 ONU full-shift PBZ samples from the test order data to estimate inhalation exposures to the 1,1-dichloroethane byproduct manufactured during the manufacturing of 1,2-dichloroethane. Note that in general, samples for employees that directly handled the chemical are categorized as “worker” and samples for employees that did not directly handle the chemical but are present at the facility are categorized as “occupational non-user” (ONU). In addition to the full-shift samples, the test order provided 23 task-length and 22 STEL (short-term exposure limit) PBZ samples. The data included samples from three representative facilities: Olin Corporation in Freeport, Texas, Oxy Vinyls LP in La Porte, Texas, and Westlake Chemical – Plaquemine in Plaquemine, Louisiana.

Table 4-2. Summary of Inhalation Monitoring Exposure Concentrations to 1,1-Dichloroethane During the Manufacturing of 1,2-Dichloroethane Based on Vinyl Institute Test Order Data^a

Exposure Type	Worker Description	No. of Samples	Number of Non-Detects ^b	Sample Duration (minutes)	Test Order Inhalation Monitoring Exposure Concentrations (ppm)	
					Central Tendency ^c	High-End ^c
Full-shift exposure concentrations	Operator/Process Technician	31	7	480	1.6E-03	9.0E-03
	Maintenance Technician	17	6		2.3E-04	2.7E-03
	Logistics/Distribution Technician	7	4		6.7E-05	1.6E-03
	Laboratory Technician	17	8		1.6E-04	3.3E-03
	ONU	26	14		6.9E-05	4.6E-03
Task-length exposure concentrations	Operator/Process Technician	9	5	17-115	2.2E-03	5.7E-02
	Maintenance Technician	4	2	17-92	3.0E-03	1.9E-02
	Logistics/Distribution Technician	2	1	145-146	3.8E-03	6.9E-03
	Laboratory Technician	8	4	31-174	2.1E-03	5.9E-03

ONU = occupational non-user

^a TSCA section 4(a)(2)(A)(i) allows the EPA to impose testing requirements via “rule, order, or consent agreement” whenever new information “is necessary” to perform a risk evaluation (15 U.S.C. 2603(a)(2)(A)(i)). EPA issued a test order for 1,1-dichloroethane manufactured as a byproduct in the manufacture of 1,2-dichloroethane ([Stantec ChemRisk, 2023](#)).

^b For the non-detects, all datasets for had a geometric standard deviation >3, so the limit of detection was divided by 2. For full-shift samples, the detection limit ranged from 0.09–0.28 ppb. For task-length samples, the limit of detection ranged from 0.37–3.8 ppb. EPA utilized a refined analysis method using maximum likelihood estimation (MLE) for cases with a high percentage of non-detects, when applicable. However, this method was not applied as Table 6-4 shows no MOE estimates for 1,1-dichloroethane below the chronic non-cancer (or acute non-cancer) benchmark and above the cancer benchmark. Thus, refinement was not necessary.

^c The high-end estimate is based on the 95th percentile of the monitoring dataset collected for each similar exposure group (SEG). The central tendency estimate is based on the 50th percentile of the monitoring dataset collected for each SEG. Sample durations were often longer than 8 hours; 8-hour TWAs were calculated from the full-shift results by multiplying the full-shift exposure (ppm) × (sample duration [hours]/8-hour)

Approach 2: Use of Surrogate Inhalation Monitoring Data

For the remaining byproducts (trichloroethylene, perchloroethylene, methylene chloride, and carbon tetrachloride), EPA used *Approach 2*, as inhalation monitoring data specific to production during the 1,2-dichloroethane manufacturing process were not identified from systematic review, test orders, or other reasonably available sources. The Agency assessed inhalation exposures using surrogate monitoring data from manufacturing of 1,2-dichloroethane ([Stantec ChemRisk, 2024](#)) and concentrations of the byproducts in the 1,2-dichloroethane stream and waste streams ([VI, 2020, 2017](#)). The inhalation monitoring data and concentration data were both provided by Vinyl Institute. Under section 4(a) of TSCA, EPA issued a test order requiring manufacturers and processors of 1,2-dichloroethane to develop and submit certain information on occupational exposure pathways for 1,2-dichloroethane ([EPA-HQ-OPPT-2018-0427-0050](#)⁹). In response, the Vinyl Institute formed a testing consortium, and prepared a study plan to collect inhalation monitoring data, including identification of representative sites for sampling ([Stantec ChemRisk, 2024](#)). Sampling was conducted following EPA's review and approval of the study plan. The testing consortium provided occupational exposure information on seven manufacturing sites from their members, including five facilities that manufacture 1,2-dichloroethane (from 16 identified sites). Results of the inhalation monitoring study were provided in the Vinyl Institute Consortium Final Study Report, and included inhalation monitoring data as well as information on worker activities, exposure controls, and PPE ([Stantec ChemRisk, 2024](#)). This information was used to assess exposures for the Manufacturing of 1,2-Dichloroethane occupational exposure scenario (OES) as part of the *1,2-Dichloroethane Risk Evaluation*.

EPA utilized the following equation (Equation 4-1) to estimate concentrations for the remaining byproducts:

Equation 4-1.

$$C_{byproduct} = C_{known} \frac{VP_{byproduct} X_{byproduct}}{VP_{known} X_{known}}$$

Where:

$C_{byproduct}$	=	Estimated airborne concentration of the byproduct (ppm)
C_{known}	=	Airborne concentration of known chemical (ppm)
$VP_{byproduct}$	=	Vapor pressure of the byproduct (torr)
$X_{byproduct}$	=	Mole fraction of the byproduct
VP_{known}	=	Vapor pressure of known chemical (torr)
X_{known}	=	Mole fraction of known chemical

EPA estimated inhalation exposures assuming both potential worker inhalation exposure to the unpurified 1,2-dichloroethane stream and the light- and heavy-end streams. Information utilized for each of the variables in this equation is provided below. The results for these calculations can be found in Section 4.1.1.5.

Information Utilized for C_{known} :

Table 4-3 summarizes the inhalation exposure data for 1,2-dichloroethane, which were used as surrogate data in this assessment. The concentrations from this table were used in the C_{known} variable in the *Approach 2* (Equation 4-1.) above.

⁹ The dermal wipe sampling requirements in TSCA section 4(a) test orders were suspended.

Table 4-3. Full-Shift Duration of Inhalation Exposures to 1,2-Dichloroethane During Manufacture of 1,2-Dichloroethane Based on Vinyl Institute Test Order Data^a

Worker Description	No. of Samples ^b	8-Hour TWA Exposure Concentrations	
		Central Tendency (ppm) ^c	High-End (ppm) ^c
Operators	53	0.48	7.3
Logistics Technicians	9	1.7E-02	0.24
Maintenance Technicians	32	4.9E-02	1.6
Laboratory Technicians	29	4.7E-02	1.3
ONU	39	1.4E-02	1.6

ONU = occupational non-user; TWA = time-weighted average
^a TSCA section 4(a)(2)(A)(i) allows the EPA to impose testing requirements via “rule, order, or consent agreement” whenever new information “is necessary” to perform a risk evaluation (15 U.S.C. 2603(a)(2)(A)(i)). EPA issued a test order for 1,2-dichloroethane on January 14, 2021; see https://www.epa.gov/sites/default/files/2021-01/documents/tsca_section_4a2_order_for_12-dichloroethane_on_ecotoxicity_and_occupational_exposure_0.pdf (Stantec ChemRisk, 2024).
^b There were no samples below the limit of detection.
^c The high-end is the 95th percentile and the central tendency is the 50th percentile (median) of occupational exposures among all workers within a similar exposure group (SEG); source: (Stantec ChemRisk, 2024).

Information Utilized for $VP_{byproduct}$ and VP_{known} :

- Per Equation 4-1, the vapor pressure for each chemical is needed to calculate the airborne concentration of each byproduct according to *Approach 2*; these values are provided in Table 4-4. The vapor pressure of 1,2-dichloroethane was VP_{known} , and the vapor pressure of each byproduct was $VP_{byproduct}$. These values were obtained from the chemicals’ respective final risk evaluations.

Table 4-4. Vapor Pressures of 1,2-Dichloroethane and Byproducts

Chemical	Vapor Pressure (torr)	Reference
1,2-Dichloroethane	78.9 mmHg at 25 °C	Table 2-1 U.S. EPA (2026k)
Trichloroethylene	73.72 mmHg at 25°C	Table 1-1 U.S. EPA (2020j)
Perchloroethylene	18.5 mmHg at 25°C	Table 1-1 U.S. EPA (2020i)
Methylene chloride	435 mmHg at 25°C	Table 1-1 U.S. EPA (2020h)
Carbon tetrachloride	115 mmHg at 25°C	Table 1-1 U.S. EPA (2020g)

Information Utilized for $X_{byproduct}$ and X_{known} (mole fraction):

- EPA assessed inhalation occupational exposures to both unpurified 1,2-dichloroethane (considered a low-end exposure estimate), and light- and heavy-end liquid streams (considered a high-end exposure estimate). Low-end concentrations were estimated for each of the byproducts based on the weight percent of the byproduct in the unpurified 1,2-dichloroethane stream. Table 4-5 summarizes the byproduct concentrations estimated by the Vinyl Institute for the unpurified 1,2-dichloroethane waste stream. The unpurified stream is the product stream directly from the manufacturing process; therefore, the byproducts have not yet been separated from the 1,2-dichloroethane product. The original data were provided in weight percent and subsequently

converted to mole fractions (mol%). The mole fractions are used for the $X_{\text{byproduct}}$ variable of the *Approach 2*. EPA estimated central tendency and high-end byproduct 8-hour TWAs based on the central tendency and high-end 1,2-dichloroethane 8-hour TWAs for the manufacturing OES. See Equation 4-1 above to estimate occupational exposure to the given byproduct from the unpurified 1,2-dichloroethane stream.

Table 4-5. Byproduct Concentrations in Unpurified 1,2-Dichloroethane Product Streams Provided by the Vinyl Institute

Byproduct	Estimated Byproduct Concentration in Unpurified 1,2-Dichloroethane (Weight %)	Maximum Byproduct Concentration in Unpurified 1,2-Dichloroethane (mol %)	Source
Trichloroethylene	<0.0035%	0.0026%	VI (2017)
Perchloroethylene	<0.015%	0.0090%	
Methylene chloride	ppm quantities (assumed 0.0999%) ^a	0.12%	
Carbon tetrachloride	<0.15%	0.10%	

^a 0.0999% assumed when “ppm levels”/“quantities” was reported.

- High-end concentrations were estimated for each of the byproducts based on the maximum weight percent of the byproduct in light- and heavy-end liquid streams. Table 4-6 summarizes the byproduct concentrations provided by the Vinyl Institute for the light- and heavy-ends waste streams after 1,2-dichloroethane purification. These are the streams of more concentrated byproducts that have been separated from the now-purified 1,2-dichloroethane product. The original data were provided in weight percent and subsequently converted to mole fractions. The mole fractions are used for the $X_{\text{byproduct}}$ variable of Equation 4-1 to estimate occupational exposure to the given byproduct from the light- and heavy-end streams (see Sections 2.1.2.2 and 4.1.1.1 for details on process releases, and workers activities and potential exposures). In cases where a byproduct had a different concentration in the light-liquid ends and heavy-liquid ends, the greater concentration was used in the below table and subsequent calculations. X_{known} was estimated with the assumption that the remaining non-byproduct concentrations in the streams is 1,2-dichloroethane.

Table 4-6. Byproduct Concentration in Light- and Heavy-Ends Liquid Provided by the Vinyl Institute^a

Byproduct	Typical Composition in Light Liquid Ends (Weight %)	Typical Composition in Heavy Liquid Ends (Weight %)	Maximum Composition in Light/Heavy Liquid Ends (mol %) ^a	Source
Trichloroethylene	Trace quantities (assumed 0.0999%) ^b	0.23%	0.20%	VI (2017)
Perchloroethylene	None	1.1%	0.76%	
Methylene chloride	ppm quantities (assumed 0.0999%) ^b	None	0.13%	
Carbon tetrachloride	30%	None	22%	

^a Values represent the highest concentration in the light or heavy liquid ends, as converted to mol%.

Byproduct	Typical Composition in Light Liquid Ends (Weight %)	Typical Composition in Heavy Liquid Ends (Weight %)	Maximum Composition in Light/Heavy Liquid Ends (mol %) ^a	Source
^b EPA assumed that “trace” and “ppm” quantities have the same meaning and come directly from the public comment. Light-ends liquid streams are the more volatile fractions in the mixture, typically derived from the initial stages of refining process, known for their lower boiling points. Heavy-ends liquid streams are the less volatile, higher boiling point fractions obtained towards the later stages of the refining process.				

As described below, the assessment (using the byproduct concentrations described above) did not indicate worker risks for perchloroethylene or methylene chloride. However, inhalation risks were identified for trichloroethylene and carbon tetrachloride, prompting further refinement of the assessment for these byproducts. The section below describes the methods utilized to perform this refinement.

For trichloroethylene and carbon tetrachloride, EPA refined the analysis by presenting results for all SEGs listed in Table 4-3 and incorporating variability in the byproduct concentrations through a Monte Carlo Simulation to better characterize potential exposure ranges (Table 4-7). EPA used the Palisade @Risk Industrial Edition, Version 7.0.0 software with 100,000 iterations and the Latin Hypercube sampling method.

To capture the full range of potential exposure concentrations, EPA developed uniform distributions using the lowest and highest concentrations of each byproduct chemical reported in Table 4-5 and Table 4-6.

Table 4-7. Byproduct Concentrations of Trichloroethylene and Carbon Tetrachloride Used in Monte Carlo Simulation

Byproduct	Byproduct Concentration Lower Bound (mol %)	Byproduct Concentration Upper Bound (mol %)	Distribution Type
Trichloroethylene	0.0026%	0.20%	Uniform
Carbon tetrachloride	0.10%	22%	
Source: (EPA-HQ-OPPT-2018-0421-0027 ; EPA-HQ-OPPT-2016-0732-0013 ; EPA-HQ-OPPT-2019-0500-0101). Values were provided in weight percent and converted to mol %.			

Additionally, EPA developed estimates for multiple SEGs using data from the 1,2-dichloroethane test order, enabling a more refined and granular characterization of exposures across the following SEGs:

- Operator;
- Lab Technician;
- Logistics Technician;
- Maintenance Technician; and
- ONU.

EPA developed triangular distributions for each SEG using exposure estimates from the 1,2-dichloroethane Vinyl Institute Test Order data. The lower and upper bounds correspond to the minimum and maximum reported inhalation monitoring exposure concentrations for each SEG, and the mode represents the central tendency estimate.

Table 4-8. 1,2-Dichloroethane Inhalation Exposure Concentrations Used in Monte Carlo Simulation

SEG	8-Hour TWA Exposure Concentrations			Distribution Type
	Lower Bound (ppm)	Upper Bound (ppm)	Mode (ppm)	
Operator	5.7E-03	9.6	0.48	Triangular
Lab Technician	1.8E-03	2.8	4.7E-02	
Logistics Technician	2.0E-03	0.29	1.7E-02	
Maintenance Technician	4.5E-03	2.7	4.9E-02	
ONU	2.2E-04	1.9	1.4E-02	

ONU = occupational non-user; SEG = similar exposure group; TWA = time-weighted average

EPA applied the distributions in Table 4-7 and Table 4-8 in a Monte Carlo simulation using Equation 4-1. to estimate inhalation exposure concentrations for these byproducts. The 50th and 95th percentile model outputs were selected to represent the central tendency and high-end exposure estimates, respectively, for each SEG. Additional details are provided in the *Byproducts Risk Calculator for 1,2-Dichloroethane* (U.S. EPA, 2026c) and the *Byproducts Risk Calculator for 1,2-Dichloroethane with Adjusted Working Years* (U.S. EPA, 2026m).

These refinements provide a more robust and representative characterization of potential exposures across SEGs for these two byproducts. The results for these calculations can be found in Section 4.1.1.5.

4.1.1.3.2 Dermal Exposure

Dermal exposure monitoring data were not reasonably available for the byproducts generated during the Manufacturing COU, including in the corresponding final risk evaluation. EPA used the Dermal Exposure to Volatile Liquids Model to estimate dermal exposure. This model calculates the acute absorbed dose rate (AADR) by considering the assumed amount of liquid on skin during one contact event per day and the theoretical steady-state fractional absorption, which estimates the absorbed portion of the applied dose. The following equation is used in this assessment to calculate AADR:

Equation 4-2.

$$APDR = S \times Q_u \times f_{abs} \times Y_{derm} \times FT$$

Where:

<i>AADR</i>	=	Acute absorbed dose rate
<i>S</i>	=	Surface area of skin
<i>Q_u</i>	=	Dermal load
<i>f_{abs}</i>	=	Fractional absorption values
<i>Y_{derm}</i>	=	Weight fraction of the chemical of interest in the liquid
<i>FT</i>	=	Number of dermal exposure events per day

EPA assessed dermal occupational exposures to both unpurified 1,2-dichloroethane (considered a low-end exposure estimates), and light- and heavy-end liquid streams (considered a high-end exposure estimates). Low-end concentrations were estimated for each of the byproducts based on the weight percent of the byproduct in the unpurified 1,2-dichloroethane stream. High-end concentrations were estimated for each of the byproducts based on the maximum weight percent of the byproduct in light- and heavy-end liquid streams. These concentration estimates were provided by Vinyl Institute and are

presented in Table 4-5 and Table 4-6, respectively. Table 4-9 provides a summary of the values that were used in this dermal assessment; the value for Y_{derm} was taken from Equation 4-2 above.

Table 4-9. Low- and High-End Byproduct Concentrations for Dermal Exposure Estimates

Byproduct	Low-End Concentration (Unpurified 1,2-Dichloroethane) (Weight %)	High-End Concentration (Maximum Concentrations in Light- and Heavy-Ends Liquid) (Weight %) ^a
1,1-Dichloroethane	0.29%	30%
Trichloroethylene	0.0035%	0.23%
Perchloroethylene	0.015%	1.1%
Methylene chloride	0.0999% ^b	0.0999% ^b
Carbon tetrachloride	0.15%	30%

^a Values represent the highest concentration in the light- or heavy-ends liquid streams.
^b The Vinyl Institute indicated “ppm quantities of methylene chloride”; EPA assumed a high-end concentration of 999 ppm.
 Light-ends liquid streams are the more volatile fractions in the mixture, typically derived from the initial stages of refining process, known for their lower boiling points. Heavy-ends liquid streams are the less volatile, and higher boiling point fractions obtained towards the later stages of the refining process.
 Source: ([EPA-HQ-OPPT-2018-0421-0027](#); [EPA-HQ-OPPT-2016-0732-0013](#); [EPA-HQ-OPPT-2019-0500-0101](#))

The fractional absorption values for each byproduct, f_{abs} , are summarized in Table 4-10. These values were obtained from the chemicals’ respective final risk evaluations. For 1,1-dichloroethane, the fraction absorbed value was based on test order data included in its risk evaluation ([U.S. EPA, 2025a](#)). For the other four byproducts, fractional absorption values were obtained from their respective final risk evaluations.

Table 4-10. Byproduct Fractional Absorption Values

Byproduct	Fractional Absorption (f_{abs})	EPA Risk Evaluation Reference Table/Section
1,1-Dichloroethane	0.003	Table_Apx D-1 U.S. EPA (2025b)
Trichloroethylene	0.08	Section 2.19 U.S. EPA (2020e)
Perchloroethylene	0.13	Table_Apx K-1 U.S. EPA (2020d)
Methylene chloride	0.08	Section 3.2 U.S. EPA (2020c)
Carbon tetrachloride	0.04	Table_Apx E-1 U.S. EPA (2020b)

The dermal load, Q_u , is the quantity of the chemical formulation on the skin after the dermal contact event, and is a constant expressed as 1.4 or 2.1 mg/cm² per event for central tendency or high-end exposures, respectively. The surface area of skin in contact with the chemical formulation, S , is assumed to be 535 or 1,070 cm² for central tendency or high-end exposures, respectively. It should be noted that though the surface area of exposed skin is derived from data for hand surface area, EPA did not assume that only the workers’ hands may be exposed to the chemical. Nor did EPA assume that the entirety of the hands are exposed for all activities. In applying the DEVL Model to estimate dermal exposures, EPA uses skin surface area values from the *Exposure Factors Handbook* ranging from the surface area of one hand (535 cm²) to two hands (1,070 cm²) for the central tendency and high-end exposure scenario, respectively.

The last variable, FT , represents the number of dermal exposure events per day. EPA does not have information on how many contact events may occur and the time between contact events; therefore, the Agency assumes that the task that may lead to dermal exposure to the amount specified in the Q_u

variable could occur once per day, and thus a single contact event per day is assumed for estimating dermal exposures. EPA considers this assumption appropriate for OESs that are closed system processes.

Dermal dose estimates are summarized in Section 4.1.1.6.

4.1.1.4 Estimating Acute, Intermediate, and Chronic (Non-Cancer and Cancer) Exposures

For each byproduct chemical, EPA assessed 1,2-dichloroethane inhalation and dermal exposures to workers and ONUs in occupational settings, presented as 8-hour (*i.e.*, full-shift) TWA described in Section 4.1.1. These estimated exposures were then used to calculate the following metrics: acute, intermediate, and chronic (non-cancer and cancer) inhalation exposures and dermal doses. These calculations require parameter inputs such as years of exposure, exposure duration and frequency, and lifetime years. EPA used combinations of point estimates of each parameter to estimate a central tendency and high-end for each exposure metric result. The Agency documented the method and rationale for selecting parametric combinations to be representative of central tendency and high-end in Section 4.1.1 and in the *Byproducts Risk Calculator for 1,2-Dichloroethane* ([U.S. EPA, 2026c](#)) and the *Byproducts Risk Calculator for 1,2-Dichloroethane with Adjusted Working Years* ([U.S. EPA, 2026m](#)).

Inhalation exposures to workers in occupational settings are presented as acute exposure (AC) concentrations, intermediate average daily concentrations ($ADC_{\text{intermediate}}$), Average Daily Concentrations (ADC) for chronic, non-cancer risks, and Lifetime Average Daily Concentrations for chronic, cancer risks (LADCs). Dermal exposures to workers in occupational settings are presented as a dermal AADR. The AADRs are then used to calculate acute absorbed doses (AAD), intermediate absorbed dose (IAD), chronic absorbed dose (CAD) for chronic non-cancer risks, and lifetime chronic absorbed dose (LCAD). Only 1,1-dichloroethane has intermediate exposure estimates; this was not estimated for the other byproduct chemicals because intermediate exposure duration was not evaluated in the respective risk evaluations.

Equations, parameter inputs, and sample calculations for inhalation and dermal exposures estimates can be found in Appendix A and Appendix B.

As described in Appendix A, working years are one of several parameters utilized in chronic cancer exposure estimates. When calculating chronic cancer estimates, EPA utilized information on working years from both the U.S. Bureau of Labor Statistics (BLS) ([U.S. Census Bureau, 2019a](#); [U.S. BLS, 2014](#)) and the Vinyl Institute ([VI, 2026](#)) ([EPA-HQ-OPPT-2018-0427-0181](#)). The central tendency and high-end estimates of working years from BLS represents an estimate of lifetime career working years and is further described in Appendix A. The BLS data used here is not specific to this industry. The demographic data provided by the Vinyl Institute is industry provided data on length of service (years) at the facilities in which the worker is currently employed and is further described in Section 4.1.1.1. Therefore, the working years data provided by Vinyl Institute does not represent lifetime working years. For the demographic data provided by the Vinyl Institute, the underlying, discrete data were not provided, and as such EPA could not calculate the 50th and 95th percentile. The Agency utilized the mean value in the central tendency calculations, and the maximum value in the high-end calculations.

While working years is a parameter in calculating chronic, non-cancer exposures (*e.g.*, ADC and CRD), the exposure dose over the working years is averaged over the working years. The working years are included in both the numerator and denominator in the calculations, and they cancel out (see Appendix A, Equation_Apx A-4 and Equation_Apx A-5). As such, EPA has included one set of chronic, non-

cancer values. For cancer effects, the exposure dose over the working years is averaged over the lifetime years, which includes the years with no exposure. EPA uses a default of 78 years for the length of lifetime years.

4.1.1.5 Occupational Inhalation Exposure Results

Table 4-11 presents the results of the inhalation exposure assessment for each byproduct, in addition to acute, intermediate, and chronic non-cancer and cancer exposure metrics. For more information on inhalation exposure estimates see the *Byproducts Risk Calculator for Occupational Exposures for 1,2-Dichloroethane* ([U.S. EPA, 2026c](#)) and the *Byproducts Risk Calculator for 1,2-Dichloroethane with Adjusted Working Years* ([U.S. EPA, 2026m](#)) supplemental files.

Table 4-12 summarizes the AADR, ARD, IRD, and CRD for each of the byproducts.

The high-end estimates are based on a higher loading rate of byproduct (2.1 mg/cm² per event) and a skin surface area equivalent to the area of two-hands (1,070 cm²), and the central tendencies are based on a lower loading rate of 1,2-dichloroethane (1.4 mg/cm² per event) and a skin surface area equivalent to the area of one-hand (535 cm²). The central tendency from the closed system monitoring data are a more representative and appropriate exposure estimate for a frequent, repeated dermal exposure (*i.e.*, chronic) and is health protective for risk estimation for closed system processes, as high-end exposures from daily connecting/disconnecting of transfer lines and sampling is not realistic and was not estimated (see Table 4-12).

Table 4-11. Summary of Inhalation Exposures to Byproducts During the Manufacture of 1,2-Dichloroethane

Byproduct	Process Stream (wt % Fraction of Byproducts in the Process Stream)	Similar Exposure Group	8-Hour TWA Exposure Concentrations		Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)		Lifetime Average Daily Concentration (LADC) – BLS Working Years		Lifetime Average Daily Concentration (LADC) – Vinyl Institute Working Years	
			CT (ppm) ^a	HE (ppm) ^b	CT (ppm)	HE (ppm)	CT (ppm)	HE (ppm)	CT (ppm)	HE (ppm)	CT (ppm)	HE (ppm)	CT (ppm)	HE (ppm)
1,1-Dichloroethane	N/A ^c	Operator/Process Technician	1.6E-03	9.0E-03	1.1E-03	6.1E-03	7.8E-04	4.5E-03	7.3E-04	4.2E-03	2.9E-04	2.2E-03	8.3E-05	1.8E-03
		Maintenance Technician	2.3E-04	2.7E-03	1.6E-04	1.8E-03	1.1E-04	1.3E-03	1.1E-04	1.3E-03	4.3E-05	6.5E-04	1.2E-05	5.3E-04
		Logistics/ Distribution	6.7E-05	1.6E-03	4.6E-05	1.1E-03	3.3E-05	8.0E-04	3.1E-05	7.5E-04	1.2E-05	3.8E-04	3.6E-06	3.2E-04
		Laboratory Technician	1.6E-04	3.3E-03	1.1E-04	2.2E-03	8.0E-05	1.6E-03	7.5E-05	1.5E-03	3.0E-05	7.9E-05	8.5E-06	6.5E-04
		ONU ^d	6.9E-05	4.6E-03	4.7E-05	3.1E-03	3.5E-05	2.3E-03	3.2E-05	2.1E-03	1.3E-05	1.1E-03	3.7E-06	9.0E-04
Trichloroethylene ^e	Unpurified 1,2-Dichloroethane (0.0035%) to Light-/Heavy-Ends (0.23%) ^f	Operator/Process Technician	1.9E-03	8.3E-03	1.3E-03	5.6E-03	9.7E-04	4.1E-03	9.0E-04	3.9E-03	1.8E-04	9.7E-04	1.0E-04	1.6E-03
		Laboratory Technician	5.4E-04	2.4E-03	3.6E-04	1.6E-03	2.7E-04	1.2E-03	2.5E-04	1.1E-03	4.9E-05	2.8E-04	2.8E-05	4.7E-04
		Logistics/ Distribution	6.0E-05	2.5E-04	4.1E-05	1.7E-04	3.0E-05	1.3E-04	2.8E-05	1.2E-04	5.4E-06	2.9E-05	3.2E-06	5.0E-05
		Maintenance Technician	5.2E-04	2.3E-03	3.5E-04	1.6E-03	2.6E-04	1.2E-03	2.4E-04	1.1E-03	4.7E-05	2.7E-04	2.8E-05	4.6E-04
		ONU ^d	3.6E-04	1.6E-03	2.4E-04	1.1E-03	1.8E-04	8.1E-04	1.7E-04	7.6E-04	3.2E-05	1.9E-04	1.9E-05	3.2E-04
Perchloroethylene	Unpurified 1,2-Dichloroethane (0.015%)	Worker	1.0E-05	1.5E-04	6.9E-06	1.1E-04	5.1E-06	7.7E-05	4.7E-06	7.2E-05	1.9E-06	3.7E-05	5.4E-07	3.1E-05
		ONU ^d	3.0E-07	3.4E-05	2.0E-07	2.3E-05	1.5E-07	1.7E-05	1.4E-07	7.7E-06	5.5E-08	8.1E-06	1.6E-08	6.7E-06
	Light-/Heavy-Ends (1.1%) ^f	Worker	9.5E-03	1.4E-02	6.5E-04	9.8E-03	4.7E-04	7.2E-03	4.4E-04	6.7E-03	1.8E-04	3.5E-03	5.1E-05	2.9E-03
		ONU ^d	2.8E-05	3.2E-03	1.9E-05	2.2E-03	1.4E-05	1.6E-03	1.3E-05	7.2E-04	5.1E-06	7.6E-04	1.5E-06	6.3E-04
Methylene chloride	Unpurified 1,2-Dichloroethane (0.0999%)	Worker	3.1E-03	4.7E-02	2.1E-03	3.2E-02	1.6E-03	2.4E-02	1.5E-03	2.2E-02	5.8E-04	1.1E-02	1.7E-04	9.3E-03
		ONU ^d	9.1E-05	1.0E-03	6.2E-05	7.1E-03	4.5E-05	5.2E-03	4.2E-05	4.8E-03	1.7E-05	2.5E-03	4.8E-06	2.0E-03
	Light-/Heavy-Ends (0.0999%) ^f	Worker	7.7E-03	0.12	5.3E-03	8.0E-02	3.9E-03	5.9E-02	3.6E-03	5.5E-02	1.4E-03	2.8E-02	4.1E-04	2.3E-02
		ONU ^d	2.3E-04	2.6E-02	1.5E-04	1.8E-02	1.1E-04	1.3E-02	1.1E-04	1.2E-02	4.2E-05	6.3E-03	1.2E-05	5.1E-03

Byproduct	Process Stream (wt % Fraction of Byproducts in the Process Stream)	Similar Exposure Group	8-Hour TWA Exposure Concentrations		Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)		Lifetime Average Daily Concentration (LADC) – BLS Working Years		Lifetime Average Daily Concentration (LADC) – Vinyl Institute Working Years	
			CT (ppm) ^a	HE (ppm) ^b	CT (ppm)	HE (ppm)	CT (ppm)	HE (ppm)	CT (ppm)	HE (ppm)	CT (ppm)	HE (ppm)	CT (ppm)	HE (ppm)
Carbon tetrachloride ^e	Unpurified 1,2-Dichloroethane (0.15%) to Light-/Heavy-Ends (30%) ^f	Operator/Process Technician	0.33	1.4	0.23	0.98	0.17	0.72	0.15	0.67	6.1E-02	0.34	1.8E-02	0.28
		Laboratory Technician	9.1E-02	0.42	6.2E-02	0.28	4.5E-02	0.21	4.2E-02	0.19	1.7E-02	0.10	4.8E-03	8.2E-02
		Logistics/Distribution	1.0E-02	4.4E-02	7.0E-03	3.0E-02	5.1E-03	2.2E-02	4.8E-03	2.0E-02	1.9E-03	1.0E-02	5.5E-04	8.6E-03
		Maintenance Technician	8.9E-02	0.40	6.1E-02	0.27	4.4E-02	0.20	4.2E-02	0.19	1.7E-03	9.6E-02	4.7E-03	7.9E-02
		ONU ^d	6.1E-02	0.28	4.2E-02	0.19	3.1E-02	0.14	2.9E-02	0.13	1.1E-02	6.7E-02	1.1E-02	6.7E-02

ONU = occupational non-user

LADC calculated using working years from the BLS data (31 years central tendency (CT), 40 years high-end (HE)) ([U.S. Census Bureau, 2019a](#); [U.S. BLS, 2014](#)). LADC calculated using Vinyl Institute years of service for workers at manufacturing facilities (8.9 years CT, 33 years HE) ([EPA-HQ-OPPT-2018-0427-0181](#)) ([VI, 2026](#)). For chronic, non-cancer exposure estimates, exposure dose over the working years is averaged over the working years. Therefore, different values of working years do not affect these estimates, and EPA has presented 1 chronic, non-cancer estimate. For more information, including example calculations, please see Appendix B and C of the *Occupational Exposure Assessment for 1,2-Dichloroethane*.

^a For 1,1-dichloroethane, the CT is the 50th percentile (median) of occupational exposures among all workers within a given similar exposure group (SEG), based on Vinyl Institute inhalation test order monitoring data ([Stantec ChemRisk, 2023](#)). For all other byproducts, the central tendency estimate is based on the 50th percentile exposure for 1,2-dichloroethane from the Vinyl Institute inhalation test order monitoring dataset ([Stantec ChemRisk, 2024](#)) adjusted for vapor pressure and mol fraction for the byproduct chemical using Equation 4-1.

^b For 1,1-dichloroethane, the HE is the 95th percentile of occupational exposures among all workers within a given SEG, based on Vinyl Institute inhalation test order monitoring data ([Stantec ChemRisk, 2023](#)). For all other byproducts, the HE estimate is based on the 95th percentile exposure for 1,2-dichloroethane from the Vinyl Institute inhalation test order monitoring dataset ([Stantec ChemRisk, 2024](#)) adjusted for vapor pressure and mole fraction for the byproduct chemical using Equation 4-1.

^c The unpurified 1,2-dichloroethane and light-/heavy-ends exposure concentrations were not used for 1,1-dichloroethane because inhalation exposure estimates are based on 1,1-dichloroethane test order monitoring data collected at 1,2-dichloroethane manufacturing facilities ([Stantec ChemRisk, 2023](#)).

^d The CT from the closed system monitoring data are a more representative and appropriate exposure estimate for a frequent, repeated inhalation exposure (*i.e.*, chronic) for the occupational non-user (ONU) exposure group. As described in Section 4.1.1.1, ONUs do not directly handle chemicals and are therefore expected to have lower inhalation exposures and are not expected to have dermal exposures through contact with liquids or solids.

^e High-end screening level exposures for trichloroethylene and carbon tetrachloride showed risk to workers; therefore, EPA further refined the analysis by performing Monte Carlo analysis to vary the concentration from the low-end to high-end exposures (equal distribution) as well as separating the exposures by SEG.

^f Light-ends liquid streams are the more volatile fractions in the mixture, typically derived from the initial stages of refining process, known for their lower boiling points. Heavy-ends liquid streams are the less volatile, higher boiling point fractions obtained towards the later stages of the refining process.

Information on respiratory protection used by the exposure groups at the facilities for 1,2-dichloroethane and byproducts is provided in Appendix C

Table 4-12. Summary of Dermal Exposure Doses to Byproducts for an Average Adult Worker During the Manufacture of 1,2-Dichloroethane^a

Byproduct	Process Stream (% Fraction of Byproducts in the Process Stream)	Acute Absorbed Dose Rate (AADR) (mg/day)		Acute Absorbed Dose (AAD) (mg/kg-day)		Intermediate Absorbed Dose (IAD), Non-Cancer		Chronic Absorbed Dose (CAD), Non-Cancer (mg/kg-day)		Lifetime Chronic Absorbed Dose (LCAD), Cancer (mg/kg-day) – BLS Working Years		Lifetime Chronic Absorbed Dose (LCAD), Cancer (mg/kg-day) – Vinyl Institute Working Years	
		Central Tendency ^b	High-End ^c	Central Tendency	High-End	Central Tendency	High-End	Central Tendency	High-End	Central Tendency	High-End	Central Tendency	High-End
1,1-Dichloroethane	Unpurified 1,2-Dichloroethane (0.29%)	6.5E-03	2.0E-02	8.2E-05	2.5E-04	6.0E-05	1.8E-04	5.6E-05	NE	2.2E-05	NE	6.4E-06	NE
	Light- /Heavy-Ends ^e (30%)	0.67	2.0	8.4E-03	2.5E-02	6.2E-03	1.9E-02	5.8E-03	NE	2.3E-03	NE	6.6E-04	NE
Trichloroethylene ^f	Unpurified 1,2-Dichloroethane (0.0035%) to Light-/Heavy-Ends ^e (0.23%)	9.0E-02	0.24	1.2E-03	3.1E-03	8.5E-04	2.2E-03	7.9E-04	NE	2.9E-04	NE	9.4E-05	NE
Perchloroethylene	Unpurified 1,2-Dichloroethane (0.015%)	1.5E-02	4.4E-02	1.8E-04	5.5E-04	1.3E-04	4.0E-04	1.3E-04	NE	5.0E-05	NE	1.4E-05	NE
	Light-/ Heavy-Ends ^e (1.1%)	1.1	3.2	1.3E-02	4.0E-02	9.8E-03	2.9E-02	9.2E-02	NE	3.6E-03	NE	1.0E-03	NE
Methylene chloride	Unpurified 1,2-Dichloroethane; Light-/ Heavy-Ends (0.0999%) ^g	6.0E-02	0.18	7.5E-04	2.2E-03	5.5E-04	1.6E-03	5.1E-04	NE	2.0E-04	NE	5.8E-05	NE
Carbon tetrachloride ^f	Unpurified 1,2-Dichloroethane (0.15%) to Light- /Heavy-Ends (30%) ^e	6.0	16	7.0E-02	0.20	0.05	0.15	5.0E-02	NE	0.02	NE	5.5E-03	NE

ONU = occupational non-user; NE = not estimated

Byproduct	Process Stream (% Fraction of Byproducts in the Process Stream)	Acute Absorbed Dose Rate (AADR) (mg/day)		Acute Absorbed Dose (AAD) (mg/kg-day)		Intermediate Absorbed Dose (IAD), Non- Cancer		Chronic Absorbed Dose (CAD), Non- Cancer (mg/kg-day)		Lifetime Chronic Absorbed Dose (LCAD), Cancer (mg/kg-day) – BLS Working Years		Lifetime Chronic Absorbed Dose (LCAD), Cancer (mg/kg-day) – Vinyl Institute Working Years	
		Central Tendency ^b	High- End ^c	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
<p>LCAD calculated using working years from the Bureau of Labor Statistics (BLS) data (31 years central tendency [CT], 40 years high-end [HE]) (U.S. Census Bureau, 2019a; U.S. BLS, 2014) or using Vinyl Institute years of service for workers at manufacturing facilities (8.9 years CT, 33 years HE) (EPA-HQ-OPPT-2018-0427-0181) (VI, 2026). For chronic, non-cancer exposure estimates, exposure dose over the working years is averaged over the working years. Therefore, different values of working years do not affect these estimates, and EPA has presented 1 chronic, non-cancer estimate. For more information, including example calculations, please see Appendix B and C of the <i>Occupational Exposure Assessment for 1,2-Dichloroethane</i>.</p> <p>^a The test order provided information on personal protective equipment (PPE) used at the facilities monitored which has been presented and the estimates in this table do not account for potential usage of dermal PPE. Information on protective gloves used by the exposure groups at the facilities for 1,2-dichloroethane and byproducts is provided in Appendix C.</p> <p>^b Central tendency is based on a lower loading rate of 1,2-dichloroethane (1.4 mg/cm² per event) and one-hand contact.</p> <p>^c High-end is based on a higher loading rate of byproduct (2.1 mg/cm² per event) and two-hand contact.</p> <p>^d The central tendency from the closed system monitoring data are a more representative and appropriate exposure estimate for a frequent, repeated dermal exposure (<i>i.e.</i>, chronic) and is health protective for risk estimation for closed system processes, as high-end exposures from daily connecting/disconnecting of transfer lines and sampling is not realistic.</p> <p>^e Light-ends liquid streams are the more volatile fractions in the mixture, typically derived from the initial stages of refining process, known for their lower boiling points. Heavy-ends liquid streams are the less volatile, higher boiling point fractions obtained towards the later stages of the refining process.</p> <p>^f High-end screening level exposures for trichloroethylene and carbon tetrachloride showed risk to workers; therefore, EPA further refined the analysis by performing Monte Carlo analysis to vary the concentration from the low-end to high-end exposures (equal distribution).</p> <p>^g Note that methylene chloride had the same concentration in the unpurified 1,2-dichloroethane stream and then light- /heavy-ends, and thus only has one row of results.</p>													

4.1.1.6 Weight of Scientific Evidence for Occupational Exposure

The primary strength of this occupational assessment is the use of PBZ and directly applicable monitoring data, which are preferable to other assessment approaches such as modeling or the use of occupational exposure limit (OELs). As stated in Section 4.1.1.3.1, EPA had full-shift worker inhalation monitoring data for both 1,2-dichloroethane, and 1,1-dichloroethane produced as a byproduct from the manufacture of 1,2-dichloroethane, provided via test order submissions from the Vinyl Institute.

For 1,1-dichloroethane, chemical-specific inhalation test order monitoring data were available from three sites that produce 1,1-dichloroethane as a byproduct during the manufacture of 1,2-dichloroethane ([Stantec ChemRisk, 2023](#)). This data was used to estimate 8-hour TWA exposure levels for 1,1-dichloroethane byproduct. A total of 98 full-shift samples were collected across five SEGs (including ONUs). Of the total samples collected, 39 samples were below the limit of detection. Worker SEGs include operators, maintenance technicians, logistics technicians, and laboratory technicians.

For the other byproducts, the Agency used the 1,2-dichloroethane surrogate inhalation test order monitoring data ([Stantec ChemRisk, 2024](#)) as surrogate data to estimate inhalation exposure to the other byproduct chemicals. For worker estimates, EPA used data from the operator SEG that included 53 full-shift samples. All samples were above the limit of detection. For ONUs, EPA used data from the ONU SEG which included 39 samples (all above the LOD). EPA applied a correction to the 8-hour TWAs to account for differences in vapor pressure and mole fraction. The mole fraction used in the screening approach is based on the maximum expected byproduct concentration in the light-/heavy-end streams in the 1,2-dichloroethane manufacturing process.

The number of samples available to assess inhalation exposures was a strength both for the 1,1-dichloroethane dataset, and the 1,2-dichloroethane dataset that was used as surrogate for the remaining four byproducts. The PBZ air concentration data used to assess inhalation exposures for the byproducts (both the 1,1-dichloroethane and 1,2-dichloroethane datasets) had a high data quality rating from the systematic review process.

EPA assumed 250 exposure days per year based on 1,2-dichloroethane exposure, each working day, for a typical worker schedule. There was data in the test order summary report that indicated that certain tasks are done daily while others are done less frequently. As demonstrated by the available inhalation monitoring data, exposure of an individual worker within an SEG varies. As EPA had SEG-level specific monitoring data, it is unlikely that the reported high-end exposure would occur regularly to every employee on a regular basis. Also, for the byproducts where 1,2-dichloroethane exposure is used as a surrogate, it was assumed that the concentration of 1,2-dichloroethane in the air can be adjusted to the concentration in the air of a given byproduct using only the byproduct's concentration in the liquid stream and the vapor pressure, which introduces uncertainty.

EPA also compared both the occupational 8-hour TWA inhalation exposure estimates and the dermal acute absorbed dose rates for each byproduct chemical produced during the manufacture of 1,2-dichloroethane to these same exposures estimated for the Manufacturing COU in previously published chemical-specific risk evaluations. This comparison is presented in Table 4-13 for the inhalation exposure and Table 4-14 for the dermal dose. These comparisons show that the estimates obtained in this assessment are reasonable. For carbon tetrachloride, the smaller difference reflects its high concentrations in the light- and heavy-end streams (Table 4-6).

Table 4-13. Comparison of Inhalation Exposures Estimated in the Byproduct Assessment for the Light- or Heavy-End Streams and in the Corresponding Final Risk Evaluations

Chemical (SEG)	8-Hour TWA Exposure as Byproduct (ppm)		8-Hour TWA Exposure from Manufacturing COU of Final Risk Evaluation (ppm)		
	Central Tendency	High-End	Central Tendency	High-End	Reference
1,1-Dichloroethane	1.6E-03	9.0E-03	4.7E-03	1.1	Table 5-18 U.S. EPA (2025a)
Trichloroethylene (Operator) ^a	1.9E-03	8.9E-03	0.12	2.5	Table 2-13 U.S. EPA (2020j)
Trichloroethylene (Laboratory Technician) ^a	5.4E-04	2.4E-03			
Trichloroethylene (Logistics Technician) ^a	6.0E-05	2.5E-04			
Trichloroethylene (Maintenance Technician) ^a	5.2E-04	2.3E-03			
Perchloroethylene	9.5E-04	1.4E-02	3.3E-02	2.7	Table 2-61 U.S. EPA (2020i)
Methylene chloride	7.7E-03	0.12	0.36	4.6	Table 2-84 U.S. EPA (2020h)
Carbon tetrachloride (Operator) ^a	0.33	1.4	0.76	4.0	Table 2-8 U.S. EPA (2020g)
Carbon tetrachloride (Laboratory Technician) ^a	0.09	0.42			
Carbon tetrachloride (Logistics Technician) ^a	0.01	0.04			
Carbon tetrachloride (Maintenance Technician) ^a	0.09	0.40			

^a High-end screening level exposures for trichloroethylene and carbon tetrachloride showed risk to workers; therefore, EPA further refined the analysis by performing Monte Carlo analysis to vary the concentration from the low-end to high-end exposures (equal distribution) and separated exposures by similar exposure group (SEG).

Table 4-14. Comparison of Dermal Dose Rate Estimated in the Byproduct Assessment and in the Corresponding Final Risk Evaluations

Chemical	Acute absorbed dose rate as Byproduct (mg/day)		Acute absorbed dose rate from Manufacturing COU of Final Risk Evaluation (mg/day)		
	Central Tendency	High-End	Central Tendency	High-End	Reference
1,1-Dichloroethane	0.67	2.0	2.3	6.7	Table 5-15 U.S. EPA (2025a)
Trichloroethylene ^a	0.09	0.24	61	180	Table 2-15 U.S. EPA (2020j)
Perchloroethylene	1.1	3.2	96	280	Table 2-63 U.S. EPA (2020i)
Methylene chloride	6.0E-02	0.18	60	180	Table 2-85 U.S. EPA (2020h)
Carbon tetrachloride ^a	6.0	16	30	90	Table 2-24 U.S. EPA (2020g)

^a High-end, screening level exposures for trichloroethylene and carbon tetrachloride showed risk to workers; therefore, EPA further refined the analysis by performing Monte Carlo analysis to vary the concentration from the low-end to high-end exposures (equal distribution).

Based on these strengths and limitations, EPA has concluded that the confidence for this occupational exposure assessment is (1) robust in the case of 1,1-dichloroethane that utilized directly applicable inhalation test order monitoring data, and (2) moderate in the case of the remaining byproducts that used 1,2-dichloroethane inhalation test order data as surrogate.

In the case of the dermal occupational exposure assessment, EPA estimated exposures using modeling methodologies that are supported by moderate evidence. Specifically, the Agency used the Dermal Exposure to Volatile Liquids Model to calculate the dermal absorbed dose. This model modifies the EPA/OPPT 2-Hand Dermal Exposure to Liquids Model by incorporating a “fraction absorbed (fabs)” parameter to account for the evaporation of volatile chemicals. These modifications improve the modeling methodology; however, the modeling approach is still limited by the low variability for different worker activities and exposure scenarios. Therefore, the weight of scientific evidence for the dermal exposure estimates is moderate.

4.1.2 General Population Exposure Assessment

The following subsections describe EPA’s approach to assessing the general population exposures to the byproducts produced during the manufacture of 1,2-dichloroethane and provide the results of the general population exposure assessment. The Agency assessed exposures to general population via inhalation, oral, and dermal routes. The full inputs and results for modeling of oral, dermal, and inhalation exposures are presented in the *Byproducts General Population Exposures for 1,2-Dichloroethane* ([U.S. EPA, 2026a](#)) and *HEM Input and Output Files for 1,2-Dichloroethane-Byproducts* ([U.S. EPA, 2026h](#)). EPA assumed that byproduct exposures could be estimated as a fraction of 1,2-dichloroethane releases from 1,2-dichloroethane manufacturing facilities. EPA estimated inhalation exposures from the byproducts to populations living within 50 km of facilities within the Manufacturing COU of 1,2-dichloroethane using HEM5.0. The Agency also estimated byproduct exposures to the general population from the facility releasing the highest concentration of 1,2-dichloroethane within the Manufacturing COU to surface waters (Section 2.2.2).

4.1.2.1 Inhalation Exposure Assessment

EPA used HEM5.0 to estimate chronic and acute inhalation exposures to each byproduct for populations living within 50 km of 1,2-dichloroethane releasing facilities. HEM5.0 calculates exposures at the centroid of census blocks within 50 km of each modeled facility and at designated polar grid receptors at

distances of 10 to 10,000 m from each facility (see *Environmental Media Concentrations for 1,2-Dichloroethane* (U.S. EPA, 2026e) and *General Population Exposure Assessment for 1,2-Dichloroethane* (U.S. EPA, 2026g)). Ambient air concentrations and the resulting exposures were estimated using releases that were calculated by multiplying the 1,2-dichloroethane releases by the respective fraction of individual byproducts in the non-purified product stream (Table 1-1). To estimate high-end exposures, TRI releases of 1,2-dichloroethane from 2018 were used since they represented the highest total reported TRI air emissions of 1,2-dichloroethane from all 1,2-dichloroethane manufacturing facilities for the reporting period considered in this risk evaluation (2015–2020). Releases from all facilities reporting to TRI in 2018 were modeled in HEM5.0. For more information on HEM5.0, see the *Environmental Media Concentrations for 1,2-Dichloroethane* (U.S. EPA, 2026e) and *General Population Exposure Assessment for 1,2-Dichloroethane* (U.S. EPA, 2026g). HEM5.0’s lifetime chronic exposure scenario assumes an individual breathing the ambient air at a given receptor 24 hours per day over a 70-year lifetime. The assumption of a continuous exposure over an entire lifetime represents a conservative exposure scenario. Lifetime average daily concentrations (LADC), average daily concentrations (ADC), and acute concentrations (AC) can be calculated using the following equations:

Equation 4-3.

$$AC = \frac{DAC \times ET}{AT}$$

$$ADC = \frac{AAC \times ET \times EF \times ED}{AT}$$

$$LADC = \frac{AAC \times ET \times EF \times ED}{AT}$$

Where:

- AC* = Acute concentration (µg/m³)
- DAC* = Daily Average Air Concentration, model output reflecting average concentrations over a 24-hour period (µg/m³)
- ET* = Exposure time (24 hours/day)
- AAC* = Annual Average Air Concentration, model output reflecting average concentrations over a year (µg/m³)
- EF* = Exposure frequency (365 days/year)
- ED* = Exposure duration (1 year for non-cancer ADC; 70 years for cancer LADC)
- AT* = Averaging time; averaging time for AC = 24 hours; averaging time for ADC = 24 hours/day × 365 days/year × 1 year; averaging time for LADC = 24 hours/day × 365 days/year × 70 years

Because the averaging times and exposure durations are the same, LADC and ADC values are equal to the concentrations shown in Table 2-6 and AC values are equal to the concentrations shown in Table 2-7.

4.1.2.2 Oral Exposure Assessment

EPA estimated the 1,2-dichloroethane exposures via the oral route for the Manufacturing COU/OES as presented in the *General Population Exposure Assessment for 1,2-Dichloroethane* (U.S. EPA, 2026g) from fish ingestion and incidental oral exposures from swimming. Because the byproducts are a fraction of the 1,2-dichloroethane oral exposures, EPA estimated the relative oral exposures for each of the byproducts based on the relative amount weight percent of each byproduct in the byproduct manufactured 1,2-dichloroethane effluent stream as released into surface waters at the point discharge.

As described in Section 2.2.2, EPA was able to characterize the 2021 releases from the Eagle US 2 facility to Bayou d’Inde for a number of the byproduct chemicals. In addition, EPA considered the Eagle 2 surface water concentrations as representative of the possible high-end exposures across the 2015 to 2020 years of releases considered in the 1,2-dichloroethane risk assessment.

Table 4-15 below presents the estimated acute (ADR) and chronic (ADD) oral exposures based on the proportion of byproduct exposure relative to 1,2-dichloroethane. A high-end level of fish ingestion is presented: 142.4g/day for 90th percentile general population and is the same as subsistence level of fish ingestion. Tribal levels of fish ingestion were not included in this estimate as the Eagle US 2 and other 1,2-dichloroethane manufacturing sites are not in or adjacent to designated tribal land and therefore, tribal levels of exposure are not expected.

In addition, two levels of exposures were presented for the incidental ingestion route: for adults and for youth aged 11 to 15 years, the latter considering the higher exposures for youth relative to adults.

EPA conducted a screening analysis to estimate oral exposures from byproducts through drinking water using the byproduct concentrations in the Bayou d’Inde. Possible infant exposures to the byproducts via drinking water used in formula are presented in Table 4-15. EPA acknowledges that this is a theoretical upper-bound estimate since the Eagle US 2 releases to a receiving water body are not a source of downstream drinking water. However, the screening analysis provides evidence that other facilities discharging byproducts under the 1,2-dichloroethane Manufacturing COU would be lower concentrations than presented in Section 2.2.2 and would result in even lower exposures if other facilities’ releases were to drinking water source waters. Therefore, byproduct releases are anticipated to result in low drinking water exposures.

Table 4-15. Oral Exposures from Byproducts Released to Bayou d’Inde from Eagle US 2 Manufacturing COU

Chemical	Fish Ingestion (General Population)		Incidental Oral Ingestion (Adult Swimming)		Incidental Oral Ingestion (11–15 years Swimming)		Drinking Water (Infants)	
	ADR (mg/kg-day)	ADD (mg/kg-day)	ADR (mg/kg-day)	ADD (mg/kg-day)	ADR (mg/kg-day)	ADD (mg/kg-day)	ADR (mg/kg-day)	ADD (mg/kg-day)
1,2-Dichloroethane	3.3E-05	7.6E-06	9.4E-05	2.6E-07	1.5E-04	4.0E-07	3.9E-03	7.4E-04
1,1-Dichloroethane	9.8E-08	2.2E-08	2.8E-07	7.7E-10	4.3E-07	1.2E-09	1.2E-05	2.2E-06
Trichloroethylene	1.2E-09	2.7E-10	3.3E-09	9.2E-12	5.2E-09	1.4E-11	1.4E-07	2.6E-08
Perchloroethylene	5.1E-09	1.2E-09	1.4E-08	3.9E-11	2.2E-08	6.1E-11	5.9E-07	1.1E-07
Methylene chloride	3.4E-08	7.6E-09	9.5E-08	2.6E-10	1.5E-07	4.0E-10	3.9E-06	7.5E-07
Carbon tetrachloride	5.1E-08	1.2E-08	1.4E-07	3.9E-10	2.2E-07	6.1E-10	5.9E-06	1.1E-06

ADD = average daily dose; ADR = acute dose rate

4.1.2.3 Weight of Scientific Evidence for General Population Exposure

Ambient Air

EPA used ambient air concentrations as modeled by HEM5.0 to estimate exposures to the general population. Additional information on HEM5.0 modeling, including uncertainties, is provided in Section 2.2.1.2 and the *Risk Evaluation for 1,2-Dichloroethane* ([U.S. EPA, 2026k](#)). The exposure scenarios

considered are most relevant to long-term residents in fence-line communities. Acute daily and chronic annual exposure estimates also use a conservative assumption of a continuous 24-hour exposure to the general population. EPA has robust confidence that the exposure scenarios used in this analysis are representative of high-end exposure and are human health protective.

Surface Water

EPA conducted a screening assessment to evaluate general population exposures to byproducts released to surface waters. Given the strong evidence of one facility, the Eagle US 2 facility in Westlake, Louisiana, representing the high-end exposure scenario of 1,2-dichloroethane and each of the byproducts, EPA used this facility's releases and surface water concentrations to assess exposures to byproducts. The Agency is confident that the permit reporting releases of 1,2-dichloroethane provide relevant data to conduct a general population exposure estimates from surface water exposures. EPA confirmed that potential exposures from byproduct releases were anticipated to be lower than those predicted in previous chemical fence-line technical reports (see Section 1.2).

5 HUMAN HEALTH HAZARD

The human health hazards and associated weight of scientific evidence for each byproduct are described in full in each respective risk evaluation. EPA is not re-opening or revising those risk evaluations at this time. This section, Table 5-1 through Table 5-3, briefly summarizes the human health hazards of byproducts used in this TSD.

Table 5-1. Inhalation Unit Risk and Cancer Slope Factor Values Used to Calculate Risk

Chemical/ Byproduct	IUR (per mg/m ³)	CSF (per mg/kg-day)	Reference(s)
Carbon tetrachloride	6.00E-03 ^a	5.00E-02	U.S. EPA (2020g) ; U.S. EPA (2022a) ; U.S. EPA (2022b)
1,1-Dichloroethane	7.10E-03 ^b	3.90E-02	Table 5-52 U.S. EPA (2025a)
Methylene chloride	5.80E-06 ^c	3.20E-05	U.S. EPA (2020h) ; U.S. EPA (2022d) ; U.S. EPA (2022c)
Perchloroethylene	3.00E-04 ^d	2.00E-03	U.S. EPA (2020i) ; U.S. EPA (2022e) ; U.S. EPA (2022f)
Trichloroethylene	4.09E-03 ^e	4.64E-02	U.S. EPA (2020j) ; U.S. EPA (2022g) ; U.S. EPA (2022h)

CSF = cancer slope factor; IUR = Inhalation Unit Risk

^a Based on adrenal pheochromocytoma in male mice.

^b Based on combined mammary gland adenomas, fibroadenomas, and adenocarcinomas and subcutaneous fibromas in female rats.

^c Based on liver and lung tumors in mice. An age dependent adjustment factor (ADAF) of 1.59 was applied to the IUR of 5.8E-06 mg/m³ to calculate risk estimates for the general population (9.22E-06 per mg/m³).

^d Based on hepatocellular tumors in male mice.

^e Based on kidney cancer in humans. An ADAF of 1.59 was applied to the IUR of 4.09E-03 mg/m³ to calculate risk estimates for the general population (6.51E-03 mg/m³).

Table 5-2. Acute Non-Cancer PODs Used to Calculate Risk for Each Byproduct

Chemical/ Byproduct	HEC ^a (mg/m ³) [ppm]	Health Effect	MOE	HED ^a (mg/kg-day)	Health Effect	MOE	Reference(s)
Carbon tetrachloride	234 [37.2]	CNS (temporarily disabling effects)	UF _H = 10 Total UF = 10	17	Fatty changes in the liver	UF _H = 10 UF _L = 3 Total UF = 30	U.S. EPA (2020g) ; U.S. EPA (2022a) ; U.S. EPA (2022b)
1,1-Dichloroethane	9.78 [2.42]	Degeneration with necrosis of the olfactory mucosa	UF _A = 3 UF _H = 10 Total UF = 30	19.9	Increased relative kidney weight	UF _A = 3 UF _H = 10 Total = 30	Table 5-35 U.S. EPA (2025a)
Methylene chloride	174 [50]	Impairment of CNS 7% ↓ visual peripheral performance at 1.5 hours	UF _H = 10 UF _L = 3 Total UF = 30	32	Impairment of CNS 7% ↓ visual peripheral performance at 1.5 hours	UF _H = 10 UF _L = 3 Total UF = 30	U.S. EPA (2020h) ; U.S. EPA (2022d) ; U.S. EPA (2022c)
Perchloroethylene	11.5 [1.7]	Neurotoxicity increased latencies for pattern reversal visual-evoked potentials	UF _H = 10 Total UF = 10	2.1	Increased latencies for pattern reversal visual-evoked potentials (CNS effect)	UF _H = 10 Total UF = 10	U.S. EPA (2020i) ; U.S. EPA (2022e) ; U.S. EPA (2022f)
Trichloroethylene	5.2 [0.973]	Mortality due to immuno-suppression	UF _A = 3 UF _H = 3 Total UF = 10	1.34	Mortality due to immuno-suppression	UF _A = 3 UF _H = 3 Total UF = 10	U.S. EPA (2020j) ; U.S. EPA (2022g) ; U.S. EPA (2022h)

CNS = central nervous system; MOE = margin of exposure; POD = point of departure; UF = uncertainty factor
The human equivalent concentration (HEC) and human equivalent dose (HED) values were converted to a 24-hour duration.

Table 5-3. Chronic Non-Cancer PODs Used to Calculate Risk for Each Byproduct

Chemical/ Byproduct	HEC ^a (mg/m ³) [ppm]	Health Effect	MOE	HED ^a (mg/kg-day)	Health Effect	MOE	Reference(s)
Carbon tetrachloride	14.3 [2.27]	Fatty changes in the liver	UF _H = 10 UF _A = 3 Total UF = 30	1.7	Fatty changes in the liver	UF _H = 10 UF _A = 3 Total UF = 30	U.S. EPA (2020g) ; U.S. EPA (2022a) ; U.S. EPA (2022b)
1,1-Dichloroethane	21.2 [5.2]	Decreases in sperm concentration	UF _A = 3 UF _H = 10 UF _S = 10 Total = 300	6.5	Increased relative Kidney weight	UF _A = 3 UF _H = 10 UF _S = 10 Total = 300	Table 5-37 U.S. EPA (2025a)
Methylene chloride	17.2 [5]	Hepatic lipid vacuolation	UF _A = 3 UF _H = 3 Total UF=10	3	Hepatic lipid vacuolation	UF _A = 3 UF _H = 3 Total UF = 10	U.S. EPA (2020h) ; U.S. EPA (2022d) ; U.S. EPA (2022c)
Perchloroethylene	35.3 [5.2]	Midpoint of the range of the 2 neurotoxicity studies (adjusted for 8-hour occupational TWA)	UF _H =10 UF _L =10 Total UF = 100	6.2	Midpoint of the range of the 2 neurotoxicity endpoints Extrapolated from chronic inhalation POD	UF _H =10 UF _L =10 Total = 100	U.S. EPA (2020i) ; U.S. EPA (2022e) ; U.S. EPA (2022f)
Trichloroethylene	0.177 [0.033]	Autoimmunity (increased anti-dsDNA and ssDNA antibodies)	UF _A = 3 UF _H = 3 UF _L = 3 Total UF = 30	0.048	Autoimmunity (increased anti-dsDNA and ssDNA antibodies)	UF _A = 3 UF _H = 3 UF _L = 3 Total UF = 30	U.S. EPA (2020j) ; U.S. EPA (2022g) ; U.S. EPA (2022h)

MOE = margin of exposure; POD = point of departure; TWA = time-weighted average; UF = uncertainty factor

^a The human equivalent concentration (HEC) and human equivalent dose (HED) values were converted to a 24-hour duration.

6 HUMAN HEALTH RISK ESTIMATES

6.1 Risk Estimates for Workers

6.1.1 Occupational Risk Summary

This section compares estimated MOEs to benchmark values. The occupational inhalation exposure metrics described in Section 6.1.1 are presented for each byproduct chemical (1,1-dichloroethane, trichloroethylene, perchloroethylene, methylene chloride, and carbon tetrachloride) in Table 4-11 and the occupational dermal exposure metrics for each byproduct chemical are presented in Table 4-12. EPA used the exposure metrics presented in those tables and the approach described in Section 6.1 and Section 6.2 to develop risk estimates for each byproduct.

Risk estimates for exposure to the light-/heavy-end streams (high-end exposures) for 1,1-dichloroethane, perchloroethylene, and methylene chloride are presented in Table 6-1. Risk estimates for exposure to the unpurified 1,2-dichloroethane stream (low-end exposures) for 1,1-dichloroethane, perchloroethylene, and methylene chloride are presented in are presented in Table 6-2. High-end, screening level MOE estimates were above the chronic non-cancer (or acute non-cancer) benchmark and below the cancer benchmark for inhalation and dermal for 1,1-dichloroethane, methylene chloride, or perchloroethylene (see Table S-1).

High-end screening level exposures for trichloroethylene and carbon tetrachloride showed MOE estimates were below the chronic non-cancer benchmark and above the cancer benchmark for inhalation and dermal; therefore, EPA further refined the analysis by performing Monte Carlo analysis to vary the concentration from the low-end to high-end exposures (equal distribution) as well as separating the exposures by SEG. These results are presented in Table 6-3.

As shown in Table 6-3, trichloroethylene presents a chronic non-cancer inhalation MOE below the benchmark for operators and laboratory technicians at high-end exposure, but not at central tendency exposures. Carbon tetrachloride presents chronic non-cancer inhalation risk below applicable benchmarks for operators (both central tendency and high-end), maintenance technicians (high-end), laboratory technicians (high-end), and ONUs (high-end). Carbon tetrachloride presents chronic cancer inhalation risk above benchmarks for operators (central tendency and high-end), maintenance technicians (central tendency and high-end), logistics technicians (high-end), laboratory technicians (central tendency and high-end), and ONUs (central tendency and high-end).

For dermal exposures, carbon tetrachloride presents cancer risk for workers at central tendency exposures. The central tendency from the closed system monitoring data are a more representative and appropriate exposure estimate for a frequent, repeated inhalation exposure (*i.e.*, chronic) for the ONU exposure group. As described in Section 4.1.1.1, ONUs do not directly handle chemicals and are therefore expected to have lower inhalation exposures and are not expected to have dermal exposures through contact with liquids or solids. For additional details on these estimates, refer to *Byproducts Risk Calculator for 1,2-Dichloroethane* ([U.S. EPA, 2026c](#)) and the *Byproducts Risk Calculator for 1,2-Dichloroethane with Adjusted Working Years* ([U.S. EPA, 2026m](#)).

In cases of inhalation exposure where MOE estimates are below the chronic non-cancer (or acute non-cancer) benchmark and above the cancer benchmark (Table 6-3), the minimum level of PPE that would be needed for estimated MOEs to meet the indicated benchmark is also provided. This level of PPE is indicated using an assigned protection factor or APF, the value of which indicates the level of protection

provided by a respirator. Where no unreasonable risk is estimated, no APF is provided. It should be noted that in addition to the use of respirators that achieve a minimum APF, these benchmarks may be met by implementation of other exposure controls (e.g., engineering controls) that may be equally or more effective in reducing worker exposure. Additionally, the provided level of PPE is based on the workers TWA full-shift exposure, and that workers experience shorter, high-intensity tasks throughout the shift, then higher levels of APF may be needed during those specific tasks. General information on PPE and respiratory protection is available in Appendix C, and more specific information is on consideration of PPE is provided in the *Risk Evaluation for 1,2-Dichloroethane*.

Discussion of Reported Use of Respiratory Protection

Data were available in the test order final study report on PPE ([Stantec ChemRisk, 2024](#)) used at the monitored facilities, as described in Section 5.3.3 of the *Risk Evaluation for 1,2-Dichloroethane*, task-specific, respirator use (as documented in Appendix N- Raw Sample Results of the final study report), varied by SEG (Stantec ChemRisk, 2024). Where risk relative to applicable benchmarks was observed, EPA has considered how available information on respiratory protection worn by workers may further refine these risk estimates. For carbon tetrachloride, chronic, non-cancer and/or cancer risks relative to applicable benchmark MOEs were observed at the central tendency for operators, maintenance workers, laboratory technicians, and ONUs; in several cases, potential risks were observed for high-end exposures as well.

A detailed analysis of the respiratory protection used by workers in each SEGs in the Manufacture of 1,2-Dichloroethane (Intentional) OES is provided in Section 5.3.3.1.1 of the *Risk Evaluation for 1,2-Dichloroethane*. Based on the information provided as part of the test order submission, there is evidence that operators and maintenance technicians wear respiratory protection during high exposure tasks, but not consistently during central tendency exposures. There was limited evidence that laboratory technicians wore respiratory protection (1 of 29 full-shift samples documented the use of respiratory protection). Use of respiratory protection was documented for 23% of ONUs sampled, but the use did not correspond to the highest measured full-shift concentrations. Because EPA has evidence that respiratory protection usage associated with central-tendency exposures is limited, the Agency has determined that the central tendency exposure estimates appropriately account for the lack of or limited use of respiratory protection and cannot be further refined. Proper use of respiratory protection with a sufficient APF during high-intensity tasks will significantly reduce overall full-shift exposure when these tasks contribute to a large percentage of the potential exposure during a shift. For example, high full-shift inhalation exposure concentrations observed in the operator SEG were typically driven by sample collection tasks and the operators with the highest full-shift exposure measurements were documented as wearing respirators, as illustrated by the full and task-based sampling information provided by Vinyl Institute. As such, EPA expects the full-shift inhalation monitoring concentrations to overestimate high-end exposures for operators.

Discussion of Reported Use of Dermal PPE

Standard dermal PPE for production process areas included neoprene gloves and leather or cut-resistant gloves, while task-specific PPE in this area may include nitrile gloves or viton/butyl gloves. For logistic work areas, neoprene gloves were standard and task-specific PPE may include heavy duty nitrile gloves. Nitrile gloves are standard PPE for laboratory work areas. EPA has reviewed the information on glove use provided in the Vinyl Institute test order final study report and associated documentation (e.g., Appendix N- Raw Sample Results) ([Stantec ChemRisk, 2024](#)). For manufacturing of 1,2-dichloroethane, use of gloves was documented for 85 of 162 full-shift samples (52%), 75 of 109 short-term samples (69%), and 45 of 77 task-length samples (58%).

Uncertainties with the PPE Use and Protection Factors

Respirator APFs have technical significance but are generic values based on assumed workplace conditions, and usage of a specific respirator type does not guarantee achieving the generic APF during all use scenarios. Nevertheless, respirator APFs are based on specific conditions and approved by the National Institute for Occupational Safety and Health (NIOSH) in conjunction with Occupational Safety and Health Administration (OSHA) regulations. OSHA does not have a comparable quantitative protection factor (APF) designation for dermal exposures.

The test order summary report describes dermal and respiratory PPE used in the facility. EPA's practice is to consider if the PPE used at the facility as described in the test order summary report provides protection consistent with the Agency's assessment of the PPE protection factor needed for acceptable MOEs. Based on the available information in the test order report, workers do not wear respiratory protection as standard PPE for full or near full-shift durations; however, respirators are used during specific tasks. Varying levels of respirator protection are associated with tasks described in the test order and use of PPE varied across workers and 1,2-dichloroethane manufacturing facilities. For example, some operators at Site A who collected samples and connected/disconnected hoses were noted as not wearing respiratory protection, while some operators at Site D were described as wearing full-face respirators during sample collection tasks. Given the variation in tasks and reported respirator use associated with specific tasks, it is difficult to assume a consistent level of respiratory protection across a job group. However, it should be noted that the proper use of respiratory protection during high-exposure tasks will reduce the overall full-shift exposure. As previously noted, where these high-exposure tasks contribute a large percentage of potential exposure during a shift then the proper use of sufficient respiratory PPE will significantly reduce full-shift exposures. This is further discussed in the *Risk Evaluation for 1,2-Dichloroethane* ([U.S. EPA, 2026k](#)).

Based on the available information, workers in manufacturing settings were documented as wearing gloves when the inhalation monitoring was performed, including during specific tasks where exposures were reported to occur. As there are no dermal exposure measurements available, EPA is unable to evaluate the reported usage of gloves in the context of specific exposure measurements or concentrations. Additionally, there are no established quantitative protection factors for gloves. Nonetheless, the occupational risk estimates, which do not include or assume the use of chemical-resistant gloves, may be overestimates of dermal exposures, if the proper gloves are worn to provide sufficient protection against the chemical of interest. This is further discussed in the 1,2-dichloroethane risk evaluation.

Table 6-1. Occupational Risk Summary Table High-End Exposures (Light-/Heavy-End Streams) and PPE Level Needed to Exceed Benchmark in Cases of Risk for 1,1-Dichloroethane, Perchloroethylene, and Methylene Chloride

Chemical	Similar Exposure Group	Exposure Route and Duration	Exposure Level	Acute Non-Cancer		Intermediate Non-Cancer		Chronic Non-Cancer		Cancer – BLS Working Years		Cancer – Vinyl Institute Working Years	
				MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b
Benchmark MOEs for 1,1-dichloroethane				30		30		300		1.0E-04 (only for inhalation)		1.0E-04 (only for inhalation)	
1,1-Dichloroethane	Worker (Operators)	Inhalation 8-hour TWA	CT	2,279	–	2.8E04	–	7,214	–	8.3E-06	–	2.4E-06	–
1,1-Dichloroethane	Worker (Operators)	Inhalation 8-hour TWA	HE	394	–	4,895	–	1,248	–	6.2E-05	–	5.1E-05	–
1,1-Dichloroethane	Worker (Maintenance Technicians)	Inhalation 8-hour TWA	CT	1.5E04	–	1.9E05	–	4.9E04	–	1.2E-06	–	3.5E-07	–
1,1-Dichloroethane	Worker (Maintenance Technicians)	Inhalation 8-hour TWA	HE	1,316	–	1.6E04	–	4,164	–	1.9E-05	–	1.5E-05	–
1,1-Dichloroethane	Worker (Logistics Technicians)	Inhalation 8-hour TWA	CT	5.3E04	–	6.6E05	–	1.7E05	–	3.6E-07	–	1.0E-07	–
1,1-Dichloroethane	Worker (Logistics Technicians)	Inhalation 8-hour TWA	HE	2,220	–	2.8E04	–	7,026	–	1.1E-05	–	9.1E-06	–
1,1-Dichloroethane	Worker (Laboratory Technicians)	Inhalation 8-hour TWA	CT	2.2E04	–	2.8E05	–	7.0E04	–	8.5E-07	–	2.4E-07	–
1,1-Dichloroethane	Worker (Laboratory Technicians)	Inhalation 8-hour TWA	HE	1,076	–	1.3E04	–	3,407	–	2.3E-05	–	1.9E-05	–
1,1-Dichloroethane	ONU	Inhalation 8-hour TWA	CT	5.1E04	–	6.4E05	–	1.6E05	–	3.7E-07	–	3.7E-07	–
1,1-Dichloroethane	ONU ^c	Inhalation 8-hour TWA	HE	778	–	9,658	–	2,462	–	3.1E-05	–	3.1E-05	–
1,1-Dichloroethane	All Worker SEGs	Dermal	CT	2,362	–	1,052	–	1,126	–	N/A	–	N/A	–
1,1-Dichloroethane	All Worker SEGs	Dermal	HE	787	–	351	–	NE ^d	–	NE ^d	–	NE ^d	–
Benchmark MOEs for perchloroethylene				10		N/A		10		1.0E-04		1.0E-04	

Chemical	Similar Exposure Group	Exposure Route and Duration	Exposure Level	Acute Non-Cancer		Intermediate Non-Cancer		Chronic Non-Cancer		Cancer – BLS Working Years		Cancer – Vinyl Institute Working Years	
				MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b
Perchloroethylene	Worker	Inhalation 8-hour TWA	CT	2,620	–	N/A	–	2.4E04	–	3.6E-07	–	1.0E-07	–
Perchloroethylene	Worker	Inhalation 8-hour TWA	HE	172	–	N/A	–	1,576	–	7.0E-06	–	5.8E-06	–
Perchloroethylene	ONU	Inhalation 8-hour TWA	CT	9.0E04	–	N/A	–	8.2E05	–	1.0E-08	–	3.0E-09	–
Perchloroethylene	ONU ^c	Inhalation 8-hour TWA	HE	786	–	N/A	–	7,190	–	1.5E-06	–	1.3E-06	–
Perchloroethylene	Worker	Dermal	CT	157	–	N/A	–	676	–	7.3E-06	–	2.1E-06	–
Perchloroethylene	Worker	Dermal	HE	52	–	N/A	–	NE ^d	–	NE ^d	–	NE ^d	–
Benchmark MOEs for methylene chloride				30		N/A		10		1.0E-04		1.0E-04	
Methylene chloride	Worker	Inhalation 8-hour TWA	CT	9,514	–	N/A	–	1,373	–	2.9E-08	–	8.3E-09	–
Methylene chloride	Worker	Inhalation 8-hour TWA	HE	626	–	N/A	–	90	–	5.7E-07	–	4.7E-07	–
Methylene chloride	ONU	Inhalation 8-hour TWA	CT	3.3E05	–	N/A	–	4.7E04	–	8.4E-10	–	2.4E-10	–
Methylene chloride	ONU ^c	Inhalation 8-hour TWA	HE	2,854	–	N/A	–	412	–	1.2E-07	–	1.0E-07	–
Methylene chloride	Worker	Dermal	CT	4.3E04	–	N/A	–	5,854	–	6.5E-09	–	1.9E-09	–
Methylene chloride	Worker	Dermal	HE	1.4E04	–	N/A	–	NE ^d	–	NE ^d	–	NE ^d	–

APF = assigned protection factor; CT = central tendency; HE = high-end; MOE = margin of exposure; NE = not estimated; PPE = personal protective equipment; TWA = time-weighted average

“–”= Inhalation APF not needed

Chronic cancer risk estimates calculated using working years from the Bureau of Labor Statistics (BLS) data (31 years CT, 40 years HE) ([U.S. Census Bureau, 2019a](#); [U.S. BLS, 2014](#)) or using Vinyl Institute years of service for workers at manufacturing facilities (8.9 years CT, 33 years HE) ([EPA-HQ-OPPT-2018-0427-0181](#)) ([VI, 2026](#)). For chronic, non-cancer exposure estimates, exposure dose over the working years is averaged over the working years. Therefore, different values of working years do not affect these estimates, and EPA has presented 1 chronic, non-cancer estimate. For more information, including example calculations, please see Appendix B and C of the *Occupational Exposure Assessment for 1,2-Dichloroethane*.

^a Risk estimates that exceed the benchmark (*i.e.*, a non-cancer MOE less than the benchmark or a cancer MOE exceeding the benchmark) are **bolded and shaded**.

Chemical	Similar Exposure Group	Exposure Route and Duration	Exposure Level	Acute Non-Cancer		Intermediate Non-Cancer		Chronic Non-Cancer		Cancer – BLS Working Years		Cancer – Vinyl Institute Working Years	
				MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b

^b APF listed in parentheses is the level of protection needed for estimated MOEs to be above benchmark.

^c The CT from the closed system monitoring data are a more representative and appropriate exposure estimate for a frequent, repeated inhalation exposure (*i.e.*, chronic) for the occupational non-user (ONU) exposure group. ONUs do not directly handle the chemical and are therefore expected to have lower inhalation exposures and are not expected to have dermal exposures through contact with liquids or solids.

^d The CT from the closed system monitoring data are a more representative and appropriate exposure estimate for a frequent, repeated dermal exposure (*i.e.*, chronic) and is health protective for risk estimation for closed system processes, as HE exposures from daily connecting/disconnecting of transfer lines and sampling is not realistic.

Table 6-2. Occupational Risk Summary Table for Low-End Exposures (Unpurified 1,2-Dichloroethane Stream) and PPE Level Needed to Exceed Benchmark in Cases of Risk for 1,1-Dichloroethane, Perchloroethylene, and Methylene Chloride

Chemical	Similar Exposure Group	Exposure Route and Duration	Exposure Level	Acute Non-Cancer		Intermediate Non-Cancer		Chronic Non-Cancer		Cancer – BLS Working Years		Cancer – Vinyl Institute Working Years	
				MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b
Benchmark MOEs for 1,1-dichloroethane				30		30		300		1.0E-04 (only for inhalation)		1.0E-04 (only for inhalation)	
1,1-Dichloroethane	Worker (Operators)	Inhalation 8-hour TWA	CT	2,279	–	2.8E04	–	7,214	–	8.3E-06	–	2.6E-05	–
1,1-Dichloroethane	Worker (Operators)	Inhalation 8-hour TWA	HE	394	–	4,895	–	1,248	–	6.2E-05	–	5.1E-05	–
1,1-Dichloroethane	Worker (Maintenance Technicians)	Inhalation 8-hour TWA	CT	1.5E04	–	1.9E05	–	4.9E04	–	1.2E-06	–	3.5E-07	–
1,1-Dichloroethane	Worker (Maintenance Technicians)	Inhalation 8-hour TWA	HE	1,316	–	1.6E04	–	4,164	–	1.9E-05	–	1.5E-05	–
1,1-Dichloroethane	Worker (Logistics Technicians)	Inhalation 8-hour TWA	CT	5.3E04	–	6.6E05	–	1.7E05	–	3.6E-07	–	1.0E-07	–

Chemical	Similar Exposure Group	Exposure Route and Duration	Exposure Level	Acute Non-Cancer		Intermediate Non-Cancer		Chronic Non-Cancer		Cancer – BLS Working Years		Cancer – Vinyl Institute Working Years	
				MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b
1,1-Dichloroethane	Worker (Logistics Technicians)	Inhalation 8-hour TWA	HE	1,076	–	2.8E04	–	7,026	–	1.1E–05	–	9.1E–06	–
1,1-Dichloroethane	Worker (Laboratory Technicians)	Inhalation 8-hour TWA	CT	2.2E04	–	2.8E05	–	7.0E04	–	8.5E–07	–	2.4E–07	–
1,1-Dichloroethane	Worker (Laboratory Technicians)	Inhalation 8-hour TWA	HE	4,523	–	1.3E04	–	3,407	–	2.3E–05	–	1.9E–05	–
1,1-Dichloroethane	ONU	Inhalation 8-hour TWA	CT	5.1E04	–	6.4E05	–	1.6E05	–	3.7E–07	–	1.1E–07	–
1,1-Dichloroethane	ONU ^c	Inhalation 8-hour TWA	HE	778	–	9,658	–	2,462	–	3.1E–05	–	2.6E–05	–
1,1-Dichloroethane	All Worker SEGs	Dermal	CT	2.4E05	–	1.1E05	–	1.2E05	–	N/A	–	N/A	–
1,1-Dichloroethane	All Worker SEGs	Dermal	HE	8.1E04	–	3.6E04	–	NE ^d	–	NE ^d	–	NE ^d	–
Benchmarks for perchloroethylene				10		N/A		10		1.0E–04		1.0E–04	
Perchloroethylene	Worker	Inhalation 8-hour TWA	CT	2.4E05	–	N/A	–	2.2E06	–	3.8E–09	–	1.1E–09	–
Perchloroethylene	Worker	Inhalation 8-hour TWA	HE	1.6E04	–	N/A	–	1.5E05	–	7.5E–08	–	6.2E–08	–
Perchloroethylene	ONU	Inhalation 8-hour TWA	CT	8.4E06	–	N/A	–	7.7E07	–	1.1E–10	–	3.2E–11	–
Perchloroethylene	ONU ^c	Inhalation 8-hour TWA	HE	7.3E04	–	N/A	–	6.7E05	–	1.7E–08	–	1.4E–08	–
Perchloroethylene	Worker	Dermal	CT	1.2E04	–	N/A	–	5.0E04	–	9.9E–08	–	2.9E–08	–
Perchloroethylene	Worker	Dermal	HE	3,834	–	N/A	–	NE ^d	–	NE ^d	–	NE ^d	–
Benchmark MOEs for methylene chloride				30		N/A		10		1.0E–04		1.0E–04	
Methylene chloride	Worker	Inhalation 8-hour TWA	CT	2.4E04	–	N/A	–	3,413	–	1.2E–08	–	3.3E–09	–

Chemical	Similar Exposure Group	Exposure Route and Duration	Exposure Level	Acute Non-Cancer		Intermediate Non-Cancer		Chronic Non-Cancer		Cancer – BLS Working Years		Cancer – Vinyl Institute Working Years	
				MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b
Methylene chloride	Worker	Inhalation 8-hour TWA	HE	1,555	–	N/A	–	224	–	2.3E-07	–	1.9E-07	–
Methylene chloride	ONU	Inhalation 8-hour TWA	CT	8.1E05	–	N/A	–	1.2E05	–	3.4E-10	–	9.7E-11	–
Methylene chloride	ONU ^c	Inhalation 8-hour TWA	HE	7,095	–	N/A	–	1,024	–	5.0E-08	–	4.1E-08	–
Methylene chloride	Worker	Dermal	CT	4.3E04	–	N/A	–	5,854	–	6.5E-09	–	1.9E-09	–
Methylene chloride	Worker	Dermal	HE	1.4E04	–	N/A	–	NE ^d	–	NE ^d	–	NE ^d	–

“–”= Inhalation APF not needed; APF = assigned protection factor; CT = central tendency; HE = high-end; NE = not estimated; PPE = personal protective equipment
Chronic cancer risk estimates calculated using working years from the Bureau of Labor Statistics (BLS) data (31 years CT, 40 years HE) ([U.S. Census Bureau, 2019a](#); [U.S. BLS, 2014](#)) or using Vinyl Institute years of service for workers at manufacturing facilities (8.9 years CT, 33 years HE) ([EPA-HQ-OPPT-2018-0427-0181](#)) ([VI, 2026](#)). For chronic, non-cancer exposure estimates, exposure dose over the working years is averaged over the working years. Therefore, different values of working years do not affect these estimates, and EPA has presented one chronic, non-cancer estimate. For more information, including example calculations, please see Appendix B and C of the *Occupational Exposure Assessment for 1,2-Dichloroethane*.

^a Risk estimates that exceed the benchmark (*i.e.*, a non-cancer MOE less than the benchmark or cancer MOE exceeding the benchmark) are **bolded and shaded**.

^b APF listed in parentheses is the level of protection needed for estimated MOEs to be above benchmark.

^c The CT from the closed system monitoring data are a more representative and appropriate exposure estimate for a frequent, repeated inhalation exposure (*i.e.*, chronic) for the occupational non-user (ONU) exposure group. ONUs do not directly handle chemicals and are therefore expected to have lower inhalation exposures and are not expected to have dermal exposures through contact with liquids or solids.

^d The CT from the closed system monitoring data are a more representative and appropriate exposure estimate for a frequent, repeated dermal exposure (*i.e.*, chronic) and is health protective for risk estimation for closed system processes, as HE exposures from daily connecting/disconnecting of transfer lines and sampling is not realistic.

Table 6-3. Occupational Risk Summary Table and PPE Level Needed to Exceed Benchmark in Cases of Risk for Trichloroethylene and Carbon Tetrachloride Using Monte Carlo Simulation

Chemical	Similar Exposure Group	Exposure Route and Duration	Exposure Level	Acute Non-Cancer		Intermediate Non-Cancer		Chronic Non-Cancer		Cancer – BLS Working Years		Cancer – Vinyl Institute Working Years	
				MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b
Benchmark MOEs for trichloroethylene				10		N/A		30		1.0E-04		1.0E-04	
Trichloroethylene	Worker (Operators)	Inhalation 8-hour TWA	CT	733	–	N/A	–	36	–	3.9E-06	–	2.3E-06	–
Trichloroethylene	Worker (Operators)	Inhalation 8-hour TWA	HE	171	–	N/A	–	8.5	85 (APF 10) ^e	2.1E-05	–	3.6E-05	–
Trichloroethylene	Worker (Maintenance Technicians)	Inhalation 8-hour TWA	CT	2,740	–	N/A	–	136	–	1.0E-06	–	6.1E-07	–
Trichloroethylene	Worker (Maintenance Technicians)	Inhalation 8-hour TWA	HE	614	–	N/A	–	31	–	6.0E-06	–	1.0E-05	–
Trichloroethylene	Worker (Logistics Technicians)	Inhalation 8-hour TWA	CT	2.4E04	–	N/A	–	1,179	–	1.2E-07	–	7.0E-08	–
Trichloroethylene	Worker (Logistics Technicians)	Inhalation 8-hour TWA	HE	5,662	–	N/A	–	281	–	6.5E-07	–	1.1E-06	–
Trichloroethylene	Worker (Laboratory Technicians)	Inhalation 8-hour TWA	CT	2,658	–	N/A	–	132	–	1.1E-06	–	6.3E-07	–
Trichloroethylene	Worker (Laboratory Technicians)	Inhalation 8-hour TWA	HE	593	–	N/A	–	29	295 (APF 10) ^f	6.2E-06	–	1.0E-05	–
Trichloroethylene	ONU	Inhalation 8-hour TWA	CT	3,983	–	N/A	–	198	–	7.1E-08	–	6.3E-07	–
Trichloroethylene	ONU ^c	Inhalation 8-hour TWA	HE	877	–	N/A	–	44	–	4.2E-06	–	1.0E-05	–
Benchmark MOEs for trichloroethylene (dermal)				10		N/A		30		1.0E-04		1.0E-04	
Trichloroethylene	Worker	Dermal	CT	1,117	–	N/A	–	61	–	1.4E-05	–	1.5E-05	–
Trichloroethylene	Worker	Dermal	HE	432	–	N/A	–	NE ^d	–	NE ^d	–	NE ^d	–
Benchmark MOEs for carbon tetrachloride (inhalation)				10		N/A		30		1.0E-04		1.0E-04	
Carbon tetrachloride	Worker (Operators)	Inhalation 8-hour TWA	CT	165	–	N/A	–	15	147 (APF 10) ^e	2.3E-03	9.3E-05 (APF 25) ^e	6.6E-04	6.6E-05 (APF 25) ^e

Chemical	Similar Exposure Group	Exposure Route and Duration	Exposure Level	Acute Non-Cancer		Intermediate Non-Cancer		Chronic Non-Cancer		Cancer – BLS Working Years		Cancer – Vinyl Institute Working Years	
				MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b
Carbon tetrachloride	Worker (Operators)	Inhalation 8-hour TWA	HE	38	–	N/A	–	3.4	34 (APF 10) ^e	1.3E–02	1.3E–05 (APF 1,000) ^e	1.1E–02	1.1E–05 (APF 1,000) ^e
Carbon tetrachloride	Worker (Maintenance Technicians)	Inhalation 8-hour TWA	CT	613	–	N/A	–	55	–	6.2E–04	6.2E–05 (APF 10) ^g	1.8E–04	1.8E–05 (APF 10) ^g
Carbon tetrachloride	Worker (Maintenance Technicians)	Inhalation 8-hour TWA	HE	136	–	N/A	–	12	122 (APF 10) ^g	3.6E–03	7.2E–05 (APF 50) ^g	3.0E–03	6.0E–05 (APF 50) ^g
Carbon tetrachloride	Worker (Logistics Technicians)	Inhalation 8-hour TWA	CT	5,333	–	N/A	–	476	–	7.2E–05	–	2.1E–05	–
Carbon tetrachloride	Worker (Logistics Technicians)	Inhalation 8-hour TWA	HE	1,255	–	N/A	–	112	–	3.9E–04	3.9E–05 (APF 10) ^h	3.1E–03	6.2E–05 (APF 50) ^h
Carbon tetrachloride	Worker (Laboratory Technicians)	Inhalation 8-hour TWA	CT	601	–	N/A	–	54	–	6.4E–04	6.4E–05 (APF 10) ^f	1.8E–04	1.8E–05 (APF 10) ^f
Carbon tetrachloride	Worker (Laboratory Technicians)	Inhalation 8-hour TWA	HE	131	–	N/A	–	12	117 (APF 10) ^f	3.8E–03	7.5E–05 (APF 50) ^f	3.8E–03	7.5E–05 (APF 50) ^f
Carbon tetrachloride	ONU	Inhalation 8-hour TWA	CT	892	–	N/A	–	80	–	4.3E–04	4.3E–05 (APF 10) ⁱ	4.3E–04	4.3E–05 (APF 10) ⁱ
Carbon tetrachloride	ONU ^c	Inhalation 8-hour TWA	HE	195	–	N/A	–	17	174 (APF 10) ⁱ	2.5E–03	5.1E–05 (APF 50) ⁱ	2.5E–03	5.1E–05 (APF 50) ⁱ
Benchmark MOEs for carbon tetrachloride (dermal)				30		N/A		30		1.0E–04		1.0E–04	
Carbon tetrachloride	Worker	Dermal	CT	243	–	N/A	–	34	–	1.0E–03	–	9.5E–04	–
Carbon tetrachloride	Worker	Dermal	HE	85	–	N/A	–	NE ^d	–	NE ^d	–	NE ^d	–

APF = assigned protection factor; CT = central tendency; HE = high-end; PPE = personal protective equipment; “–”= Inhalation APF not needed; NE = not estimated
Chronic cancer risk estimates calculated using working years from the Bureau of Labor Statistics (BLS) data (31 years CT, 40 years HE) ([U.S. Census Bureau, 2019a](#); [U.S. BLS, 2014](#)) or using Vinyl Institute years of service for workers at manufacturing facilities (8.9 years CT, 33 years HE) ([EPA-HQ-OPPT-2018-0427-0181](#)) ([VI, 2026](#)). For chronic, non-cancer exposure estimates, exposure dose over the working years is averaged over the working years. Therefore, different values of working years do not affect these estimates, and EPA has presented 1 chronic, non-cancer estimate. For more information, including example calculations, please see Appendix B and C of the *Occupational Exposure Assessment for 1,2-Dichloroethane*.

^a Risk estimates that exceed the benchmark (*i.e.*, a non-cancer MOE less than the benchmark or a cancer MOE exceeding the benchmark) are **bolded and shaded**.

^b APF listed in parentheses is the level of protection needed for estimated MOEs to be above benchmark.

Chemical	Similar Exposure Group	Exposure Route and Duration	Exposure Level	Acute Non-Cancer		Intermediate Non-Cancer		Chronic Non-Cancer		Cancer – BLS Working Years		Cancer – Vinyl Institute Working Years	
				MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b	MOE – No PPE ^a	MOE – APF ^b

^c The central tendency from the closed system monitoring data are a more representative and appropriate exposure estimate for a frequent, repeated inhalation exposure (*i.e.*, chronic) for the occupational non-user (ONU) exposure group. ONUs do not directly handle chemicals and are therefore expected to have lower inhalation exposures and are not expected to have dermal exposures through contact with liquids or solids.

^d The CT from the closed system monitoring data are a more representative and appropriate exposure estimate for a frequent, repeated dermal exposure (*i.e.*, chronic) and is health protective for risk estimation for closed system processes, as HE exposures from daily connecting/disconnecting of transfer lines and sampling is not realistic.

^e Test order data described operators as wearing respirators with APFs ranging from 10–1,000 while performing various tasks.

^f Test order data described laboratory technicians as wearing respirators with APFs ranging from 10–1,000 while performing various tasks.

^g Test order data described maintenance technicians as wearing full-face airline respirators of APF 1,000 during major maintenance tasks.

^h Test order data described logistics technicians as wearing respirators with APFs ranging from 10–50 during loading or offloading tasks.

ⁱ Test order data described ONUs as not wearing respiratory protection during routine daily tasks, although 1 supervisor was described as wearing a full-face respirator (APF 50) while observing loading activities from 20 feet away.

6.2 Risk Estimates for General Population

General population exposures and associated risks were estimated from byproduct releases to ambient air and surface waters resulting from the manufacture of 1,2-dichloroethane.

Ambient Air

For the ambient air pathway, EPA estimated acute, chronic non-cancer, and cancer risks from exposure to the byproducts for populations living in the vicinity of facilities manufacturing 1,2-dichloroethane using HEM5.0. It provides estimates of risks and exposures at centroids of census blocks and radial distance up to 50 km from releasing facilities. HEM5.0 calculates an aggregated exposure for each byproduct by accounting for the combined emissions across all modeled facilities in proximity to one another. Table 6-4 presents the highest estimated cancer risk value and the lowest acute and chronic non-cancer values across all facilities for each byproduct at centroids of census blocks. No cancer risks were above the cancer benchmark range of 1×10^{-6} to 1×10^{-4} . Additionally, none of the acute or chronic non-cancer risks were below the benchmarks of 30 or 300, respectively.

EPA also compared the releases of each of the byproduct chemicals assessed in the previously published fenceline analyses to the estimated byproduct air releases in this TSD. This comparison showed lower exposures from the byproduct estimates vs. from the manufacture of chemical itself, which supports the reasonableness of the byproduct estimates.

Table 6-4. Estimated Acute, Chronic Non-Cancer, and Cancer Inhalation Risk Values for Each Byproduct Estimated Using HEM5.0^a

Chemical/ Byproduct	Minimum Calculated Acute Inhalation Risk Value Across All Facilities (Benchmark = 30) ^b	Minimum Calculated Chronic Non-Cancer Inhalation Risk Value Across All Facilities (Benchmark = 300) ^b	Maximum Calculated Cancer Risk Value Across All Facilities (Benchmark = 1E-06 to 1E-04) ^c
1,1-Dichloroethane	8.47E05	8.81E06	7.17E-08
Carbon tetrachloride	1.44E07	5.97E06	3.12E-08
Methylene chloride	1.74E07	4.96E06	7.59E-12
Perchloroethylene	1.36E07	1.90E08	1.56E-10
Trichloroethylene	2.19E07	3.67E06	7.91E-10

^a Risk values calculated using ambient air concentrations that are based on each facility's maximum release from the 2015–2024 TRI reporting years. Releases for each byproduct were calculated by multiplying the TRI-reported releases of 1,2-dichloroethane from Manufacturing COU by the associated percentage in Table 1-1. This table presents the highest estimated cancer risk value and the lowest acute and chronic non-cancer values across all facilities for each byproduct at centroids of census blocks.

^b Non-cancer risk is indicated when value is below the benchmark.

^b Non-cancer risk is indicated when value is below the benchmark.

^c Consistent with other EPA programs, for TSCA risk evaluations, EPA has generally used 1E-06 to 1E-04 as an acceptable cancer risk range for general population exposures. While a handful of TSCA risk evaluations relied solely on 1E-06, EPA generally believes that the use of a range is more appropriate. These values provide a range for evaluating risk but do not constitute a “bright-line.”

Surface Water

For the surface water pathway, the Eagle US 2 facility surface water release data was used for a screening analysis of general population byproduct exposures and risks. Because the Eagle US 2 facility releases of 1,2-dichloroethane result in the highest 1,2-dichloroethane receiving water body

concentrations as well as byproducts compared to other 1,2-dichloroethane Manufacturing COU facilities, EPA considered this facility to be appropriate of representing high-end byproduct surface water exposures. The Agency was able to characterize the 2021 releases from the Eagle US 2 to Bayou d'Inde for the byproduct chemicals as well as from 1,2-dichloroethane releases. EPA was not able to discern at the point of discharge of the total amount released of the individual chemicals is from its manufacture or as a byproduct from 1,2-dichloroethane manufacture or the combination of the two processes. The latter was assumed likely so that EPA could estimate the amount of byproduct chemicals released per day (350 days of release per year) based on the percentages as the process stream (see Table 1-1).

Table 6-5 presents several of the risk estimates resulting from the screening analysis for the high-end 1,2-dichloroethane and byproduct releasing facility, the Eagle US 2 facility in Westlake, Louisiana. Risk estimates were calculated based on the acute, chronic or lifetime doses of fish ingestion and oral/dermal exposures through swimming and drinking water ingestion. Infant drinking water ingestion from formula represents the highest exposure estimates for all the byproducts and is presented as the highest risk that would occur from reported byproduct releases under the 1,2-dichloroethane Manufacturing COU. Although estimates are presented using releases from Eagle US 2, this specific facility does not discharge to drinking water source waters. However, the Eagle US 2 receiving water body concentrations at the point of discharge present the highest exposures among discharging manufacturing facilities and provide an upper-bound risk estimate. The adult subsistence fish ingestion and infant drinking water risk estimates are the highest among the surface water exposure routes. Other exposure risk estimates from incidental oral and dermal from swimming, high-end fish ingestion and other life stages for drinking water ingestion are presented in the *Byproducts General Population Exposures for 1,2-Dichloroethane* ([U.S. EPA, 2026a](#)).

Table 6-5. Select Estimated Acute, Chronic Non-Cancer, and Cancer Risk Values for Each Byproduct from the Eagle US 2 Surface Water Exposure Screening Analysis^a

Chemical/ Byproduct	Calculated Adult Subsistence Acute Fish Ingestion Risk Value (Highest Benchmark = 30)^b	Calculated Adult Subsistence Chronic Non-Cancer Fish Ingestion Risk Value (Highest Benchmark = 300)^b	Calculated Infant Acute Drinking Water Ingestion Risk Value (Highest Benchmark = 30)^b	Calculated Infant Chronic Drinking Water Ingestion Risk Value (Highest Benchmark = 300)^b	Calculated Drinking Water Ingestion Cancer Risk Value (Benchmark = 1E-06 to 1E-04)^c
1,1-Dichloroethane	3.2E07	1.0E07	1.7E06	3.0E06	1.4E-09
Trichloroethylene	1.8E08	6.3E06	9.7E06	1.8E06	4.7E-12
Perchloroethylene	6.5E07	1.9E08	3.6E06	5.5E07	5.7E-13
Methylene chloride	1.5E08	1.4E07	8.1E06	4.0E06	2.2E-13
Carbon tetrachloride	5.2E07	5.2E06	2.9E06	1.5E06	9.5E-11

^a Risk values were calculated using Eagle US 2 surface water concentrations from 2021 Discharge Monitoring Report (DMR) and the corresponding cancer, acute, and chronic non-cancer hazard values for each byproduct as presented in Table 5-1, Table 5-2, and Table 5-3.

^b Risk is indicated when value is below the benchmark.

^c Risk is indicated when value is above the benchmark.

6.2.1 General Population Risk Summary

EPA did not find MOE estimates below the chronic non-cancer (or acute non-cancer) benchmark or above the cancer risk range of 1×10^{-6} to 1×10^{-4} for any of the byproducts via inhalation of ambient air based on an analysis using HEM5.0. The estimated inhalation MOEs to the general population from the assessed byproducts are expected to be high-end estimates for the following reasons: (1) EPA used each facility's highest annual TRI-reported release of 1,2-dichloroethane from the reporting years of 2015 to 2024; (2) the highest annual release reported to TRI for each facility from 2015 to 2024 was used to calculate releases of each byproduct using percentages provided by industry presented in Table 1-1 that represent high-end estimates of the typical composition of each byproduct; and (3) the exposure scenarios assume continuous exposure (1 day for acute risk, 1 year for chronic non-cancer risks, and 70 years for lifetime cancer risks). A comparison between releases used in this assessment and those used in the fence line analyses and *Risk Evaluation for 1,1-Dichloroethane* (U.S. EPA, 2025a) indicates that the releases modeled in HEM5.0 are unlikely to be overestimated (Section 2.2.1.1). For this assessment, general population inhalation risks via ambient air for each byproduct were considered individually.

EPA did not find MOE estimates below the chronic non-cancer (or acute non-cancer) benchmark or above the cancer risk range of 1×10^{-6} to 1×10^{-4} for any of the byproducts via oral or dermal exposures. This conclusion is based primarily on a quantitative screening analysis that estimates general population exposures to receiving water concentrations from the facility representing the highest byproduct release concentrations. For this assessment, general population oral/dermal risks via surface water for each byproduct were considered individually.

7 CONCLUSIONS

EPA considered all reasonably available information identified through its systematic review process under TSCA ([U.S. EPA, 2026l](#)) to characterize exposures and associated potential risks from the assessed 1,2-dichloroethane byproducts to (1) workers via inhalation and dermal routes; (2) the general population residing in the vicinity of 1,2-dichloroethane manufacturing facilities via inhalation, oral, and dermal routes; and (3) aquatic and terrestrial ecological receptors.

1,2-Dichloroethane has a total production volume in the United States between 30 and 40 billion lb from the 2020 CDR reporting period ([U.S. EPA, 2026k](#)), which may result in a total byproduct production volume produced from the manufacturing of 1,2-dichloroethane as high as 375 to 500 million lb. To evaluate environmental releases for each byproduct, EPA used 1,2-dichloroethane release data to air and water from the TRI, NEI, and DMR databases. These release data, as well as the 1,2-dichloroethane product stream compositions provided by industry in several public comments, were used to estimate environmental releases for each byproduct.

To evaluate occupational exposures, EPA used inhalation monitoring data—either directly applicable data or surrogate data obtained through test orders—to evaluate acute, intermediate, and chronic exposures to workers for each byproduct.¹⁰ For 1,1-dichloroethane, the Agency used inhalation monitoring data submitted in response to a test order that measured 1,1-dichloroethane inhalation exposures during 1,2-dichloroethane manufacturing. For the remaining assessed byproducts (trichloroethylene, perchloroethylene, methylene chloride, and carbon tetrachloride), the Agency used surrogate inhalation monitoring data submitted in response to the 1,2-dichloroethane test order, following the same methodology outlined in the *Risk Evaluation for 1,2-Dichloroethane* ([U.S. EPA, 2026k](#)). Dermal exposure was also modeled for each of the assessed byproduct.

High-end screening level exposures for trichloroethylene and carbon tetrachloride showed MOE estimates were below the chronic non-cancer benchmark and above the cancer benchmark for inhalation and dermal to workers. Therefore, EPA further refined the analysis by performing Monte Carlo analysis to vary the concentration from the low-end to high-end exposures (equal distribution) as well as separating the inhalation exposures by SEG. Trichloroethylene presents a chronic non-cancer inhalation MOE below the benchmark for operators and laboratory technicians at only the high-end exposure. Carbon tetrachloride presents chronic non-cancer inhalation risk below applicable benchmarks for operators (both central tendency and high-end), maintenance technicians (high-end), laboratory technicians (high-end), and ONUs (high-end). Carbon tetrachloride presents chronic cancer inhalation risk above benchmarks for operators (central tendency and high-end), maintenance technicians (central tendency and high-end), logistics technicians (high-end), laboratory technicians (central tendency and high-end), and ONUs (central tendency and high-end). For dermal exposures, carbon tetrachloride presents cancer risk for workers at central tendency exposures. Chronic non-cancer and cancer effects involved repeated exposures over a high exposure frequency and high number exposure days, as well as higher estimates of byproduct concentrations. As such, use of the high-end estimate in combination with these other conservative default values may result in an overly conservative estimate of chronic risks.

For dermal exposures, carbon tetrachloride presents cancer risk estimates above benchmark for workers at central tendency exposures (high end exposures not estimated). EPA considered the central tendency

¹⁰ As described noted in Footnote 1, and in accordance with TSCA section 4 that allows EPA to impose testing requirements when necessary to perform a risk evaluation, the Agency issued a [test order for 1,2-dichloroethane on January 14, 2021](#) ([Stantec ChemRisk, 2024](#)). EPA also received inhalation monitoring data from the test order submission for 1,1-dichloroethane manufactured as a byproduct in the manufacture of 1,2-dichloroethane ([Stantec ChemRisk, 2023](#)).

from the closed system monitoring data as a more representative and appropriate exposure estimate for a frequent, repeated dermal exposure (*i.e.*, chronic), as high-end exposures from daily connecting/disconnecting of transfer lines and sampling is not expected. As described in Section 4.1.1.1, ONUs do not directly handle chemicals and are therefore expected to have lower inhalation exposures and are not expected to have dermal exposures through contact with liquids or solids (Section 6.1.1).

The Agency has (1) robust confidence in the case of occupational exposure estimates of 1,1-dichloroethane that utilized directly applicable inhalation test order monitoring data, (2) moderate confidence in the case of the occupational exposure estimates of the remaining byproducts that used 1,2-dichloroethane inhalation test order data as surrogate data, and (3) moderate confidence in the dermal occupational exposure assessment for all of the assessed byproducts.

EPA conducted fenceline analyses for ambient air and water pathways to support the risk management of trichloroethylene, perchloroethylene, methylene chloride and carbon tetrachloride, under TSCA (see list of references provided in Section 1.2). The ambient air pathway was not previously evaluated in the risk evaluations for these chemicals for exposures to the general population. The comparison of air release data in the published chemical-specific risk evaluations and fenceline analyses for the Manufacturing COU, with the estimated air releases presented herein, suggested similar exposures (Section 4.1.2.1). Additionally, EPA estimated exposures and associated potential risks to the general population via inhalation route for each byproduct using HEM5.0. Releases modeled in HEM5.0 were calculated using the percentages in Table 1-1 provided by industry in several public comments. As shown in Section 6.2, for acute and chronic non-cancer, none of the calculated risk values were below the Agency benchmarks of 30 or 300, respectively, which indicates no potential risk to the general population. Additionally, none of the estimated cancer risks were above the benchmark range of 1×10^{-6} to 1×10^{-4} . The Agency has robust confidence in the conclusion that there is no expected risk to general population from exposure to the assessed byproducts from releases to air.

EPA compared the amount of byproduct chemicals released to surface water as listed in respective final risk evaluations with the estimated releases in this TSD for the facility that has reported all assessed byproducts and 1,2-dichloroethane. This facility (the Eagle US 2 LLC - Lake Charles Complex facility) in Westlake, Louisiana, represents the high-end exposure scenario for 1,2-dichloroethane manufacturing releases. As it releases other byproduct chemicals, it also represents an appropriate comparator of releases, surface water concentration, and exposures. As listed in Table 2-10, estimated byproduct releases from Eagle US 2 are a high-end exposure scenario that provides robust confidence in the conclusion that there is no expected cancer nor non-cancer risk to the general population resulting from exposure to the assessed byproducts' releases to surface water.

EPA evaluated exposure to aquatic and terrestrial species from the byproducts and used relevant environmental hazard thresholds from each byproducts' published respective risk evaluation and considered physical and chemical and fate properties of each chemical to conduct the environmental risk assessment. The Agency has moderate confidence in the conclusion that exposure does not exceed hazard for aquatic organisms and robust confidence in the conclusion that exposure does not exceed hazard for terrestrial organisms.

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APPENDICES

Appendix A EQUATIONS FOR CALCULATING ACUTE, INTERMEDIATE, AND CHRONIC (NON-CANCER AND CANCER) INHALATION AND DERMAL EXPOSURES

This report assesses inhalation exposures to workers in occupational settings, presented as 8-hour (*i.e.*, full-shift) time-weighted average (TWA). The full-shift TWA exposures are then used to calculate acute exposure concentrations (AC), intermediate average daily concentrations ($ADC_{intermediate}$), average daily concentrations (ADC) for chronic, non-cancer risks, lifetime average daily concentrations (LADC) for chronic, cancer risks.

This report also assesses dermal exposures to workers in occupational settings, presented as a dermal acute absorbed dose rate (AADR). The AADRs are then used to calculate acute absorbed doses (AAD), intermediate absorbed doses (IAD), average daily doses (ADD) for chronic non-cancer risks, and lifetime average daily doses (LADD) for chronic cancer risks.

This appendix presents the equations and input parameter values used to estimate each exposure metric.

A.1 Equations for Calculating Acute, Intermediate, and Chronic (Non-Cancer, and Cancer) Inhalation Exposures

AC is used to estimate workplace inhalation exposures for acute risks (*i.e.*, risks occurring as a result of exposure for <1 day), per Equation_Apx A-1.

Equation_Apx A-1.

$$AC = \frac{C \times ED \times BR}{AT_{acute}}$$

Where:

AC	=	Acute exposure concentration
C	=	Contaminant concentration in air (TWA)
ED	=	Exposure duration (hr/day)
BR	=	Breathing rate ratio (unitless)
AT_{acute}	=	Acute averaging time (hr)

$ADC_{intermediate}$ is used to estimate workplace exposures for intermediate risks and is estimated as follows:

Equation_Apx A-2.

$$ADC_{intermediate} = \frac{C \times ED \times EF_{intermediate} \times BR}{AT_{intermediate}}$$

Equation_Apx A-3.

$$AT_{intermediate} = D_{intermediate} \times 24 \frac{h}{day}$$

Where:

$ADC_{intermediate}$	=	Intermediate average daily concentration
$EF_{intermediate}$	=	Intermediate exposure frequency
$AT_{intermediate}$	=	Averaging time (hours) for intermediate exposure
$D_{intermediate}$	=	Days for intermediate duration (day)

ADC and LADC are used to estimate workplace exposures for non-cancer and cancer risks, respectively. These exposures are estimated as follows:

Equation_Apx A-4.

$$ADC \text{ or } LADC = \frac{C \times ED \times EF \times WY \times BR}{AT \text{ or } AT_c}$$

Equation_Apx A-5.

$$AT = WY \times 365 \frac{\text{day}}{\text{yr}} \times 24 \frac{\text{hr}}{\text{day}}$$

Equation_Apx A-6.

$$AT_c = LT \times 365 \frac{\text{day}}{\text{yr}} \times 24 \frac{\text{hr}}{\text{day}}$$

Where:

ADC	=	Average daily concentration used for chronic non-cancer risk calculations
$LADC$	=	Lifetime average daily concentration used for chronic cancer risk calculations
ED	=	Exposure duration (hours/day)
EF	=	Exposure frequency (day/yr)
WY	=	Working years/lifetime (yr)
AT	=	Averaging time (hours) for chronic, non-cancer risk
AT_c	=	Averaging time (hours) for cancer risk
LT	=	Lifetime years (yr) for cancer risk

A.2 Equations for Calculating Acute, Intermediate, and Chronic (Non-Cancer and Cancer) Dermal Exposures

AD is used to estimate workplace dermal exposures for acute risks and are calculated using Equation_Apx A-7.

Equation_Apx A-7.

$$AAD = \frac{AADR}{BW}$$

Where:

AAD	=	Acute absorbed dose (mg/kg-day)
$AADR$	=	Acute absorbed dose rate (mg/day)
BW	=	Body weight (kg)

IAD is used to estimate workplace dermal exposures for intermediate risks and is estimated using Equation_Apx A-8.

Equation_Apx A-8.

$$IAD = \frac{AADR \times EF_{intermediate}}{BW \times D_{intermediate}}$$

Where:

IAD = Intermediate average daily dose (mg/kg-day)

CAD and LCAD are used to estimate workplace dermal exposures for non-cancer and cancer risks and are calculated using Equation_Apx A-9.

Equation_Apx A-9.

$$CAD \text{ or } LCAD = \frac{AADR \times EF \times WY}{BW \times 365 \frac{days}{yr} \times (WY \text{ or } LT)}$$

Where WY and LT are used in the denominator for CAD and LCAD, respectively.

A.3 Acute, Intermediate, and Chronic (Non-Cancer and Cancer) Equation Inputs

The input parameter values in Table_Apx A-1 are used to calculate each of the above acute, intermediate, and chronic exposure estimates. Where exposure is calculated using probabilistic modeling, the calculations are integrated into the Monte Carlo simulation. Where multiple values are provided for ED, it indicates that EPA may have used different values for different conditions of use. The EF and EF_{intermediate} used for each OES can differ and the values used are described in the appropriate sections of this report. The maximum values used in the equations as well as a general summary for these differences are described below in this section.

Table_Apx A-1. Parameter Values for Calculating Inhalation Exposure Estimates

Parameter Name	Symbol	Value	Unit
Exposure Duration	ED	8	h/day
Breathing Rate Ratio	BR	2.04	unitless
Exposure Frequency	EF	24–250 ^a	days/yr
Exposure Frequency, Intermediate	EF _{intermediate}	22	days
Days for Intermediate Duration	D _{intermediate}	30	days
Working Years ^a	WY	31 (50th percentile) 40 (95th percentile)	years
Lifetime Years, Cancer	LT	78	years
Averaging Time, Intermediate	AT _{intermediate}	720	hours
Averaging Time, Non-Cancer	AT	271,560 (central tendency) ^b 350,400 (high-end) ^c	hours
Averaging Time, Cancer	AT _c	683,280	hours
Body Weight	BW	80 (average adult worker) 72.4 (female of reproductive age)	kg

Parameter Name	Symbol	Value	Unit
^a Depending on the occupational exposure scenario (OES).			
^b Calculated using the 50th percentile value for WY, varied for occupational exposure scenario (OES) with industry-specific data.			
^c Calculated using the 95th percentile value for WY, varied for OES with industry-specific data.			

A.3.1 Exposure Duration (ED)

EPA generally uses an exposure duration of 8 hours/day for averaging full-shift exposures.

A.3.2 Breathing Rate Ratio

EPA uses a breathing rate ratio, which is the ratio between the worker breathing rate and resting breathing rate, to account for the amount of air a worker breathes during exposure. The typical worker breathes about 10 m³ of air in 8 hours, or 1.25 m³/h (CEB, 1991) while the resting breathing rate is 0.6125 m³/h (CEB, 1991). The ratio of these two values is equivalent to 2.04.

A.3.3 Exposure Frequency (EF)

EPA generally uses a maximum exposure frequency of 250 days/year. The estimation of the exposure frequency and associated distributions for each OES are described in the relevant section of this report.

EF is expressed as the number of days/year a worker is exposed to the chemical being assessed. In some cases, it may be reasonable to assume a worker is exposed to the chemical on each working day. In other cases, it may be more appropriate to estimate a worker's exposure to the chemical occurs during a subset of the worker's annual working days. The relationship between exposure frequency and annual working days can be described mathematically as follows:

Equation_Apx A-10.

$$EF = f \times AWD$$

Where:

<i>EF</i>	=	Exposure frequency, the number of days/year a worker is exposed to the chemical (day/yr)
<i>f</i>	=	Fractional number of annual working days during which a worker is exposed to the chemical (unitless)
<i>AWD</i>	=	Annual working days, the number of days/year a worker works (day/yr)

BLS (2016) provides data on the total number of hours worked and total number of employees by each industry NAICS code. These data are available from the 3- to 6-digit NAICS level (where 3-digit NAICS are less granular and 6-digit NAICS are the most granular). Dividing the total, annual hours worked by the number of employees yields the average number of hours worked/employee per year for each NAICS.

EPA has identified approximately 140 NAICS codes applicable to the multiple conditions of use for the ten chemicals undergoing risk evaluation. For each NAICS code of interest, the Agency looked up the average hours worked per employee/year at the most granular NAICS level available (*i.e.*, 4-digit, 5-digit, or 6-digit). EPA converted the working hours/employee to working days/year per employee assuming employees work an average of 8 hours/day. The average number of days/year worked, or AWD, ranges from 169 to 282 days/year, with a 50th percentile value of 250 days/year. EPA repeated this analysis for all NAICS codes at the 4-digit level. The average AWD for all 4-digit NAICS codes ranges from 111 to 282 days/year, with a 50th percentile value of 228 days/year. 250 days/year is

approximately the 75th percentile. In the absence of industry- and 1,2-dichloroethane specific data, EPA assumes the parameter f is equal to one for all COUs.

A.3.4 Intermediate Exposure Frequency ($EF_{\text{intermediate}}$)

For 1,2-dichloroethane, the $D_{\text{intermediate}}$ was set at 30 days. EPA estimated the maximum number of working days within the $D_{\text{intermediate}}$, using the following equation and assuming 5 working days/wk:

Equation_Apx A-11.

$$EF_{\text{intermediate}}(\text{max}) = 5 \frac{\text{working days}}{\text{wk}} \times \frac{30 \text{ total days}}{7 \frac{\text{total days}}{\text{wk}}} = 21.4 \text{ days, rounded up to 22 days}$$

A.3.5 Intermediate Duration ($D_{\text{intermediate}}$)

EPA assessed an intermediate duration of 30 days based on the available health data.

A.3.6 Working Years (WY)

EPA has developed a triangular distribution for working years. EPA has defined the parameters of the triangular distribution as follows:

- Minimum value: BLS Current Population Survey (CPS) tenure data with current employer as a low-end estimate of the number of lifetime working years: 10.4 years;
- Mode value: The 50th percentile tenure data with all employers from SIPP as a mode value for the number of lifetime working years: 36 years; and
- Maximum value: The maximum average tenure data with all employers from SIPP as a high-end estimate on the number of lifetime working years: 44 years.

This triangular distribution has a 50th percentile value of 31 years and a 95th percentile value of 40 years. EPA uses these values for central tendency and high-end ADC and LADC calculations, respectively. Additionally, EPA utilized industry specific estimates for working years for select OESs where such information was available.

The BLS ([U.S. BLS, 2014](#)) provides information on employee tenure with *current employer* obtained from the CPS, which is a monthly sample survey of about 60,000 households that provides information on the labor force status of the civilian non-institutional population aged 16 years and over. CPS data are released every 2 years. The data are available by demographics and by generic industry sectors but are not available by NAICS codes.

The U.S. Census' ([U.S. Census Bureau, 2019a](#)) Survey of Income and Program Participation (SIPP) provides information on *lifetime tenure with all employers*. SIPP is a household survey that collects data on income, labor force participation, social program participation and eligibility, and general demographic characteristics through a continuous series of national panel surveys of between 14,000 and 52,000 households ([U.S. Census Bureau, 2019a](#)). EPA analyzed the 2008 SIPP Panel Wave 1, a panel that began in 2008 and covers the interview months of September 2008 through December 2008 ([U.S. Census Bureau, 2019a, b](#)). For this panel, lifetime tenure data are available by Census Industry Codes, which can be crosswalked with NAICS codes.

SIPP data include fields for the industry in which each surveyed, employed individual works (TJBIND1), worker age (TAGE), and years of work experience *with all employers* over the surveyed

individual’s lifetime.¹¹ Census household surveys use different industry codes than the NAICS codes used in its firm surveys, so these were converted to NAICS using a published crosswalk. EPA calculated the average tenure for the following age groups: (1) workers aged 50 years and older, (2) workers aged 60 and older, and (3) workers of all ages employed at time of survey. The Agency used tenure data for age group “50 and older” to determine the high-end lifetime working years, because the sample size in this age group is often substantially higher than the sample size for age group “60 and older.” For some industries, the number of workers surveyed, or the *sample size*, was too small to provide a reliable representation of the worker tenure in that industry. Therefore, EPA excluded data where the sample size was less than five from the Agency’s analysis.

Table_Apx A-2 summarizes the average tenure for workers age 50 years and older from SIPP data. Although the tenure may differ for any given industry sector, there is no significant variability between the 50th and 95th percentile values of average tenure across manufacturing and non-manufacturing sectors.

Table_Apx A-2. Overview of Average Worker Tenure from U.S. Census SIPP (Age Group Aged 50+ Years)

Industry Sectors	Working Years			
	Average	50th Percentile	95th Percentile	Maximum
All industry sectors relevant to the first 10 chemicals that have undergone a risk evaluation	35.9	36	39	44
Manufacturing sectors (NAICS 31–33)	35.7	36	39	40
Non-manufacturing sectors (NAICS 42–81)	36.1	36	39	44

Source: ([U.S. Census Bureau, 2019a](#)).
 Note: Industries where sample size is <5 were excluded from this analysis.

BLS CPS data provides the median years of tenure that wage and salary workers had been with their current employer. Table_Apx A-3 presents CPS data for all demographics (men and women) by age group from 2008 to 2012. To estimate the low-end value on number of working years, EPA used the most recent (2014) CPS data for workers aged 55 to 64 years, which indicated a median tenure of 10.4 years with their current employer. The use of this low-end value represents a scenario where workers are only exposed to the chemical of interest for a portion of their lifetime working years as they may change jobs or move from one industry to another throughout their career.

Table_Apx A-3. Median Years of Tenure with Current Employer by Age Group

Age (years)	January 2008	January 2010	January 2012	January 2014
16+	4.1	4.4	4.6	4.6
16–17	0.7	0.7	0.7	0.7
18–19	0.8	1.0	0.8	0.8
20–24	1.3	1.5	1.3	1.3

¹¹ To calculate the number of years of work experience EPA took the difference between the year first worked (TMAKMNYR) and the current data year (*i.e.*, 2008). The Agency then subtracted any intervening months when not working (ETIMEOFF).

Age (years)	January 2008	January 2010	January 2012	January 2014
25+	5.1	5.2	5.4	5.5
25–34	2.7	3.1	3.2	3.0
35–44	4.9	5.1	5.3	5.2
45–54	7.6	7.8	7.8	7.9
55–64	9.9	10.0	10.3	10.4
65+	10.2	9.9	10.3	10.3

Source: ([U.S. Census Bureau, 2015](#))

A.3.7 Lifetime Years (LT)

EPA assumed a lifetime of 78 years for all worker demographics.

A.3.8 Body Weight (BW)

EPA assumed a body weight of 80 kg for average adult workers. EPA assumed a body weight of 72.4 kg for females of reproductive age, per Chapter 8 of the *Exposure Factors Handbook* ([U.S. EPA, 2011](#)).

Appendix B SAMPLE CALCULATIONS FOR CALCULATING ACUTE AND CHRONIC (NON-CANCER AND CANCER) INHALATION EXPOSURES

Sample calculations for high-end and central tendency acute and chronic (non-cancer and cancer) exposure concentrations for one condition of use (COU) under TSCA, Manufacturing of 1,2-Dichloroethane, are demonstrated below. The explanation of the equations and parameters used is provided in Appendix A.

B.1 Example High-End AC, ADC, LADC, and SADC Calculations

Calculate AC_{HE} :

$$AC_{HE} = \frac{C_{HE} \times ED \times BR}{AT_{acute}}$$
$$AC_{HE} = \frac{7.3 \text{ ppm} \times 8 \text{ hr/day} \times 2.04}{24 \text{ hr/day}} = 5.0 \text{ ppm}$$

Calculate $SADC_{HE}$:

$$SADC = \frac{C_{HE} \times ED \times EF_{SC} \times BR}{AT_{sc}}$$
$$SADC_{HE} = \frac{7.3 \text{ ppm} \times 8 \frac{\text{hr}}{\text{day}} \times 22 \frac{\text{days}}{\text{year}} \times 2.04}{24 \frac{\text{hr}}{\text{day}} \times 30 \frac{\text{days}}{\text{year}}} = 3.6 \text{ ppm}$$

Calculate ADC_{HE} :

$$ADC_{HE} = \frac{C_{HE} \times ED \times EF \times WY \times BR}{AT}$$
$$ADC_{HE} = \frac{7.3 \text{ ppm} \times 8 \frac{\text{hr}}{\text{day}} \times 250 \frac{\text{days}}{\text{year}} \times 40 \text{ years} \times 2.04}{40 \text{ years} \times 365 \frac{\text{days}}{\text{yr}} \times 24 \frac{\text{hr}}{\text{day}}} = 4.8 \text{ ppm}$$

Calculate $LADC_{HE}$:

$$LADC_{HE} = \frac{C_{HE} \times ED \times EF \times WY \times BR}{AT_c}$$
$$LADC_{HE} = \frac{7.3 \text{ ppm} \times 8 \frac{\text{hr}}{\text{day}} \times 250 \frac{\text{days}}{\text{year}} \times 40 \text{ years} \times 2.04}{78 \text{ years} \times 365 \frac{\text{days}}{\text{year}} \times 24 \text{ hr/day}} = 2.4 \text{ ppm}$$

B.2 Example Central Tendency AC, ADC, LADC, and SADC Calculations

Calculate AC_{CT} :

$$AC_{CT} = \frac{C_{CT} \times ED \times BR}{AT_{acute}}$$
$$AC_{CT} = \frac{0.48 \text{ ppm} \times 8 \text{ hr/day} \times 2.04}{24 \text{ hr/day}} = 0.33 \text{ ppm}$$

Calculate $SADC_{CT}$:

$$SADC_{CT} = \frac{C_{CT} \times ED \times EF_{sc} \times BR}{AT_{sc}}$$
$$SADC_{CT} = \frac{0.48 \text{ ppm} \times 8 \frac{\text{hr}}{\text{day}} \times 22 \frac{\text{days}}{\text{year}} \times 2.04}{24 \frac{\text{hr}}{\text{day}} \times 30 \frac{\text{days}}{\text{year}}} = 0.24 \text{ ppm}$$

Calculate ADC_{CT} :

$$ADC_{CT} = \frac{C_{CT} \times ED \times EF \times WY \times BR}{AT}$$
$$ADC_{CT} = \frac{0.48 \text{ ppm} \times 8 \frac{\text{hr}}{\text{day}} \times 250 \frac{\text{days}}{\text{year}} \times 31 \text{ years} \times 2.04}{31 \text{ years} \times 365 \frac{\text{days}}{\text{yr}} \times 24 \frac{\text{hr}}{\text{day}}} = 0.31 \text{ ppm}$$

Calculate $LADC_{CT}$:

$$LADC_{CT} = \frac{C_{CT} \times ED \times EF \times WY \times BR}{AT_c}$$
$$LADC_{CT} = \frac{0.48 \text{ ppm} \times 8 \frac{\text{hr}}{\text{day}} \times 250 \frac{\text{days}}{\text{year}} \times 31 \text{ years} \times 2.04}{78 \text{ years} \times 365 \frac{\text{days}}{\text{year}} \times 24 \text{ hr/day}} = 0.12 \text{ ppm}$$

Appendix C INFORMATION ON PERSONAL PROTECTIVE EQUIPMENT

According to the final study report published by the Vinyl Institute ([Stantec ChemRisk, 2024](#)), workers in production areas are required to wear the following standard PPE: fire-resistant clothing, coveralls, hard hats, hearing protection, neoprene gloves, leather gloves, safety glasses, and steel toed boots. The report also mentioned use of task-specific PPE by workers, such as chemical suits worn during process opening, chemical splash goggles, face shields, and full-face respirators. Additionally, engineering controls are present at all representative facilities but differ by process area. In production areas, facilities typically use a closed-loop sampling system so that workers can collect process samples with minimal exposure to 1,2-dichloroethane. Logistic areas, where transport and storage activities occur, may employ a vapor recovery system which removes vapors from storage vessels and implement a nitrogen purge practice that utilizes nitrogen gas to displace unwanted impurities from the system to minimize exposures during loading and unloading activities. The report also discusses use of a solution spray to monitor for leaks during loading setup, alongside isolation of devices and physical barriers in loading and unloading areas ([Stantec ChemRisk, 2024](#)).

Summaries of tasks, frequencies, durations, and PPE used for each SEG are provided in Table_Apx C-1 and Table_Apx C-2 for the 1,2-dichloroethane, and 1,1-dichloroethane test orders, respectively. Additional description is provided later in this section as well.

Table_Apx C-1. Description of SEGs in Vinyl Institute 1,2-Dichloroethane Test Order Report

SEG General Category	SEG Specific Category	Full-Shift/Task	Weekly Task Frequency	Daily Frequency Range	Average Task Duration (hour)	PPE
Operator/ Process Technician	Operator – Routine (Daily)	Full-Shift	Daily	1 Time/shift	12 (range: 8- to 12-hour shifts)	<u>Standard PPE</u> <ul style="list-style-type: none"> • Fire-resistant clothing • Coveralls, Tyvek suits, or Nomex shirts • Long-sleeved attire • High visibility vests • Hard hat • Hearing protection • Neoprene gloves • Leather or cut-resistant gloves • Safety glasses • Safety toed boots <u>Task-Specific PPE</u> <ul style="list-style-type: none"> • Chemical suit (Tychem) worn during process opening • Chemical-resistant apron or jacket (polyvinyl chloride) • Chemical boots • Chemical splash goggles • Face shield • Nitrile gloves • Viton/butyl gloves • Full-face, supplied air respirator (Scott AV3000 with organic vapor cartridges) worn during process and line breaks and openings
	Operator – Closed Loop Sample Collection, High Concentration	Task	Daily	1–2 Times/Shift	0.5	
	Operator – Closed Loop Sample Collection, Low to Moderate Concentration	Task	Daily	1–3 Times/shift	0.25	
	Operator – Open Loop Sample Collection, Low to Moderate Concentration	Task	Daily	1–2 Times/shift	0.25	
	Operator – Maintenance Preparation	Task	“As needed” to Daily	1 Time/shift to “As needed”	0.25	
	Operator – Other Tasks with Exposure Potential	Task	“As needed” to Daily	1–2 Times/shift to “As needed”	0.75	
Maintenance Technician	Maintenance – Routine (daily)	Full-Shift	Daily	1 Time/shift	10 (range: 8- to 12-hour shifts)	

SEG General Category	SEG Specific Category	Full-Shift/Task	Weekly Task Frequency	Daily Frequency Range	Average Task Duration (hour)	PPE
Maintenance Technician	Maintenance – Line Breaks and Equipment Opening ^a	Task	“As needed” to 1–4 times/month to Daily	“As needed” to 5 times/shift	1.0	<ul style="list-style-type: none"> • Full-face, negative pressure respirator with organic vapor cartridges (MSA Ultra Elite with GME Cartridges) worn during product sample collection • Half- and full-face air purifying respirator (3M 7800 series with organic vapor cartridges; Scott multi-gas cartridges) worn during sample collection and railcar loading/offloading
	Maintenance – Other Tasks with Exposure Potential	Task	“Random”	“Random”	4.0	
Logistics/Distribution Technician	Logistics Technician – Routine (daily)	Full-Shift	Daily	1 Time/shift	11 (range: 8- to 12-hour shifts)	<p><u>Standard PPE</u></p> <ul style="list-style-type: none"> • Fire-resistant clothing • Hard hat • Hearing protection • Neoprene gloves • Safety glasses (nonline/equipment opening tasks) • Safety-toed boots • High visibility vests • Long-sleeved attire <p><u>Task-Specific PPE</u></p> <ul style="list-style-type: none"> • Chemical boots • Personal fall arrest systems harness worn while mounting platforms • Life preserver worn during barge Loading • Full-face, negative pressure respirator with organic vapor cartridges (MSA Ultra Elite with GME Cartridges) worn during product sample collection • Half- and full-face air purifying respirator (3M 7800 series with organic vapor cartridges) worn during ISO or railcar loading/offloading • Full-face respirator (Honeywell 7600 series or MSA 4000 or 4100 with P100 filters) worn during truck hose connection /disconnection • Chemical splash goggles (monogoggle) (V70/V80 series) • Heavy duty nitrile gloves (Ansell AlphaTec 37-185 Solvex) • Full-face, air-purifying respirator (3M Scott 742 Series cartridges and filters)
	Logistics Technician – Barge Loading/Offloading	Task	Daily	1 Time/shift	0.25	
	Logistics Technician – Railcar Loading/Offloading	Task	“As needed” to Daily	“As needed” to 1 time/shift	0.75	
	Logistics Technician – Truck Loading/Offloading	Task	Daily	1–2 Times/Shift	1.0	
	Logistics Technician – Other Tasks with Exposure Potential	Task	Weekly to Daily	1–2 Times/shift	0.75	
Laboratory Technician	Lab Technician – Routine (daily)	Full-Shift	Daily	1 Time/shift	11 (range: 8- to 12-hour shifts)	<p><u>Standard PPE</u></p> <ul style="list-style-type: none"> • Fire-resistant clothing • Lab coat • Safety glasses • Safety glasses with side shields • Chemical splash goggles
	Lab Technician – Sample Processing	Task	Weekly to Daily to Monthly	1–5 Times/shift	0.75	

SEG General Category	SEG Specific Category	Full-Shift/ Task	Weekly Task Frequency	Daily Frequency Range	Average Task Duration (hour)	PPE
Laboratory Technician	Lab Technician – Other Tasks with Exposure Potential	Task	Twice weekly to daily	1–4 Times/ shift	0.25	(monogoggle – 3M) <ul style="list-style-type: none"> • Nitrile gloves • Closed-toe shoes/steel toed Boots <u>Task-Specific PPE</u> <ul style="list-style-type: none"> • Full-face respirator with organic vapor/acid gas cartridges (Scott AV 3000) (worn while disposing of hazardous waste from fume hoods)
ONU	ONU – Routine (daily)	Full-Shift	Daily	1 Time/shift	10 (range: 5- to 12-hour shifts)	None listed

ONU = occupational non-user; PPE = personal protective equipment; SEG = similar exposure group

Source: ([Stantec ChemRisk, 2024](#))

“Maintenance tasks do not require differentiation by process stream concentration because, in accordance with SOPs, all equipment and process lines are drained or purged prior to routine maintenance tasks. Despite low anticipated concentrations following equipment purging, maintenance workers wear full respiratory protection (e.g., supplied air or self-contained breathing apparatuses) in the event the residual concentration of EDC (i.e., ethylene dichloride another name for 1,2-dichloroethane) in the process lines cannot be verified.

Table Apx C-2. Description of SEGs in Vinyl Institute 1,1-Dichloroethane Test Order Report

SEG General Category	SEG Specific Category	Full-Shift/ Task	Weekly Task Frequency	Daily Frequency Range	Average Task Duration (hour)	PPE
Operator/ Process Technician	Operator – Routine (daily)	Daily	Full-Shift	1 Time/ shift	12 (range: 9- to 12-hour shifts)	<u>Standard PPE</u> <ul style="list-style-type: none"> • Fire-resistant clothing • Coveralls or Nomex shirts • Hard hat • Hearing protection • Neoprene gloves • Leather gloves • Safety glasses • Steel-toed boots <u>Task-Specific PPE</u> <ul style="list-style-type: none"> • Chemical suit (Tychem) worn during process opening • Chemical-resistant apron • Chemical boots • Chemical splash goggles • Face shield • Nitrile gloves • Viton/butyl gloves • Full-face, supplied air respirator worn during process opening • Full-face, negative pressure respirator with organic vapor
	Operator – Container Transfer; Present as Impurity and Isolate	Daily	Task	4–5 Times/ Shift	0.25	
	Operator – Closed Loop Sample Collection, Present as Impurity and Isolate	Daily	Task	1–3 Times/ Shift	0.50	
	Operator – Open Loop Sample Collection, Present as an Isolate	Daily	Task	2–3 Times/ Shift	0.50	
	Operator – Maintenance Preparation	“As needed”	Task	“As needed”	0.25	
	Other Tasks with Exposure Potential	“As needed” to Daily	Task	1–2 Times/ shift to “As needed”	0.75	

SEG General Category	SEG Specific Category	Full-Shift/ Task	Weekly Task Frequency	Daily Frequency Range	Average Task Duration (hour)	PPE
Maintenance Technician	Maintenance – Routine (daily)	Daily	Full-Shift	1 Time/ shift	9.5 (range: 8- to 10.5-hour shifts)	cartridges (MSA Ultra Elite with GME Cartridges) worn during product sample collection
	Maintenance – Line Breaks and Equipment Opening; Present as Impurity and Isolate	“As needed”	Task	“As needed”	1.5	
	Other Tasks with Exposure Potential	Daily to Monthly to twice Annually	Task	2–16 Times/ shift to 2–12 times/ year	1.0	
Logistics/ Distribution Technician	Logistics Technician – Routine (daily)	Daily	Full-Shift	1 Time/ shift	10	<p><i>Standard PPE</i></p> <ul style="list-style-type: none"> • Fire-resistant clothing • Hard hat • Hearing protection • Heavy duty nitrile gloves (Ansell AlphaTec 37-185 Solvex) • Neoprene gloves • Safety Glasses (nonline / equipment opening tasks) • Steel toed boots • Full-face, air-purifying respirator (3M Scott 742 Series cartridges and fillers) <p><u>Task-Specific PPE</u></p> <ul style="list-style-type: none"> • Chemical boots • Full-face, negative pressure respirator with organic vapor cartridges (MSA Ultra Elite with GME Cartridges) worn during product sample collection • Chemical splash goggles (monogoggle) (V70/V80 series)
	Logistics Technician – Railcar Loading/ Offloading; Present as Impurity and Isolate	Daily	Task	1 Time/ shift	1.0	
Laboratory Technician	Lab Technician – Routine (daily)	Daily	Full-Shift	1 Time/ shift	11 (range: 8- to 12-hour shifts)	<p><i>Standard PPE</i></p> <ul style="list-style-type: none"> • Fire-resistant clothing • Lab coat • Safety glasses • Chemical splash goggles (monogoggle) • Nitrile gloves • Closed-toe shoes/Steel-toed Boots <p><u>Task-Specific PPE</u></p> <p>Half-face dust respirator (when adding dry standards)</p> <ul style="list-style-type: none"> • Half-face respirator with organic vapor cartridges (when standards are weighed on benchtop) • Chemical splash goggles
	Lab Technician – Sample Processing	Daily	Task	1–4 Times/ shift	1.0	
	Other Tasks with Exposure Potential	Daily	Task	1 Time/ shift	1.5	

SEG General Category	SEG Specific Category	Full-Shift/ Task	Weekly Task Frequency	Daily Frequency Range	Average Task Duration (hour)	PPE
						<ul style="list-style-type: none"> • Face shield • Nitrile gloves
ONU	ONU – Routine (daily)	Daily	Full-Shift	1 Time/ shift	10 (range: 8- to 12-hour shifts)	Not listed

ONU = occupational non-user; PPE = personal protective equipment; SEG = similar exposure group
Source: ([Stantec ChemRisk, 2023](#))

Respiratory APF Associated with PPE Use During the Test Order Sampling Study

The Vinyl Institute’s test order provided description of various PPE worn during the inhalation sampling study ([Stantec ChemRisk, 2024](#)). It is important to note that reported use of respiratory PPE varied by OES and SEG, as documented in Appendix N- Raw Sample Results of the final study report. A general summary of task-based respiratory PPE worn by workers in manufacturing and processing settings from the final study report is provided below:

Operators were described as wearing half- or full-face, air-purifying respirators during sample collection tasks (open or closed loop). This corresponds to an assigned protection factor (APF) 10 or 50, when the employer implements a continuing, effective respiratory protection program under the OSHA Respiratory Protection Standard.¹² Additionally, operators were described as wearing full-face respirators of varying types (APF 50–1,000) during other tasks with exposure potential such as process leak response, maintenance preparation activities, and filling totes.

Logistics technicians were described as wearing half-face or full-face respirators (APF 10 or 50) during loading or offloading tasks, which required connecting and disconnecting process lines to railcars, barges, and trucks. Maintenance technicians were described as wearing full-face airline respirators (APF 1,000) during major maintenance tasks (e.g., line breaks and other equipment openings).

Laboratory technicians were described as wearing half-face respirator (APF 10) with organic vapor cartridges (when standards are weighed on benchtop). Certain lab personnel were described as wearing full-face air-purifying respirators (APF 1,000) during disposal of hazardous wastes from fume hoods. ONUS were “primarily” not reported to wear respiratory protection during any routine daily tasks, although one supervisor was described as wearing a full-face respirator (APF 50) while observing loading activities from 20 feet away.

Dermal Protection Associated with Glove Use Reported in the Test Orders

Information on PPE, including gloves, used at monitored facilities for the test order is detailed in Table_Apx C-1 and Table_Apx C-2. According to the test order report, generally, within the production process areas, standard dermal PPE worn included neoprene, leather, or cut-resistant gloves whereas task-specific PPE included nitrile or viton/butyl gloves. Similarly, in logistics work areas, standard dermal PPE included neoprene gloves and task-specific PPE included heavy-duty nitrile gloves and eye protection. In the laboratory areas, standard PPE included nitrile gloves. There was no documentation on glove changeout, efficacy, or what was worn relative to each specific task. OSHA has not established quantitative protection factors for gloves.

¹² <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.134> (accessed October 21, 2025).

Information on PPE from Other Sources

OSHA’s Respiratory Protection Standard (29 CFR 1910.134) requires employers in certain industries to address workplace hazards by implementing engineering control measures and, if these are not feasible, provide respirators that are applicable and suitable for the purpose intended. Respirator selection provisions are provided in CFR 1910.134(d) and require that appropriate respirators are selected based on the respiratory hazard(s) to which the worker will be exposed and workplace and user factors that affect respirator performance and reliability. APFs are provided in Table 1 under CFR

1910.134(d)(3)(i)(A) (see below in Table_Apx C-3) and refer to the level of respiratory protection that a respirator or class of respirators is expected to provide to employees when the employer implements a continuing, effective respiratory protection program according to the requirements of OSHA’s Respiratory Protection Standard. Hand protection provisions are provided in CFR 1910.138, but OSHA has not established quantitative protection factors for gloves.

Table_Apx C-3. Assigned Protection Factors for Respirators in OSHA Standard 29 CFR 1910.134

Type of Respirator	Quarter Mask	Half Mask	Full Facepiece	Helmet	Type of Respirator
1. Air-Purifying Respirator	5	10	50		
2. Power Air-Purifying Respirator (PAPR)		50	1,000	25/1,000	25
3. Supplied-Air Respirator (SAR) or Airline Respirator					
• Demand mode		10	50		
• Continuous flow mode		50	1,000	25/1,000	25
• Pressure-demand or other positive-pressure mode		50	1,000		
4. Self-Contained Breathing Apparatus (SCBA)					
• Demand mode		10	50	50	
• Pressure-demand or other positive-pressure mode (e.g., open/closed circuit)			10,000	10,000	
Source: 29 CFR 1910.134(d)(3)(i)(A)					