



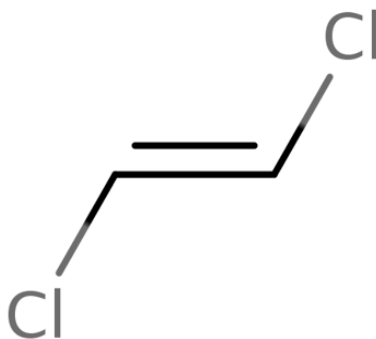
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Draft Chemistry, Fate, Release, and Exposure Assessment for *trans*-1,2-Dichloroethylene

Technical Support Document for the Draft Risk Evaluation

CASRN 156-60-5



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880 **KEY ABBREVIATIONS AND ACRONYMS**

881	7Q10	The lowest 7-day average flow that occurs (on average) once every 10 years
882	AC	Acute concentrations
883	ACC	American Chemistry Council
884	ADC	Average daily concentrations
885	ADD	Average daily dose
886	ADME	Absorption, distribution, metabolism, and elimination
887	APF	Assigned protection factor
888	APR	Air-purifying respirator
889	AF	Assessment factor
890	AMTIC	Ambient Monitoring Technology Information Center
891	AQS	Air Quality System
892	BAF	Bioaccumulation factor
893	BCF	Bioconcentration factor
894	BLS	Bureau of Labor Statistics (U.S.)
895	CAA	Clean Air Act
896	CARB	California Air Resources Board
897	CASRN	Chemical Abstract Service registry number
898	CDF	Cumulative distribution function
899	CDR	Chemical Data Reporting
900	CEHD	OSHA Chemical Exposure Health Database
901	COU	Condition of use
902	EPA	Environmental Protection Agency (U.S.)
903	DMR	Discharge Monitoring Report
904	DOD	Department of Defense (U.S.)
905	DRE	Destruction removal efficiency
906	ECHO	Enforcement and Compliance History Online
907	EIS	Emissions Inventory System
908	EPA	Environmental Protection Agency (U.S.)
909	ESD	Emission scenario document
910	FRS ID	Facility Registry Services identification number
911	HAP	Hazardous air pollutant
912	HEC	Human Equivalent Concentration
913	HEM	Human Exposure Model
914	HLC	Henry's Law constant
915	ICR	Information Collection Request
916	IIOAC	Integrated Indoor-Outdoor Air Calculation
917	IUR	Inhalation unit risk
918	K _{OA}	Octanol-air partition coefficient
919	K _{OC}	Organic carbon-water partition coefficient
920	K _{OW}	Octanol-water partition coefficient
921	LADC	Lifetime average daily concentrations
922	LCD	Life cycle diagram
923	LOD	Limit of detection
924	MOE	Margin of exposure
925	MDL	Method detection limit

926	MLE	Maximum likelihood estimation
927	NADP	National Atmospheric Deposition Program
928	NAAQS	National Ambient Air Quality Standard
929	NAICS	North American Industry Classification System
930	ND	Non-detect
931	NEI	National Emissions Inventory
932	NESHAP	National Emission Standard for Hazardous Air Pollutants
933	NIOSH	National Institute for Occupational Safety and Health
934	NIST	National Institute of Standards and Technology
935	NLM	National Library of Medicine
936	NPDES	National Pollutant Discharge Elimination System
937	OCSPP	Office of Chemical Safety and Pollution Prevention (EPA)
938	OECD	Organisation for Economic Co-operation and Development
939	OEL	Occupational exposure limits
940	OES	Occupational exposure scenario
941	ONU	Occupational non-user
942	OPPT	Office of Pollution Prevention and Toxics (EPA)
943	OSHA	Occupational Safety and Health Administration (U.S)
944	OTVD	Open top vapor degreaser
945	PESS	Potentially exposed and susceptible subpopulations
946	POD	Point of departure
947	PBZ	Personal breathing zone
948	POTW	Publicly owned treatment works
949	PPE	Personal protective equipment
950	PV	Production volume
951	RCRA	Resource Conservation and Recovery Act
952	RfC	Reference concentration
953	SCC	Source Classification Code
954	SDS	Safety data sheet
955	SIC	Standard Industrial Classification
956	SOC	Standard Occupational Classification
957	TLV	Threshold Limit Values
958	TRFID	TRI identification number
959	TRI	Toxics Release Inventory
960	TSCA	Toxic Substance Control Act
961	TWA	Time-weighted average
962	U.S.	United States
963	VOC	Volatile organic compound
964	VP	Vapor pressure
965	WQP	Water Quality Portal
966	WWTP	Wastewater treatment plant
967	WQX	Water Quality Exchange

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Docket

Supporting information can be found in the public docket, Docket ID ([EPA-HQ-OPPT-2018-0465](#)).

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SUMMARY

This technical support document (TSD) is part of the Toxic Substances Control Act (TSCA) *Draft Risk Evaluation for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)). This draft TSD provides detailed information on the approaches and methodologies used to assess the human and environmental exposure to *trans*-1,2-dichloroethylene.

EPA considered all reasonably available information identified by the Agency through its systematic review process under TSCA ([U.S. EPA, 2026x](#)) for the chemical *trans*-1,2-dichloroethylene. The approaches and methodologies used in this draft TSD have previously undergone peer review and public comment, and those recommendations have been incorporated as appropriate into this draft exposure assessment of *trans*-1,2-dichloroethylene.

Chemical Properties

trans-1,2-Dichloroethylene is a liquid under ambient conditions. It is a volatile chlorinated compound with a high vapor pressure (331 mmHg 25 °C) and water solubility (4,520 mg/L at 25 °C).

Fate and Transport

trans-1,2-Dichloroethylene released to air is expected to remain in air and exist in the vapor form of the chemical. Air is expected to be a major pathway of exposure. Fugacity modeling showed that releases to air or water are largely expected to remain in air or water, respectively. Conversely, releases to soil are expected to largely partition to air. *trans*-1,2-Dichloroethylene can undergo various transformation processes in environmental media that affect its persistence and retention in the environment. Transformation processes include photodegradation, hydrolysis, and biodegradation.

Environmental Releases

EPA's assessment of environmental releases from industrial processes relied upon industry-reported releases to a variety of publicly available databases including: the 2019 to 2023 Toxics Release Inventory (TRI; air, water, and land); and the 2019 to 2023 Discharge Monitoring Report (DMR; (water)). The *trans*-1,2-dichloroethylene release assessment identified occupational exposure scenarios (OESs) to categorize releases based on similar process operations and creates a crosswalk of OESs to conditions of use (COUs) under TSCA. Because seven OESs (Repackaging, Vapor Degreasing, Commercial Aerosol, Application of Paints and Coatings, Adhesives and Sealants, Blowing Agent in Spray Foam, and Laboratory Chemicals) evaluated did not have reported releases, EPA estimated releases for those OESs using previously peer-reviewed modeling practices.

Ambient Air Pathway

For the general population, the major route of exposure considered was ambient air inhalation. A Tier 1 screening-level assessment was completed for the ambient air pathway. Air monitoring concentrations were obtained from Air Quality System (AQS) from 2018 to 2022. The reported AQS monitored concentrations ranged from 0 to 34.89 ($\mu\text{g}/\text{m}^3$). Ambient air concentrations were modeled using the Integrated Indoor-Outdoor Air Calculator (IIOAC Model) based on highest stack and fugitive facility releases reported to TRI between 2019 to 2023. There were six estimated generic scenarios (GSs) that were modeled using IIOAC including: Vapor Degreasing, Use of Adhesives, Use as a Blowing Agent in Spray Foam, Laboratory Chemicals, Aerosol Degreasing, and Import-Repackaging. The highest OES for releases (1,177.41 kg/site/day) and modeled daily concentrations ($2,130 \mu\text{g}/\text{m}^3$) were for the GS Use of Adhesives.

Consumer Exposure

For consumer uses, *trans*-1,2-dichloroethylene is primarily found in degreasers for mechanical equipment, flux removers for electronics, and in spray foam insulation. This draft assessment evaluated acute and chronic non-cancer exposures for inhalation and dermal, which are the major routes of exposure. For this draft assessment, EPA used a range of reported weight fractions from safety data sheets (SDSs) and representative exposure scenarios of product use for each COU. The highest inhalation and dermal exposures for both acute and intermediate/chronic durations were found for a flux remover.

Surface Water and Sediment Pathway Exposure Assessment

EPA assessed environmental media concentrations for the surface water, sediment, and drinking water pathways; the Agency used a tiered approach to evaluate chemical concentrations in these media using both facility-specific releases and generic scenario releases. This includes assumptions, strengths, and limitations associated with the approaches and methodologies used for each environmental media and tier of analysis. These calculated media concentrations were used for both the characterization of potential general population exposures (oral and dermal while swimming and drinking water) and environmental exposure (surface water and sediment).

EPA's assessment of general population exposure via surface water and drinking water was evaluated for oral ingestion and dermal exposure to surface water while swimming and ingestion of drinking water due to both facility-specific releases and generic scenario releases. Depending on the route and pathway of exposure, multiple tiers of analysis are employed to refine potential exposures when identified exposures indicate preliminary risk relative to their respective benchmark for either the human general population or aquatic environmental population. These additional tiers aim to increase confidence in estimated exposures until no further refinements were needed. Following tiers of refinement, no exposures indicating preliminary risk were identified for facility-specific releases or generic scenario releases across all evaluated pathways and routes.

Land and Groundwater Pathway Exposure Assessment

EPA considered a number of sources of *trans*-1,2-dichloroethylene in soils via (1) air deposition to soil, (2) biosolids application to soils, and (3) disposal to landfills. Tier 1 quantitative assessments were conducted for biosolids and landfills. Based on its relatively high vapor pressure, limited partitioning to atmospheric particles, and supporting fate modeling, air deposition was not expected to be a significant pathway for *trans*-1,2-dichloroethylene; therefore, a quantitative air-deposition assessment was not conducted. Overall, evidence suggests that the concentrations of *trans*-1,2-dichloroethylene in soil from these sources are likely to be low based on the limited potential for air deposition, low concentrations predicted from Tier 1 biosolids and landfill assessments, as well as the chemical's physical, chemical and fate properties.

Bioaccumulation and Trophic Transfer

Trophic transfer exposures were not quantitatively evaluated in the exposure assessment for *trans*-1,2-dichloroethylene because EPA qualitatively evaluated the physical-chemical properties of *trans*-1,2-dichloroethylene, along with the results from quantitative analyses of other similar chlorinated solvents, and concluded that the trophic transfer pathway was not a viable pathway of exposure for *trans*-1,2-dichloroethylene. The TSCA risk evaluations for 1,1-dichloroethane and 1,2-dichloroethane quantitatively evaluated the trophic transfer of chlorinated solvents with subsequent dietary exposures for terrestrial mammals and birds as the result of oral exposures. The results of these analyses for chlorinated solvents did not show risk for terrestrial wildlife, food chain (oral) exposures. Therefore, trophic transfer exposures are not quantitatively evaluated for *trans*-1,2-dichloroethylene based on its

similar physical-chemical properties as well as both reported and estimated bioconcentration and bioaccumulation factors—which are less than 10 L/kg for all three chemicals and well below the 1,000 L/kg value of concern ([U.S. EPA, 2010](#)).

Occupational Exposure Assessment

EPA assessed occupational inhalation and dermal exposures for the OESs that were identified for the COUs of *trans*-1,2-dichloroethylene. Where there was sufficient exposure monitoring data, EPA was able to assess exposure for exposure groups that had been identified and monitored for the OES. For other OESs, exposures were assessed for the generic exposure groups of worker and “occupational non-users” (ONU¹).

Inhalation exposure monitoring data were collected and submitted to EPA as a requirement of a test order. The test order data were directly applied to five OESs: (1) Manufacture of *trans*-1,2-Dichloroethylene as a Primary Product; (2) Incorporation into Formulation, Mixture, and Reaction Product; (3) Vapor Degreasing; (4) Miscellaneous Commercial and Industrial Non-Aerosol Uses; and (5) Commercial Aerosol Uses. Portions of the same dataset were also utilized as analogous data (same chemical) for similar OESs to assess exposure. For other OESs, surrogate chemical data available from previous EPA risk evaluations as well as from the systematic review of the scientific literature were used to estimate inhalation exposure for *trans*-1,2-dichloroethylene because the test order did not contain data relevant to those OESs.

Dermal exposure was assessed using the Dermal Exposure to Volatile Liquids (DEVL) Model to assess potential dermal exposure to volatile chemicals. Chemical-specific data for the parameters of fraction absorbed obtained from a test order for *trans*-1,2-dichloroethylene as handled during the OESs was used. The dermal modeling also incorporated variability in the value of fraction of *trans*-1,2-dichloroethylene absorbed.

Chemical- and OES-specific data on the number of working years and frequency of exposure were incorporated (where available) into estimates of doses for evaluation of chronic non-cancer risks. The use of personal protective equipment (PPE) such as from test orders was documented for consideration in the risk characterization along with information on PPE that EPA identified from other sources.

¹ ONUs do not directly handle *trans*-1,2-dichloroethylene but may be indirectly exposed to it in the workplace as part of their employment.

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1 INTRODUCTION

This draft TSD presents the preliminary chemistry, fate, release, and exposure assessment (also referred to as the “draft exposure TSD”) in support of the TSCA *Draft Risk Evaluation for trans-1,2-Dichloroethylene* (also referred to as the “draft risk evaluation”) ([U.S. EPA, 2026t](#)). The draft risk evaluation was conducted under the Frank R. Lautenberg Chemical Safety for the 21st Century Act, which amended TSCA on June 22, 2016, which includes statutory requirements and deadlines for actions related to conducting risk evaluations of existing chemicals.

Under TSCA section 6(b), EPA must designate chemical substances as high-priority substances for risk evaluation or low-priority substances for which risk evaluations are not warranted at the time. Upon designating a chemical as a high priority, the Agency must initiate a risk evaluation on the substance. TSCA section 6(b)(4) directs EPA to conduct risk evaluations for existing chemicals to “determine whether a chemical substance presents an unreasonable risk of injury to health or the environment, without consideration of costs or other non-risk factors, including an unreasonable risk to a potentially exposed or susceptible subpopulation identified as relevant to the risk evaluation by the Administrator under the conditions of use [COUs].”

TSCA section 6(b)(4)(D) and implementing regulations require that EPA publish the scope of the risk evaluation to be conducted—including the hazards, exposures, conditions of use (COUs), and potentially exposed and susceptible subpopulations (PESS) that the Administrator expects to consider—within 6 months after the initiation of a risk evaluation. In addition, a draft scope is to be published pursuant to 40 CFR [Code of Federal Regulations] 702.43. In December 2019, EPA published a list of 20 chemical substances that have been designated high priority substances for risk evaluations (Docket ID: [EPA-HQ-OPPT-2019-0131](#)) (84 FR 71924, December 30, 2019), as required by TSCA section 6(b)(2)(B), which initiated the risk evaluation process for those chemical substances. *trans*-1,2-Dichloroethylene is one of the chemicals designated as a high priority substance for risk evaluation.

2 PHYSICAL AND CHEMICAL PROPERTY ASSESSMENT

EPA evaluated the reasonably available chemical property data and environmental fate and transport information for *trans*-1,2-dichloroethylene. The following are key points from EPA's draft assessment:

- Environmental distribution
 - *trans*-1,2-Dichloroethylene is a volatile liquid that is soluble in water under environmental conditions. *trans*-1,2-Dichloroethylene is expected to be released primarily in air and remain in air after release.
- Fate and transport in air
 - *trans*-1,2-Dichloroethylene released to air is expected to remain in air and exist in the vapor form of the chemical.
 - *trans*-1,2-Dichloroethylene will not undergo direct photolysis, but will undergo indirect photolysis primarily through reactions with hydroxyl radicals ($\cdot\text{OH}$).
 - Based on the release patterns reported to TRI and the physical and chemical properties, air is expected to be an important medium for exposure to *trans*-1,2-Dichloroethylene.
- Fate and transport in surface water and sediment
 - In surface water, *trans*-1,2-dichloroethylene will be subject to rapid volatilization, slow biodegradation, very slow hydrolysis, advection, dispersion, and dilution.
 - Due to its water solubility, higher or continuous releases of *trans*-1,2-dichloroethylene to deep, slow moving surface waters might result in a portion remaining in water and potentially being bioavailable.
- Fate and transport in soil and groundwater
 - *trans*-1,2-Dichloroethylene in soil will be subject to volatilization, slow biodegradation, run off to surface water, and migration to groundwater.
 - Due to its low affinity for soil organic matter, *trans*-1,2-dichloroethylene is expected to migrate rapidly to groundwater.
 - *trans*-1,2-Dichloroethylene in groundwater is expected to undergo slow biodegradation.
- Persistence and bioaccumulation/bioconcentration
 - Based on the EPA TSCA PBT (*i.e.*, persistent, bioaccumulative, and toxic) bioaccumulation concern typically begins at bioaccumulation factor (BAF) at least 1,000 L/kg; *trans*-1,2-dichloroethylene is not expected to be bioaccumulative based on its estimated BAF and bioconcentration factor (BCF) both being much less than 1,000 L/kg.
 - Based on the EPA TSCA PBT persistence criteria (where air persistence is of concern at an atmospheric half-life ≥ 2 days and water and soil persistence is of concern at half-life ≥ 2 months), *trans*-1,2-Dichloroethylene is expected to be persistent in air, may exhibit persistence in groundwater under some environmental conditions, and is not expected to be persistent in surface water or soil.

2.1 Approach and Methodology for Physical and Chemical Property Assessment

trans-1,2-Dichloroethylene is a liquid under ambient conditions (*i.e.*, at $\approx 20^\circ\text{C}$ and 760 mmHg) (NLM, 2018b; Dreher et al., 2014; Belpoggi et al., 2012; Lewis, 2012). It is qualitatively described as being colorless with a sweetish scent (NLM, 2018a). Due to the relative availability of data, only studies with an overall data quality determination of "high" were selected for use in determining the representative physical and chemical properties for the purposes of this draft risk evaluation. EPA gathered and evaluated physical and chemical property data and information for *trans*-1,2-dichloroethylene according to the process described in the *Draft Systematic Review Protocol Supporting TSCA Risk Evaluations for Chemical Substances, Version 1.0: A Generic TSCA Systematic Review Protocol with Chemical-Specific Methodologies* (also called the "2021 Draft Systematic Review Protocol") (U.S. EPA, 2021c).

When a specific data point is cited for a given physical and chemical parameter, priority is given to data from expert-curated, peer-reviewed databases that have been identified as “trusted sources” ([U.S. EPA, 2021c](#)). If no data were available from trusted databases, second preference was given to measured data from studies that implement experimental measurements according to established test guidelines or which were conducted according to scientific principles with sufficient documentation. Finally, estimated, or calculated data were only presented in the instance that no measured data were available. The systematic review process identified multiple data with the same quality rating for many physical and chemical properties discussed in this document. Some of these data were duplicates that were initially extracted more than once (*e.g.*, when multiple databases cite the same study), but were later removed during data curation before any further analysis. Much of the remaining data were collected under standard environmental conditions (*i.e.*, 20–25 °C and 760 mmHg).

2.2 Final Selected Physical and Chemical Property Values for *trans*-1,2-Dichloroethylene

Table 2-1. Summary of Physical and Chemical Property Values for *trans*-1,2-Dichloroethylene

Property	Selected Value(s)	Reference(s)	Data Quality Rating
Molecular formula	C ₂ H ₂ Cl ₂	N/A	N/A
Molecular weight	96.94 g/mol	N/A	N/A
Physical form	Clear, colorless liquid at ambient conditions with a sweetish scent	NLM (2018b) ; Dreher et al. (2014) ; Belpoggi et al. (2012) ; Lewis (2012)	High
Melting point	−49.8 °C	Rumble (2018b)	High
Boiling point	47.64 °C	Rumble (2018b)	High
Density	1.2565 g/cm ³	O'Neil (2013)	High
Vapor pressure	331 mmHg	NLM (2018b)	High
Vapor density	3.34 (unitless; relative to air = 1)	NCBI (2020)	High
Water solubility	4,520 mg/L at 25 °C	NLM (2018b)	High
Octanol/water partition coefficient (log K _{ow})	1.93 (unitless)	Rumble et al. (2018)	High
Henry's Law constant	7.51×10 ^{−3} atm·m ³ /mol	Hovorka and Dohnal (1997)	High
Flash point	4 °C	Dreher et al. (2014)	High
Autoflammability	460 °C	Rumble (2018a)	High
Viscosity	0.425 centipoise (cP) at 20 °C	Elsevier (2019)	High
Refractive index	1.4454	Rumble (2018b)	High

2.2.1 Endpoint Assessments

2.2.1.1 Melting Point

Systematic review identified 11 melting point data points that range from −50.0 to −49.4 °C. The average melting point value of the 11 data points was −49.73 ± 0.26 °C. The value −49.8 °C ([Rumble, 2018b](#)) was selected as the melting point of *trans*-1,2-dichloroethylene for this draft risk evaluation because it is in close agreement with the average of all data points identified, has a high level of precision, and was independently reported in multiple high-quality studies. The standard deviation of the collected data is relatively low, indicating that the value of this parameter is well-defined.

2.2.1.2 Boiling Point

Systematic review identified 33 boiling point data points that cover the range 47.00 to 49.55 °C. The average boiling point value of the 33 data points was 47.92 ± 0.57 °C. The value 47.64 °C ([Rumble, 2018b](#)) was selected as the boiling point of *trans*-1,2-dichloroethylene for this draft risk evaluation because it is in close agreement with the average of all data points identified and it has a high level of precision. The standard deviation of the collected data is relatively low, indicating that the value of this parameter is well-defined.

2.2.1.3 Density

Systematic review identified 39 density data points, including 15 data points collected at 25 °C. The data collected under standard conditions (20–25 °C) cover the range 1.2277 to 1.2743 g/cm³ (specific gravity and density were assumed to be equal). The average density of the 15 data points was 1.251 ± 0.010 g/cm³. The value 1.2565 g/cm³ at 25 °C ([O'Neil, 2013](#)) was selected as the density of *trans*-1,2-dichloroethylene for this draft risk evaluation because it is in close agreement with the average of the data points identified, it has a high level of precision, and it was independently reported in multiple studies. The standard deviation of the collected data is relatively low, indicating that the value of this parameter is well-defined.

2.2.1.4 Vapor Pressure

Systematic review identified 57 vapor pressure data points, including 5 data points collected at 25 °C. The data collected under standard conditions (20–25 °C) cover the range 322.2 to 331.0 mmHg at 25 °C. The average vapor pressure of the five data points collected at 25 °C was 328.7 ± 3.8 mmHg. The value 331 mmHg at 25 °C ([NLM, 2018b](#)) was selected as the vapor pressure of *trans*-1,2-dichloroethylene for this draft risk evaluation because it is in close agreement with the average of the values at 25 °C and was independently reported by multiple high-quality studies. The standard deviation of the collected data is relatively low, indicating that the value of this parameter is well-defined.

2.2.1.5 Vapor Density

Systematic review identified four vapor density data points that cover the range 3.34 to 3.67 (unitless; relative to air = 1 g/cm³). The average vapor density of the four data points was 3.44 ± 0.16 . The value 3.34 ([NCBI, 2020](#)) was selected as the vapor density of *trans*-1,2-dichloroethylene for this draft risk evaluation because it is in close agreement with the average of all the data identified, it has a high level of precision, and it was independently reported in multiple high-quality studies. The standard deviation of the collected data is relatively low, indicating that the value of this parameter is well-defined.

2.2.1.6 Water Solubility

Systematic review identified 18 water solubility data points, including six data points collected at 25 °C. The data collected under standard conditions (20–25 °C) cover the range 4,520 to 6,300 mg/L at 25 °C. The average water solubility value of the six data points was $5,707 \pm 919$ mg/L at 25 °C. The value 4,520 mg/L at 25 °C ([NLM, 2018b](#)) was selected as the water solubility of *trans*-1,2-dichloroethylene for this draft risk evaluation because it is considered the most representative experimental value. Review of the available dataset indicates that most reported measurements fall within the 4,000 to 5,000 mg/L range, while 6,300 mg/L is the highest reported value. Restricting the dataset to 25 °C leaves two candidate values (4,520 and 6,300 mg/L). Because the 4,520 mg/L value is supported by multiple independent, high-quality studies and is more consistent with the central tendency of the overall dataset, it was selected over the 6,300 mg/L value, which represents the upper end of the reported range. The standard deviation of the collected data is relatively high, indicating that the value of this parameter is poorly defined.

2.2.1.7 Octanol/Water Partition Coefficient (Log K_{ow})

Systematic review identified seven log K_{ow} data points that cover the range 1.51 to 2.09. The average log K_{ow} of the seven data points was 1.95 ± 0.21 . The value 1.93 ([Rumble et al., 2018](#)) was selected as the log K_{ow} of *trans*-1,2-dichloroethylene for this draft risk evaluation because it is in close agreement with the average of the identified values. The standard deviation of the collected data is relatively low, indicating that the value of this parameter is well-defined.

2.2.1.8 Henry's Law Constant

Systematic review identified 18 Henry's Law constant data points that cover the range 4.18×10^{-3} to 1.13×10^{-2} atm-m³/mol. The average value of the data points was $7.53 \times 10^{-3} \pm 1.85 \times 10^{-3}$ atm-m³/mol. The value 7.51×10^{-3} atm-m³/mol ([Hovorka and Dohnal, 1997](#)) was selected as the Henry's Law constant of *trans*-1,2-dichloroethylene for this draft risk evaluation because it is in close agreement with the average of the identified data. The standard deviation of the collected data is relatively high, indicating that the value of this parameter is poorly defined.

2.2.1.9 Flash Point

Systematic review identified 13 flash point data points that cover the range 2 to 6.1 °C. The flash point data collected include values measured using both closed cup and open cup techniques, with some sources reporting values from both techniques, and some sources not indicating the technique used. Closed and open cup measurement techniques generally result in a different value for flash point, and so for each value reported it is important to note the measurement technique used. The average flash point of the 13 data points was 3.9 ± 1.9 °C. The value 4 °C ([Dreher et al., 2014](#)) was selected as the flash point of *trans*-1,2-dichloroethylene for this draft risk evaluation because it is near to the average of the data identified. Due to the multiple experimental methods for quantifying flash point (e.g., open cup and closed cup), there is considerable variance in the data collected.

2.2.1.10 Autoflammability

Systematic review identified three autoflammability data points. All three data points were equal at 460 °C. The value 460 °C ([Rumble, 2018a](#)) was selected as the autoflammability of *trans*-1,2-dichloroethylene for this risk assessment because it is the only value reported.

2.2.1.11 Viscosity

Systematic review identified 32 viscosity data points, including 10 data points collected at 20 to 25 °C. The data points collected under standard conditions (20–25 °C) cover the range 0.317 to 0.570 centipoise (cP). The average viscosity of the 10 data points collected at a temperature range of 20 to 25 °C was 0.431 ± 0.076 cP. The value 0.425 cP at 20 °C ([Elsevier, 2019](#)) was selected for the viscosity of *trans*-1,2-dichloroethylene for this draft risk evaluation because it is in close agreement with the average of the identified data. The standard deviation of the collected data is relatively low, indicating that the value of this parameter is well-defined.

2.2.1.12 Refractive Index

Systematic review identified 18 refractive index data points that cover the range 1.44154 to 1.44903 (unitless). The average refractive index of the 18 data points was 1.445 ± 0.002 . The value 1.4454 ([Rumble, 2018b](#)) was selected as the refractive index of *trans*-1,2-dichloroethylene for this draft risk evaluation because it is in close agreement with the average of all data identified and it was independently reported in multiple high-quality studies. The standard deviation of the collected data is relatively low, indicating that the value of this parameter is well-defined.

2.3 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for the Physical and Chemical Property Assessment

The physical and chemical property data discussed in this document were the product of a systematic review of reasonably available information. The data analyses, therefore, consider only a subset of all physical and chemical data, not an exhaustive acquisition of all potential data. Due to cross-referencing between many of the databases identified and assessed through the systematic review process, there is potential for data from one primary source to be collected multiple times resulting in duplication within the dataset. This duplication is a potential source of uncertainty in the data analyses because repeated values could have a large impact on the calculated mean and media; however, data-collection procedures and expert judgement were used to minimize this possibility whenever possible.

Overall, there is little uncertainty in the physical and chemical properties data and analyses presented. The analyses above present the average and standard deviation of all data collected through the systematic review process for each physical and chemical parameter. The standard deviation is reported as uncertainty in the form of tolerance limits ($\pm$ range on the average value). Data extracted as a range of values were excluded from the calculations unless expert judgement in the specific science field could identify precise data points within the range. These statistical analyses may be indicative of the amount of uncertainty related to different instrumental techniques or other experimental differences between the studies used to generate the data. Additional sources of uncertainty in these reported physical and chemical property values may be inherent to the measurement of the data point itself (*e.g.*, sources of uncertainty or measurement error related to the instrumental method, precision with which a data point is measured and reported in the data source). Finally, all data was assumed to be collected under standard environmental conditions (*i.e.*, 20–25 °C and 760 mmHg) unless otherwise specified.

3 FATE AND TRANSPORT ASSESSMENT

Reasonably available environmental fate data – including biotic and abiotic degradation rates, removal during wastewater treatment, volatilization from lakes and rivers, and organic carbon:water partition coefficient (log K_{OC}) – are the parameters used in this draft risk evaluation. In assessing the environmental fate and transport of *trans*-1,2-dichloroethylene, EPA considered the full range of results from data sources that were rated high- and medium-quality. Information on the full extracted data set is available in the *Draft Data Quality Evaluation and Data Extraction Information for Physical and Chemical Properties for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026h](#)). Other fate estimates were based on modeling results from EPI Suite™ ([U.S. EPA, 2012](#)), a predictive tool for physical and chemical properties and environmental fate estimation. Information regarding the model inputs is available in Section 3.1.1. Specifically, the data were analyzed to characterize transport and partitioning pathways, identify the environmental persistence potential, and assess the bioaccumulation potential of *trans*-1,2-dichloroethylene.

3.1 Approach and Methodology for Fate and Transport Assessment

EPA conducted a Tier I assessment to identify the environmental compartments (*i.e.*, surface water, sediment, soil, biosolids, groundwater, air) of major and minor relevance to the fate and transport of *trans*-1,2-dichloroethylene. EPA then conducted a Tier II assessment to identify the fate pathways and media most likely to result in exposure due to environmental releases. Media-specific fate analyses are described in Section 3.4.

3.1.1 EPI Suite™ Model Inputs

In the estimation of the physical, chemical, and fate properties of *trans*-1,2-dichloroethylene using EPI Suite™, the properties listed in Table 2-1 were utilized—including log K_{OW}, Henry's Law constant, melting point, boiling point, vapor pressure, and solubility. The log K_{OC} value of 1.23 was used because it was the only empirically measured log K_{OC} value identified during systematic review (Table 3-1).

3.1.2 Fugacity Modeling

To inform how environmental releases of *trans*-1,2-dichloroethylene partition between environmental compartments (air, water, sediment, and soil) the approach described by Mackay et al. ([1996](#)) using the Level III Fugacity Model in EPI Suite™ ([U.S. EPA, 2012](#)) was employed. The model predicts the partitioning of a substance released to an evaluative environment between air, water, soil, and sediment and identifies important intermedia transfer processes. The Level III Fugacity Model is described as a steady-state, non-equilibrium model that includes the processes of degradation, advection (flow out of the evaluative environment), and intermedia transfer. The Level III Fugacity Model requires fate assessor input for *trans*-1,2-dichloroethylene physical and chemical properties (Table 2-1), its releases to each compartment of the evaluative environment, and half-lives of the chemical in each compartment

The selected half-life values for *trans*-1,2-dichloroethylene are as follows: 5.9 days in air ([U.S. EPA, 2012](#); [Klamt, 1993](#)), 365 days in water (Section 3.1.3), 365 days in soil (Section 3.1.3), and 147 days in sediments ([Barrio-Lage et al., 1986](#)). These values are based on measured references obtained through systematic review and documented in Table 3-1. The photodegradation half-life for *trans*-1,2-dichloroethylene ranges from 4.57 to 5.9 days, with the upper end of the range selected for a conservative estimate and assuming the chemical remains in the air longer. Similarly, for sediments, a half-life of 147 days was selected because it is the upper end of the available data range. For water, evidence indicates no biodegradation, and one case of very slow biodegradation, leading to the selection of a 365-day half-life for fugacity modeling to represent this process conservatively. In soil, biodegradation half-lives vary from 21 to over 4,000 days, depending on factors such as exposure

history, soil type, and microbial density. A 365-day ($\approx$ 1-year) half-life was chosen to conservatively reflect slow degradation. Evaluation of longer soil biodegradation half-lives is not expected to meaningfully alter the fugacity model results because biodegradation is already represented conservatively, and increasing the half-life beyond 365 days would have little influence on steady-state partitioning among environmental compartments. Conversely, using shorter half-lives would increase soil degradation, resulting in slightly lower steady-state soil concentrations; however, because the model predicts only a small fraction of *trans*-1,2-dichloroethylene partitions to soil, the overall effect on model results is expected to be minimal. The fugacity modeling was conducted using EPISuite™, which is a screening-level tool that estimates the distribution of a chemical among environmental compartments under steady-state conditions in a generic environment. The model assumes constant emissions, well-mixed compartments, and first-order degradation processes; therefore, results are intended to indicate relative partitioning among media rather than predict site-specific environmental concentrations.

For fugacity modeling, EPA used releases from the reporting year of 2023 based on releases reported to the Toxic Release Inventory (TRI). For the reporting year 2023, greater than 88% of releases were to air, with less than 1% to water and approximately 12% to land. This release pattern is consistent with general release patterns for the other release years (2019–2022) considered in this draft assessment. TRI reporting does not distinguish between the *cis*- and *trans*- isomers; however, for the purposes of the fugacity modeling, EPA assumed that the relative amounts released to each media are the same for both isomers. The model was also run for three additional release scenarios with 100% releases to either water, land, or air, and one scenario with equal releases to all media.

3.1.3 Evidence Integration

Reasonably available environmental fate data—including biodegradation rates, removal during wastewater treatment, volatilization from lakes and rivers, and organic carbon:water partition coefficient (K_{OC})—are among the selected parameters for use in the risk evaluation. In assessing the environmental fate and transport of *trans*-1,2-dichloroethylene, EPA considered the full range of results from sources that were rated as either high or medium confidence during systematic review. Data evaluation and information on the full extracted dataset are available in the *Draft Data Quality Evaluation and Data Extraction Information for Environmental Fate and Transport for trans-1,2-Dichloroethylene* (U.S. EPA, 2026g). Other fate estimates were based on modeling results from EPI Suite™ (U.S. EPA, 2012), a predictive tool for physical and chemical and environmental fate properties. Information regarding the model inputs is available in Section 3.1.1. EPI Suite™ was reviewed by the EPA Science Advisory Board (SAB, 2007), and the individual models that comprise it have been peer reviewed through publication in technical journals. Citations for the supporting manuscripts are available in the EPI Suite™ help files.

Table 3-1. Environmental Fate Properties for *trans*-1,2-Dichloroethylene

Property or Endpoint	Value ^a	Reference	Data Quality Rating
Indirect photodegradation	$t_{1/2}$ = 4.57 days (assuming 12-hour day, $1.5E06$ OH/cm ³)	U.S. EPA (2012)	High
	$t_{1/2}$ = 5.9 days (estimated, assuming 12-hour day, $1.5E06$ OH/cm ³)	Klamt (1993)	High
Direct photodegradation	Not expected	N/A	N/A
Hydrolysis	$t_{1/2}$ = $2.1E10$ years	Jeffers et al. (1989)	High

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Property or Endpoint	Value ^a	Reference	Data Quality Rating
Aerobic biodegradation in water	Negligible biodegradation/24 days (modified shake-flask method and modified river die-away method)	Mudder (1981)	High
	0% biodegradation/28 days (OECD 301C)	NCBI (2020)	Medium
	8% biodegradation/28 days (OECD 301D), $t_{1/2}$ = 234 days assuming first-order kinetics	U.S. EPA (2015c)	Medium
Aerobic biodegradation in soil/sediments	$t_{1/2}$ = 21–23 days (contaminated soil and synthetic groundwater samples)	Olaniran et al. (2006)	High
	35% loss/35 days (1 ppm, london soil); 10% in 280 days (1 ppm, Oklahoma soil); 6% in 400 days (10 ppm, london soil); $t_{1/2}$ = 68–4,545 days assuming first-order kinetics (no prior exposure history)	Klier et al. (1999)	High
Anaerobic biodegradation in soils/sediments	$t_{1/2}$ = 32 days (reductive dechlorination in pre-exposed aquifer material and groundwater microcosm)	Hunkeler et al. (2002)	High
	$t_{1/2}$ = 132–147 days (dehalogenation to form vinyl chloride)	Barrio-Lage et al. (1986)	High
	0% biodegradation after 20 days (everglades surface water and muck samples)	Dow Chemical (1980)	Medium
	82% loss in 40 weeks including a lag time of 112 days. (aquifer material beside landfill). $t_{1/2}$ = 68 days assuming first order kinetics.	(NCBI, 2020)	Medium
	73% biodegradation after 180 days (sediments from Florida everglades)	U.S. EPA (2015c)	Medium
	16–40% over 60 days in anoxic sediments	Bradley (2007)	Medium
Bioconcentration factor (BCF)	8.7 ^b L/kg	U.S. EPA (2012)	High
Bioaccumulation factor (BAF)	9.3 ^b L/kg	U.S. EPA (2012)	High
Organic carbon:water partition coefficient (log K_{oc})	1.23 (unitless)	Lam (1994)	High
	1.64 (estimated; unitless)	RIVM (2007)	Medium
	1.81 ^b (unitless)	U.S. EPA (2012)	High
Organic carbon:air partition coefficient (log K_{OA})	2.56 ^b (unitless)	U.S. EPA (2012)	High

Property or Endpoint	Value ^a	Reference	Data Quality Rating
Removal in wastewater treatment	84% (activated sludge system, isomer not specified)	Tansel and Eyma (1999)	Medium
	>90% (activated sludge and trickling filter systems)	U.S. EPA (1982b)	High
	79% ^b	U.S. EPA (2012)	High
	t _{1/2} = 26–27 days (contaminated wastewater samples)	Olaniran et al. (2006)	High
	93–95% loss/28 days of which 26–33% was volatilized (settled sludge amended with yeast extracts); t _{1/2} = 16–21 days assuming first-order kinetics	U.S. EPA (2015c)	Medium
^a Measured unless otherwise noted			
^b Information estimated using EPI Suite™ (U.S. EPA, 2012)			

3.2 Partitioning

3.2.1 Tier I Analysis

Environmental transport and partitioning consist of processes such as volatilization, advection, dispersion, diffusion, association with dissolved organic matter, and sorption to solids. These processes, in turn, are controlled by the physical and chemical interaction between *trans*-1,2-dichloroethylene and the surrounding media (*e.g.*, air, water, soil, sediments). *trans*-1,2-Dichloroethylene released to the environment is subject to these processes, though some processes are more likely than others based on its physical and chemical characteristics. To understand the fate of *trans*-1,2-dichloroethylene in the environment EPA identified partitioning coefficients that can provide insight into how the chemical will favor one media over another.

EPA identified a log K_{OW} of 1.93 through the systematic review process (Section 2.2.1.7). EPA also identified a Henry's Law constant of 7.51×10^{-3} atm·m³/mol through its systematic review process (Section 2.2.1.8), which was then converted to a unitless air-water partitioning coefficient (K_{AW}), as shown in Table 3-2.

EPA identified one measured log K_{OC} of 1.23 ([Lam, 1994](#)). This value was calculated using a linear isotherm for a soil with an organic content of 3.5% and spiked with concentrations of *trans*-1,2-dichloroethylene of 0.3 to 8 mmol/L at a liquid:solid ratio of 2:1. EPA also identified a study reporting a log K_{OC} of 1.77 that was estimated using a fragment constant method ([RIVM, 2007](#)). The KOCWIN™ Model in EPI Suite™ was used to estimate K_{OC} values of 39.6 L/kg (log K_{OC} = 1.60) using the molecular connection index method and 47.28 L/kg (log K_{OC} = 1.67) using the K_{OW} method ([U.S. EPA, 2012](#)). EPA used the singular measured log K_{OC} of 1.23 for the partitioning analysis in this draft assessment.

EPA identified one measured log K_{OA} value 2.56 ([U.S. EPA, 2012](#)). This value suggests that *trans*-1,2-dichloroethylene has a moderate affinity for organic phases and is expected to exist mainly as a vapor in the ambient atmosphere and with limited sorption to particulate matter in the air.

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Overall, the vapor pressure (331 mmHg) and Henry's Law constant (7.51×10^{-3} atm·m³/mol) suggest that air will be the major environmental compartment for *trans*-1,2-dichloroethylene. Furthermore, the K_{OA} suggests that it will exist primarily as a vapor in the ambient atmosphere. The log K_{AW} suggests that *trans*-1,2-dichloroethylene will be moderately volatile from water, with the chemical preferentially remaining in water but capable of volatilizing to air under environmental conditions. The log K_{OW} (1.93) and log K_{OC} (1.23) suggest that *trans*-1,2-dichloroethylene will not partition strongly to organic phases in surface water or groundwater. This means that in soil, *trans*-1,2-dichloroethylene will be highly mobile in the subsurface. Additionally, *trans*-1,2-dichloroethylene is likely to volatilize from surface soils based on its Henry's Law constant and vapor pressure.

Table 3-2. Selected Partitioning Values for *trans*-1,2-Dichloroethylene

Partition Coefficient	Value	Log Value	Source(s)
Octanol/water (K_{OW})	85 (unitless)	1.93	Rumble et al. (2018)
Organic carbon/water (K_{OC})	17 (L/kg)	1.23	Lam (1994)
Octanol/air (K_{OA})	363 (unitless)	2.56	U.S. EPA (2012)
Air/water (K_{AW})	0.31 ^a (unitless)	-0.51 ^a	Hovorka and Dohnal (1997)

^a Calculated using the Henry's Law constant reported in Table 2-1.

3.2.2 Tier II Analysis

A Tier II analysis using EPI Suite™ was performed to evaluate how *trans*-1,2-dichloroethylene would partition between environmental compartments based on physical and chemical characteristics ([U.S. EPA, 2012](#)). EPI Suite™ contains a Level III model which assumes steady state but not equilibrium conditions in an environment. A Tier II analysis helps to identify the fate pathways and media most likely to result in exposure following environmental releases and identifies which media should be assessed in the evaluation. Environmental degradation half-lives were selected for each media based on their predominant transformation pathway.

The fugacity calculation results for 100% release to air, water, and soil show that releases to air or water are largely expected to remain in air or water, respectively. Conversely, releases to soil are expected to largely partition to air. Under the modeled continuous water release scenario, losses to air through volatilization do not exceed the continuous input to water at steady state. As a result, the greatest fraction of the modeled mass remains in the water compartment, despite ongoing volatilization to air. Volatilization is expected to be greater from soil when compared to water, and fugacity (tendency to escape from a compartment) is the lowest for the air compartment (Figure 3-1), meaning releases to air will remain in air. Based on release patterns and fugacity calculations, air and to a lesser extent water, are expected to be major environmental compartments for *trans*-1,2-dichloroethylene whereas soil is expected to be a minor compartment. Modeling using reported releases to TRI suggests that air will be the most important medium for exposure.

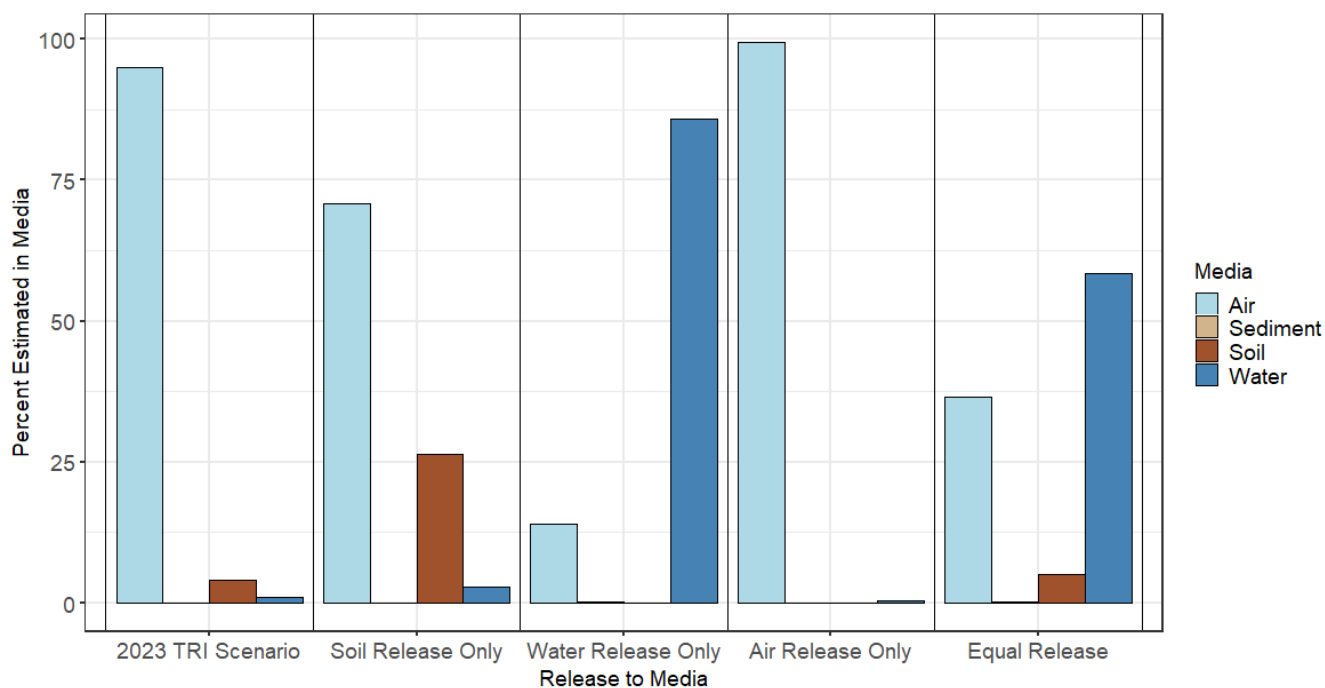


Figure 3-1. EPI Suite™ Level II Fugacity Modeling Graphical Results for *trans*-1,2-Dichloroethylene

3.3 Transformation Processes

trans-1,2-Dichloroethylene can undergo various transformation processes in environmental media that affect its persistence and retention in the environment. Transformation processes include photodegradation, hydrolysis, and biodegradation.

3.3.1 Biodegradation

3.3.1.1 Biodegradation in Surface Water and Groundwater

trans-1,2-Dichloroethylene is expected to biodegrade slowly in water and groundwater. A Japanese MITI (Ministry of International Trade and Industry) test showed 0% of the theoretical biological oxygen demand was measured after 4 weeks, indicating that the chemical is not readily biodegradable in surface water (NCBI, 2020). The experimental conditions for MITI test were not reported in the available database record. In a second study that followed OECD 301D guidelines, *trans*-1,2-dichloroethylene achieved 8% of its theoretical biological oxygen demand after 28 days at an initial concentration of 6 mg/L and was classified as not readily biodegradable. It also achieved 0% of its theoretical biological oxygen demand at concentrations of 2.32 and 6.06 mg/L (U.S. EPA, 2015c). A third study using the modified shake flask and river-die away tests (a laboratory test using natural river water to assess biodegradation under environmentally relevant conditions) showed negligible biodegradation of *trans*-1,2-dichloroethylene after 24 days in using an unacclimated inoculum (Mudder, 1981). A fourth study reported that the chemical underwent 67% biodegradation after 7 days at an initial concentration of 5 mg/L and 40% biodegradation after 7 days at an initial concentration of 10 mg/L; however, approximately 33 and 26% loss, respectively, was attributed to volatilization in abiotic controls. Biodegradation was determined from the decrease in parent compound concentration measured by gas chromatography after correction for abiotic (volatilization) losses. The use of acclimated wastewater inoculum; however, may limit the environmental relevance of these results (Tabak et al., 1981).

3.3.1.1 Biodegradation in Surface Soil and Sediment

Several studies have shown that *trans*-1,2-dichloroethylene (1) has the potential to undergo biodegradation in anaerobic and aerobic sediments and soils; and (2) methanotrophic activity in oxic environments can be a major driver of biodegradation ([Lorah and Olsen, 1998](#); [Semprini et al., 1990](#); [Henson et al., 1988](#); [Janssen et al., 1988](#)). Data further suggest that degradative potential will vary with soil type, microbial population, and *trans*-1,2-dichloroethylene concentration ([Klier et al., 1999](#)).

Anaerobic biodegradation in sediments is expected to occur slowly through reductive dechlorination with a half-life of 132 to 147 days ([U.S. EPA, 2015c](#); [Barrio-Lage et al., 1986](#); [Dow Chemical, 1980](#)) but may be enhanced in sediments with microbial communities previously exposed to *trans*-1,2-dichloroethylene ([Hunkeler et al., 2002](#)). Additionally, vinyl chloride was shown to be a biodegradation product in anaerobic sediments ([NCBI, 2020](#); [Barrio-Lage et al., 1986](#)). One study showed that aerobic biodegradation in sediments can occur through methanotrophic activity in microcosms with half-lives ranging from 5.3 to 7.7 days ([Lorah and Olsen, 1998](#)). Another laboratory study saw potential for both oxic degradation (35–60% in 60 days) and anoxic degradation (16–40% in 60 days) in wetland sediments ([Bradley, 2007](#)). Based on two studies, *trans*-1,2-dichloroethylene is expected to have an aerobic biodegradation half-life in soil of 21 weeks to over 28 weeks ([Olaniran et al., 2006](#); [Klier et al., 1999](#)).

3.3.2 Hydrolysis

No hydrolysis data was identified during systematic review that were definitively for the *trans*- isomer of 1,2-dichloroethylene. EPA only identified one measured hydrolysis half-life of 2.1×10^{10} years for 1,2-dichloroethylene at pH 7 and 25 °C; however, it is not clear if this half-life is for the *trans*- or *cis*- isomer of 1,2-dichloroethylene or a mixture of the two ([Jeffers et al., 1989](#)). Hydrolysis rates for other chlorinated ethylenes assist to qualitatively assess the importance of hydrolysis for *trans*-1,2-dichloroethylene. The study also reported hydrolysis half-lives for 1,1-dichloroethene, perchloroethylene, and trichloroethylene of 1.2×10^8 , 1.3×10^6 , and 9.9×10^6 years, respectively. These results suggest that hydrolysis of chlorinated ethenes in environmentally relevant conditions is negligible.

3.3.3 Photolysis

trans-1,2-Dichloroethylene is not expected to undergo significant direct photolysis in the atmosphere since its chemical structure does not absorb light at wavelengths greater than 290 nm; however, it is expected to degrade by reaction with photochemically produced hydroxyl radicals ($\cdot\text{OH}$) in the atmosphere. EPA identified one measured rate for reactions with hydroxyl radicals of 2.34×10^{-6} cm³/molecule-second, which equates to a half-life of 4.57 days when assuming an atmospheric hydroxyl radical concentration of 1.5×10^6 molecules/cm³ and a 12-hour day ([U.S. EPA, 2012](#)). A second reference estimated a half-life of 5.9 days based on reactions with hydroxyl radicals ([Klamt, 1993](#)). A half-life of 3.8 days was estimated from the AOPWINTM module in EPI SuiteTM at 25 °C, assuming an atmospheric hydroxyl radical concentration of 1.5×10^6 molecules/cm³ and a 12-hour day. *trans*-1,2-Dichloroethylene will also be degraded by reaction with ozone, with a half-life of approximately 320 days estimated from AOPWINTM assuming an atmospheric ozone concentration of 7×10^{11} molecules/cm³ and a 12-hour day ([U.S. EPA, 2012](#)). A third reference estimated an overall environmental atmospheric lifetime of 12.7 days for *trans*-1,2-dichloroethylene using a three-dimensional model of atmospheric chemistry and physics ([Patten and Wuebbles, 2010](#)). These half-life values suggest that *trans*-1,2-dichloroethylene may persist in the air based on the EPA PBT persistence criterion of a 2-day half-life in air ([Federal Register, 1999](#)).

3.4 Media Assessments

3.4.1 Air and Atmosphere

trans-1,2-Dichloroethylene may be released to the atmosphere by fugitive and stack industrial facility emissions. It is not expected to undergo significant direct photolysis in the atmosphere because its chemical structure does not absorb light at wavelengths greater than 290 nm; however, it is expected to degrade by reaction with photochemically produced hydroxyl radicals in the atmosphere. EPA identified a half-life range of 3.8 to 5.90 days when assuming an atmospheric hydroxyl radical concentration of 1.5×10^6 molecules/cm³ and a 12-hour day (U.S. EPA, 2012; Klamt, 1993). An estimated overall atmospheric persistence of 12.7 days was reported by Patten and Wuebbles (2010). They also report a relatively low ozone depleting potential of 22.4×10^{-4} , suggesting minimal impact to the ozone layer at quantities likely to be emitted to the atmosphere.

With an estimated log K_{OA} of 2.56 (U.S. EPA, 2012), *trans*-1,2-dichloroethylene is not expected to adsorb strongly to organic carbon present in airborne particles and consequently, not expected to undergo significant dry deposition or long-range transport. If released to air, *trans*-1,2-dichloroethylene is expected to largely remain in vapor phase based on its Henry's Law constant of 7.51×10^{-3} atm·m³/mol at 20 °C (Hovorka and Dohnal, 1997) and vapor pressure of 331 mmHg at 25 °C (NLM, 2018b). With an estimated log K_{OA} of 2.56 (U.S. EPA, 2012), *trans*-1,2-dichloroethylene is not expected to adsorb strongly to organic carbon present in airborne particles and consequently, not expected to undergo significant dry deposition or long-range transport. If released to air, *trans*-1,2-dichloroethylene is expected to largely remain in vapor phase based on its Henry's Law constant of 7.51×10^{-3} atm·m³/mol at 20 °C (Hovorka and Dohnal, 1997) and vapor pressure of 331 mmHg at 25 °C (NLM, 2018b).

The Organisation for Economic Co-operation and Development (OECD) Overall Environmental Persistence (POV) and long-range transport potential (LRTP) Screening Tool, Version 2.2, was used to estimate overall persistence for *trans*-1,2-dichloroethylene and its potential for long range transport (Wegmann et al., 2009). The tool was run with the following physical and chemical and fate data: molar mass (96.94 g/mol), log K_{OW} (1.93), log K_{AW} (−0.51), half-life in air (5.9 days), half-life in water (365 days), and soil (365 days). The physical and chemical properties were input based on the values in Table 2-1 and Table 3-1.

The tool estimates overall persistence (POV) for *trans*-1,2-dichloroethylene of 9 days when emissions occur in the air. Additionally, it calculated a transfer efficiency (TE) of 0.035%, indicating the proportion of *trans*-1,2-dichloroethylene expected to deposit onto surface media after being transported from the release region. This low TE suggests that vapor deposition to surface water or soil will not be significant, aligning with results from partitioning coefficients and fugacity modeling. A characteristic travel distance (CTD) of 2,934 km was estimated for *trans*-1,2-dichloroethylene, meaning its concentration in air would be reduced to 38% of the initial release concentration at this distance from the release region. The low TE and limited POV indicate that, despite the potential for regional transport, *trans*-1,2-dichloroethylene is not expected to undergo efficient long-range transport or to accumulate in remote environment. Despite the apparently high CTD estimated for *trans*-1,2-dichloroethylene, the tool indicated that long-range atmospheric transport was not a concern for *trans*-1,2-dichloroethylene. The tool groups *trans*-1,2-dichloroethylene with chemicals like biphenyl or aldrin, which are not expected to undergo long-range transport and have not been detected in remote locations; similarly, *trans*-1,2-dichloroethylene itself has not been detected in remote locations.

Ambient air monitoring data retrieved from the U.S. EPA Air Quality System (AQS) indicates that there were 6,741 reported values across the entire AQS archive dataset evaluated for *trans*-1,2-

dichloroethylene between 2018 and 2025. The reported monitored concentrations ranged from 0 to 34.89 $\mu\text{g}/\text{m}^3$ across available monitoring locations in the United States between 2018 and 2025. The overall detection frequency was 19%. The AQS database queried did not contain detection limits. Section 5.1 contains additional information regarding the AQS data.

3.4.1.1 Key Sources of Uncertainty in the Assessment of Air and Atmosphere

Based on the fugacity modeling, transport modeling, and physical and chemical properties, EPA has robust confidence that air will be a major environmental compartment for *trans*-1,2-dichloroethylene. The physical and chemical properties provide strong evidence that *trans*-1,2-dichloroethylene will exist as a vapor in the atmosphere and will not significantly partition to particulate matter.

3.4.2 Aquatic Environments

trans-1,2-Dichloroethylene is most likely to enter surface waters and sediments through direct and indirect discharges from industrial and municipal wastewater treatment plants.

3.4.2.1 Surface Water

The hydrolysis data extracted during systematic review suggests that hydrolysis of *trans*-1,2-dichloroethylene is not expected to occur at environmentally relevant conditions (Section 3.3.2). Direct or indirect photolysis is also not expected to be a significant removal pathway for *trans*-1,2-dichloroethylene as it does not absorb environmentally relevant solar radiation and reacts slowly with photochemically generated oxidants (Section 3.3.3); volatilization is expected to be the dominant removal process. EPI Suite™ estimates a volatilization half-life of 1.08 hours from a river of 1 m depth, 5 m/s prevailing wind speed and 1 m/s current velocity. Additionally, it estimates a half-life of 94.4 hours from a lake 1 m deep, 0.5 m/s prevailing wind speed and 0.05 m/s current velocity ([U.S. EPA, 2012](#)). Biodegradability studies indicate that *trans*-1,2-dichloroethylene is not readily biodegradable and biodegradation in water is expected to be limited under most environmental conditions ([NCBI, 2020](#); [U.S. EPA, 2015c](#); [Mudder, 1981](#)). Given a low K_{OC} value of 17, *trans*-1,2-dichloroethylene is not expected to adsorb to suspended organic matter in water, and as a result is expected to be very mobile in environmental waters. *trans*-1,2-Dichloroethylene is expected to be bioavailable in water due to its low adsorption potential but is not expected to bioaccumulate in aquatic organisms given an estimated bioconcentration factor (BCF) of 8.7 and a bioaccumulation factor (BAF) of 9.3 (Section 3.4.2.2). A study measuring *trans*-1,2-dichloroethylene in surface water near a landfill did not find detectable concentrations in surface water however the detection limits were not specified. The study attributed the absence of *trans*-1,2-dichloroethylene from surface waters to a combination of volatilization, dilution and biodegradation ([Chen and Zoltek, 1995](#)). In summary, based on a HLC of $7.51 \times 10^{-3} \text{ atm}\cdot\text{m}^3/\text{mol}$ and vapor pressure of 331 mmHg and EPI Suite™ modeling, *trans*-1,2-dichloroethylene is expected to volatilize rapidly from surface water but could be persistent in deep, stagnant water where volatilization would not occur.

Surface water monitoring data retrieved from the Water Quality Portal (WQP) included 1,094 surface water samples collected in the United States between 2015 and 2025 with 1,011 of those reported as being below the detection limit. Concentrations ranged from 0.037 to 1 $\mu\text{g}/\text{L}$ and detection limits ranged from 0.025 to 10 $\mu\text{g}/\text{L}$.

3.4.2.2 Sediments

Based on a measured soil organic log K_{OC} of 1.23, *trans*-1,2-dichloroethylene is not expected to bind strongly to sediments and as a result, is expected to be mobile in the aquatic environment. *trans*-1,2-Dichloroethylene can undergo microbial degradation while associated with sediment solids. Anaerobic biodegradation in sediments is expected to occur slowly through reductive dechlorination with a half-life

ranging from 132 to 147 days ([U.S. EPA, 2015c](#); [Barrio-Lage et al., 1986](#); [Dow Chemical, 1980](#)), but may be enhanced in sediments with microbial communities previously exposed to *trans*-1,2-dichloroethylene ([Hunkeler et al., 2002](#)). Aerobic biodegradation in sediments is expected to occur through methanotrophic activity with half-life ranging from 5.3 to 7.7 days ([Lorah and Olsen, 1998](#)). Additionally, one laboratory study saw potential for both oxic degradation (35–60% in 60 days) and anoxic degradation (16–40% in 60 days) in wetland sediments ([Bradley, 2007](#)). The data show that biodegradation of *trans*-1,2-dichloroethylene will occur in sediments; however, the rates can vary depending on site-specific factors, including presence of specialized microbes, presence or absence of electron acceptors/donors, and exposure history of the site.

A total of 351 WQP samples were retrieved; detection limits ranged from 0.96 to 110,000 µg/kg and all reported results were at or equal to their sample-specific detection limits (*i.e.*, likely NDs).

3.4.2.3 Key Sources of Uncertainty in the Assessment of Aquatic Environments

While *trans*-1,2-dichloroethylene is expected to volatilize from surface waters, the rates presented in this section are based on a modeled water body and actual rates will vary depending on the local environmental conditions. Biodegradation in water is expected to be slow, but there is uncertainty in the exact rate since biodegradation rates are highly dependent on local water conditions (*e.g.*, temperature and available nutrients) and the composition of the existing microbial communities.

3.4.3 Terrestrial Environments

trans-1,2-Dichloroethylene can enter terrestrial environments via leaching from soil contaminated with biosolids, or ground water impacted by landfill leachate and/or recharge from a surface water body.

3.4.3.1 Biosolids

For the purposes of this draft assessment, sludge is defined as the solid, semi-solid, or liquid residue generated by wastewater treatment processes. Also, for the purposes of this draft assessment, the term “biosolids” refers to treated sludge that meets the EPA pollutant and pathogen requirements for land application and surface disposal (40 CFR 305) ([U.S. EPA, 1993](#)).

Based on a measured log K_{OC} value ranging from 1.23 to 1.77 (Section 3.2.1), *trans*-1,2-dichloroethylene is not expected to partition to sludge from wastewater treatment facilities. In addition, any *trans*-1,2-dichloroethylene in land applied biosolids is likely to be lost through volatilization given its Henry’s Law constant of 7.51×10^{-3} atm·m³/mol at 20 °C ([Hovorka and Dohnal, 1997](#)). The publicly owned treatment works (POTW) study was an EPA-sponsored investigation of 40 full-scale POTWs located across the United States and selected to represent a range of geographic regions, plant sizes, treatment processes, and wastewater characteristics. The study was conducted to characterize the fate and removal of priority pollutants during municipal wastewater treatment and it reported concentrations ranging from 1 to 96 mg/L in raw sludge samples with a detection frequency of 60% from a sample size of 477 and detection limits between 5 and 10 µg/L ([U.S. EPA, 1982a](#)).

In the 1988 National Sewage Sludge Survey (NSSS), the maximum concentration measured in sewage sludge from secondary or more advanced treatment was 10.7 mg/kg, with a 1% detection frequency among 178 samples from 176 U.S. POTWs. A maximum concentration of 10.7 mg/kg was measured in sludge (sewage sludge generated during secondary or more advanced treatment) by the 1988 NSS, with a detection frequency of 1% from a sample size of 178. Detection limits ranged from 3 to 41 µg/kg ([U.S. EPA, 1996, 1990](#)). No more recent national occurrence data for *trans*-1,2-dichloroethylene in sewage sludge are available. Subsequent EPA sewage sludge surveys did not analyze for chlorinated volatile organic compounds (VOCs) and have focused on other contaminants. Although sludge concentrations of

trans-1,2-dichloroethylene as high as 96 mg/L have been reported in POTW studies, it is important to note that these raw sludge values reflect the primary sludge as it was removed from the primary clarifiers before further treatment—not concentrations in treated sludge that would be land applied. In contrast, the significantly lower maximum concentration of 10.7 mg/kg and the associated detection frequency of 1% reported for stabilized biosolids in the 1988 NSSS are likely more indicative of the expected levels of *trans*-1,2-dichloroethylene in biosolids that are being land applied.

3.4.3.2 Soil

trans-1,2-Dichloroethylene may be expected to impact soil primarily via infiltration of contaminated water. Measured log K_{OC} values ranging from 1.23 to 1.77 were reported for *trans*-1,2-dichloroethylene (Section 3.2.1). This range of values indicates that *trans*-1,2-dichloroethylene will have low sorption to soil and is expected to be bioavailable in soil porewater. Aerobic biodegradation in soil is expected to have a half-life ranging from 3 weeks to several years ([Olaniran et al., 2006](#); [Klier et al., 1999](#)). With *trans*-1,2-dichloroethylene's biodegradation potential, its mobility in groundwater, and its potential to volatilize from moist or dry soil surfaces, soil is not expected to be a major compartment for *trans*-1,2-dichloroethylene.

Surface soil monitoring data retrieved from the WQP indicated that the database contained only 33 soil samples collected between 2015 and 2025 with concentrations reported at the detection limits and detection limits ranged from 4.5×10^{-4} to 1.3×10^{-3} mg/kg. It is unclear whether these are true detections or non-detect concentrations reported at the limit of detection (LOD).

3.4.3.3 Groundwater

Due to *trans*-1,2-dichloroethylene's water solubility of 4,500 mg/L and its mobility in soil, groundwater contamination can occur through the leaching of contaminated water through soil. Unlike surface waters, biodegradation is expected to occur in groundwater but the rate may vary widely from weeks to years. In addition, volatilization is not expected to be significant in groundwater. A combination of low to no biodegradation and low volatility may lead to persistence of *trans*-1,2-dichloroethylene in groundwater. Studies have measured concentrations in groundwater ranging from less than 1 to 98 µg/L ([Chen and Zoltek, 1995](#); [Lesage et al., 1990](#); [Sabel and Clark, 1984](#)). One of these studies found evidence of *trans*-1,2-dichloroethylene contamination in a well located close to a landfill in central Florida with concentrations up to 6.22 µg/L, but did not detect the contaminant in surface waters nearby. Reported concentrations ranged from 0.14 to 6.22 µg/L in eight groundwater samples. The detection limit was not specified ([Chen and Zoltek, 1995](#)). A second paper reported concentrations of *trans*-1,2-dichloroethylene for five groundwater samples as non-detect or less than 1 µg/L, which is likely the detection limit though not explicitly stated. The samples were collected at a waste disposal site in Ontario, Canada ([Lesage et al., 1990](#)). The last study reported 20 groundwater samples collected from locations near municipal solid waste landfills and dumps across Minnesota, 7 of which were reported as concentrations ranging from 0.2 to 98 µg/L. Detection limits were not reported ([Sabel and Clark, 1984](#)). Evidence of *in situ* reductive dechlorination of chlorinated solvents in groundwater contaminated by leachate from an anoxic landfill was observed and *trans*-1,2-dichloroethylene was identified as a potential daughter product within the degradation pathway ([Freedman et al., 2001](#); [Lesage et al., 1990](#)).

Groundwater monitoring data retrieved from the WQP included 3,812 groundwater samples collected in the United States between 2015 and 2025 with 16% of the samples reporting concentrations for *trans*-1,2-dichloroethylene ranging from 0.01 to 6,700 µg/L. The detection limits for the samples ranged from 1.49×10^{-4} to 149 µg/L.

3.4.3.4 Landfills

Landfill leachate is generated by excess rainwater percolating through the waste layers of a landfill. Pollutants such as *trans*-1,2-dichloroethylene can be transferred from the landfilled waste material to the percolating leachate through combined physical and chemical and microbial processes ([Christensen et al., 2001](#)). Compounds in leachate entering an aquifer will be subject to dilution as the leachate mixes with groundwater. *trans*-1,2-Dichloroethylene is included on the list of hazardous waste pursuant to the Resource Conservation and Recovery Act (RCRA) Section 3001 (40 CFR 261.33) as a listed waste on the U (U079) and F (F024, F025) lists.

Across the TRI reporting years of 2019 to 2023, the maximum annual amounts of *trans*-1,2-dichloroethylene disposed of in Subtitle C and non-Subtitle C landfills by TRI reporting facilities were 5.5 and 1.1×10^4 lb, respectively. *trans*-1,2-Dichloroethylene can also potentially be present in non-hazardous landfills due to consumer uses and as the degradation product of other chlorinated ethenes such as trichloroethylene or perchloroethylene ([Freedman et al., 2001](#); [Lorah and Olsen, 1998](#); [Lesage et al., 1990](#); [Lage and Parsons, 1985](#)).

Limited data directly applicable to the fate of *trans*-1,2-dichloroethylene in landfills and landfill leachate plumes were found in the literature search conducted as part of the systematic review process. Available data suggest that *trans*-1,2-dichloroethylene can be found in groundwater near non-hazardous waste landfills (Section 3.4.3.3); however, its presence was attributed to the biodegradation of other chlorinated ethenes, such as perchloroethylene or trichloroethylene. Hydrolysis in landfills is expected to be very slow (Section 3.3.2). Biodegradation rates of *trans*-1,2-dichloroethylene in landfills and landfill leachate plumes were informed by laboratory studies on biodegradation conducted in soil/groundwater microcosms (Section 3.3.1). Overall, the studies suggest biodegradation will be slow in groundwater and anaerobic soils and sediments; therefore, it is assumed that biodegradation in landfills and landfill leachate plumes will also be slow.

3.4.3.5 Key Sources of Uncertainty in the Assessment of Terrestrial Environments

When released to land, there is little uncertainty that *trans*-1,2-dichloroethylene will be mobile in the subsurface and that it will volatilize from surface soils. There is uncertainty as to the rate of volatilization, as there were no identified empirical data measuring volatilization rates from soil. Similarly, biodegradation is expected to be slow, but there is uncertainty as to the exact rate as it depends on soil type, microbial population, and *trans*-1,2-dichloroethylene concentration. There is also an uncertainty as to the source of *trans*-1,2-dichloroethylene in groundwater monitoring studies, as it may be present due to biodegradation of high-chlorinated ethenes. Additionally, there is uncertainty about the presence of *trans*-1,2-dichloroethylene in biosolids. EPA identified one study reporting concentrations in biosolids, but this study was conducted in 1988, and the Agency did not identify any recent reports of *trans*-1,2-dichloroethylene in biosolids.

3.5 Persistence Potential of *trans*-1,2-Dichloroethylene

trans-1,2-Dichloroethylene is expected to persist in the environment. *trans*-1,2-Dichloroethylene in the gaseous phase will be degraded by reacting with hydroxyl radicals ($\cdot\text{OH}$), with a half-life of 4.57 to 5.9 days; thus, it is expected to persist for a limited duration in the atmosphere (Section 3.3.3). In aquatic environments, *trans*-1,2-dichloroethylene is not expected to undergo hydrolysis or significant biodegradation. Volatilization is expected to be the main removal process for *trans*-1,2-dichloroethylene from aquatic environments thus limiting its persistence (Section 3.4.2.1). In the terrestrial environment, *trans*-1,2-Dichloroethylene will biodegrade under both oxic and anoxic conditions, with the rate of biodegradation depending on the presence or absence of acclimatized microbes ([Olaniran et al., 2006](#)), its concentration in soil or sediment, and the presence or absence of co-substrates ([Hopkins and](#)

[Mccarty, 1995](#)). It is also expected to volatilize from wet or dry soil and be highly mobile in the subsurface; hence, it is not expected to persist in soils and sediments. It can however persist in groundwater where volatilization can be limited (Section 3.4.3.3).

3.5.1 Destruction and Removal Efficiency

There were no high-quality studies measuring the destruction and removal efficiency (DRE) for *trans*-1,2-dichloroethylene identified during systematic review. Other chlorinated ethanes and ethenes that are classified as hazardous air pollutants (HAP) (e.g., 1,2-dichloroethane and trichloroethylene) are covered by regulations at 40 CFR part 63, Subpart EEE – National Emission Standards for Hazardous Air Pollutants from Hazardous Waste Combustors, which require all hazardous waste combustors (incinerators, cement kilns, lightweight aggregate kilns, solid fuel boilers, liquid fuel boilers, and hydrochloric acid production furnaces) to achieve a DRE of 99.99% for each principal organic hazardous constituent (POHC). Given the physical and chemical similarities between *trans*-1,2-dichloroethylene and other chlorinated ethanes and ethenes, EPA assumed that *trans*-1,2-dichloroethylene will have the same DRE as these HAPs.

3.5.2 Removal in Wastewater Treatment

Based on *trans*-1,2-dichloroethylene's Henry's Law constant, air stripping is expected to be the primary removal mechanism in wastewater treatment plants (WWTP). Measured removal efficiencies of *trans*-1,2-dichloroethylene in conventional wastewater treatment plants range from approximately 70 to over 90% in activated sludge and trickling filter systems. These observed removal efficiencies are consistent with the compounds Henry's Law constant and the expectation that volatilization (air stripping) is the dominant removal mechanism. Although some biodegradation may occur in activated sludge systems ([U.S. EPA, 2015c](#); [Olaniran et al., 2006](#)), it is expected to be slow and incomplete. Reported biodegradation half-lives of approximately 16 to 27 days ([U.S. EPA, 2015c](#); [Olaniran et al., 2006](#)). While some biodegradation in wastewater is possible in activated sludge systems ([U.S. EPA, 2015c](#); [Olaniran et al., 2006](#)), it is expected to be slow and incomplete. Reported biodegradation half-lives of approximately 16 to 27 days ([U.S. EPA, 2015c](#); [Olaniran et al., 2006](#)) exceed the hydraulic residence time of activated sludge systems and are comparable to or longer than typical solids retention times—indicating that only limited biodegradation is expected before wastewater exits the treatment process. Furthermore, sorption to sludge is expected to be minimal due to the compound's low log K_{OC} .

One study found 84% of *trans*-1,2-dichloroethylene was removed during secondary treatment in a WWTP solely by volatilization/stripping ([Tansel and Eyma, 1999](#)). A second study of 40 POTWs found a range in influent concentrations of 1 to 200 µg/L, whereas the range in effluent concentrations ranged from 1 to 17 µg/L (>90% removal efficiency) ([U.S. EPA, 1982a](#)). *trans*-1,2-Dichloroethylene was one of the 24 commonly found pollutants out of 129 priority pollutants studied. At least 60% of the treatment plants studied accomplished 100% removal, while less than 20% of the plants had an effluent concentration above 1 µg/L. STPWINTM, an EPI SuiteTM module that estimates chemical removal from sewage treatment plants, estimated that a total of 78.73% of *trans*-1,2-dichloroethylene wastewater will be removed: 0.02% by biodegradation, 77.8% by air stripping, and 0.91% by sorption to sludge ([U.S. EPA, 2012](#)). STPWINTM simulates a conventional wastewater treatment plant that uses activated sludge as a secondary treatment. The biodegradation half-life parameter was set to 10,000 hours for the primary clarifier, aeration vessel, and settling tank, which is a default for recalcitrant chemicals. This was used as a conservative input to represent limited biodegradation and avoid overestimating biological removal. The physical and chemical properties used in modeling are provided in Table 2-1.

The results from STPWINTM provide additional evidence that the primary mode of removal of *trans*-1,2-dichloroethylene from waste treatment plants is by air stripping. The measured data available for

removal efficiency suggests that *trans*-1,2-dichloroethylene will not persist in WWTPs.

3.5.3 Removal in Drinking Water Treatment

No studies on the removal efficiency of *trans*-1,2-dichloroethylene from drinking water treatment plants were identified during systematic review. Given its solubility and low affinity for particulates, *trans*-1,2-dichloroethylene is not expected to be effectively removed by conventional drinking water treatment methods. However, the Drinking Water Treatability Database ([U.S. EPA, 2025a](#)) references studies indicating that advanced treatment processes, such as packed tower aeration (PTA) and granular activated carbon (GAC), are effective at removing *cis*-1,2-dichloroethylene and other VOCs (e.g., trichloroethylene and perchloroethylene). EPA anticipates that due to its volatility, *trans*-1,2-dichloroethylene would similarly be efficiently removed during the drinking water treatment process by employing volatilization-based processes like PTA, with adsorption using GAC as a secondary treatment step.

3.5.4 Bioaccumulation Potential of *trans*-1,2-Dichloroethylene

No high-quality studies were found that measured the bioconcentration or bioaccumulation of *trans*-1,2-dichloroethylene in aquatic or terrestrial environments. However, one study estimated the BAF of *trans*-1,2-dichloroethylene to be 32.66 ([IDEM, 1998](#)). Using the EPI Suite™ model, a BCF value of 8.7 L/kg, an upper-trophic fish BAF value of 9.3 L/kg wet-weight, and a biotransformation half-life (normalized to 10 g fish) of 0.53 days were estimated ([U.S. EPA, 2012](#)). The estimated BCF and BAF values, all below 1,000, indicate that *trans*-1,2-dichloroethylene has low bioaccumulation potential in fish based on the EPA TSCA PBT Bioaccumulation criteria ([Federal Register, 1999](#)). The biotransformation half-life further suggests that *trans*-1,2-dichloroethylene is rapidly metabolized in the body of a fish.

3.5.5 Key Sources of Uncertainty in the Assessment of Overall Persistence Potential

trans-1,2-Dichloroethylene is generally expected to be persistent in the environment; however, there is uncertainty in the specific degradation rates, which affect the overall persistence. There is strong evidence that hydrolysis will be very slow. There were limited data on biodegradation and reported rates vary; however, biodegradation is generally expected to be slow in water and anaerobic soils, with half-lives on the order of months to years, but could be faster in aerobic sediments, with half-lives on the order of weeks, under certain environmental conditions. With an indirect photolysis half-life of 4 days, *trans*-1,2-dichloroethylene is expected to be persistent in the atmosphere. The indirect photolysis rate for reactions with hydroxyl radicals was based on one measured value; thus, there is some uncertainty in the exact rate.

EPA did not identify a DRE for *trans*-1,2-dichloroethylene during systematic review; therefore, the Agency is assuming a DRE based on emissions standards specified for hazardous air pollutants. There is uncertainty in the wastewater treatment removal efficiency, as a wide range of efficiencies were reported; however, efficiencies are generally expected to be high. Volatilization is expected to be the major removal mechanism, but efficiencies will depend on the specific treatment process being used (e.g., diffused aeration, mechanical aeration, or attached growth). Reported biodegradation half-lives of approximately 16 to 27 days ([U.S. EPA, 2015c](#); [Olaniran et al., 2006](#)) indicate that biodegradation is relatively slow under wastewater treatment conditions. These half-lives also exceed the hydraulic residence time of activated sludge systems and are comparable to or longer than typical solids retention times, indicating that only limited biodegradation is expected before wastewater exits the treatment process. Sorption to biosolids is also expected to be low based on a K_{OC} of 1.23 to 1.77. No data on the removal of *trans*-1,2-dichloroethylene from drinking water treatment plants were identified during systematic review. The available data suggest that VOCs will be efficiently removed by advanced treatment processes such as PTA and GAC.

EPA did not identify any sources reporting measured BCF or BAF values for *trans*-1,2-dichloroethylene and therefore relied on modeled values. While there is uncertainty in exact BCF and BAF values, the physical and chemical properties and results of the modeling all suggest that *trans*-1,2-dichloroethylene is unlikely to be bioaccumulative.

3.6 Weight of Scientific Evidence Conclusions for Fate and Transport

Evaluation of the weight of scientific evidence conclusions for the fate and transport of *trans*-1,2-dichloroethylene is shown below and is based on categorization of either slight, moderate, or robust, as described in the 2021 Draft Systematic Review Protocol ([U.S. EPA, 2021c](#)).

Given the consistent results from the high-quality studies discussed, there is robust evidence that *trans*-1,2-dichloroethylene

- Will undergo slow indirect photodegradation in air primarily by reaction with hydroxyl radicals (Section 3.3.3)
- Will not hydrolyze in environmental waters (Section 3.3.2)
- Will not sorb to soil/sediment and will therefore be mobile in the environment (Section 3.2.1)
- Will biodegrade slowly in anaerobic soils and sediments (Section 3.3.1)
- Will not readily biodegrade in surface water (Section 3.3.1)
- Has high removal rates during wastewater treatment, with volatilization being the major removal process, and biodegradation and sorption to sludge being minor processes (Section 3.5.2)
- Is the degradation product of higher chlorinated ethenes (*e.g.*, trichloroethylene and perchloroethylene) and can degrade to form vinyl chloride (Section 3.3.1)
- Will not be removed with high efficiency in conventional water treatment processes but will be removed with high efficiency in treatment processes that used packed aeration towers or granular activated carbon (Section 3.5.3)
- Can biodegrade rapidly in certain aerobic environments, especially when there is previous exposure to *trans*-1,2-dichloroethylene, the presence of methanotrophic bacteria, or the presence of certain nutrients and substrates (Section 3.3.1)
- Will not undergo long range transport in air (Section 3.4.1)
- Will not bioaccumulate in fish (Section 3.5.4).

3.6.1 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for the Fate and Transport Assessment

The partitioning analyses, which incorporate high-quality physical and chemical properties, provide robust evidence that air is likely to be the major medium of exposure for *trans*-1,2-dichloroethylene. TRI data for 2019 to 2023 indicate that reported environmental releases of 1,2-dichloroethene (reported in TRI as the combined *cis*- and *trans*-isomers) were predominantly to air. Air emissions accounted for approximately 99.7% of total reported releases in 2019, 99.8% in 2020, 99.7% in 2021, and 98.8% in 2022, indicating that atmospheric release was the primary disposal pathway during these years. In 2023, the proportion of releases to air decreased to approximately 68% because reported land disposal and off-site disposal increased; however, air remained the single largest reported release pathway. In this draft assessment, EPA considered the TRI reporting years of 2019 to 2023. The TRI-reported releases show that, while small compared to air, there are releases to water and land. The partitioning analysis shows that when released to water and land, some *trans*-1,2-dichloroethylene will stay in the media of release. Therefore, land and water pathways could be important depending on the specific release pattern.

When released to air, there is strong evidence that *trans*-1,2-dichloroethylene will exist as a vapor and will not partition to particulate matter. Modeling suggests that *trans*-1,2-dichloroethylene will not be

subject to long-range transport given its atmospheric half-life (≈ 5 days).

In aquatic environments, *trans*-1,2-dichloroethylene is expected to volatilize from surface waters. EPA did not identify any studies directly measuring volatilization rates and used EPI Suite™ ([U.S. EPA, 2012](#)) to estimate a rate for a model lake and stream. Therefore, there is uncertainty in the volatilization rate of this chemical as it can vary based on the characteristics of the water body as well as prevailing wind speeds. EPA has strong evidence that *trans*-1,2-dichloroethylene is not readily biodegradable in surface water and that hydrolysis is slow under environmentally relevant conditions. Additionally, EPA has strong evidence that *trans*-1,2-dichloroethylene will not sorb strongly to sediment, but given its solubility, there is a possibility that it could be bioavailable in sediment porewater. The Agency identified limited monitoring data with measurable concentrations in surface water but monitoring locations for water samples are not necessarily spatially or temporally aligned with releases from COUs and therefore might not be representative of actual release scenarios. EPA also identified limited sediment monitoring data with reported concentrations at or below the reported detection limit. EPA identified only one study with an estimated BAF of 32.66 L/kg. Modeling using EPI Suite™ ([U.S. EPA, 2012](#))-estimated BAF and BCF values of 9.3 L/kg and 8.7 L/kg respectively. Overall, EPA has high confidence the BAF and BCF values will be low given available evidence.

In terrestrial environments, *trans*-1,2-dichloroethylene is expected to volatilize from surface soils; however, because EPA did not identify any studies measuring volatilization rates from soil, there is uncertainty in the exact rate as it will depend on the specific soil characteristics and local conditions (*e.g.*, temperature). Soil and groundwater biodegradation studies reported a large range of half-lives. Despite the uncertainty, EPA expects biodegradation rates to be slow in both aerobic and anaerobic soils and groundwater. The Agency has strong evidence demonstrating that *trans*-1,2-dichloroethylene will migrate to groundwater when released to land, given the amount of data measuring it in groundwater across the United States.

4 RELEASE ASSESSMENT

A key component of EPA's risk evaluation is assessing risks to the environment and general population from releases of *trans*-1,2-dichloroethylene from industrial and commercial facilities. This consists of

- estimating releases of *trans*-1,2-dichloroethylene to environmental media (air, water, land) from the COUs at industrial and commercial facilities;
- estimating the environmental media and general population exposure concentrations of *trans*-1,2-dichloroethylene that result from the releases; and
- comparing the estimated environmental media and general population concentrations with the appropriate hazard values to determine if there is a risk in the risk evaluation.

Additionally, the following four (of 9 total) appendices have been developed that describe release assessment methodologies in more detail:

- Appendix A Environmental Release and Occupational Exposure Model Approaches and Parameters: Includes detailed description of standard models used by EPA in addition to model-specific approaches and parameters.
- Appendix B Procedures for Mapping Facilities from Standard Engineering Sources to Occupational Scenarios: Outlines the procedures EPA follows to map facilities from data sources including Chemical Data Reporting (CDR), Toxics Release Inventory (TRI), and Discharge Monitoring Reports (DMR).
- Appendix C Estimating Daily Wastewater Discharges from DMR and TRI data: Provides steps and examples for estimating daily wastewater discharges from industrial and commercial facilities manufacturing, processing, or using *trans*-1,2-dichloroethylene.
- Appendix D Guidance for Using the Toxic Release inventory for Estimating Releases: Provides steps and examples for estimating air releases from industrial and commercial facilities manufacturing, processing, or using *trans*-1,2-dichloroethylene.

EPA collected and analyzed a significant amount of data in completing this release assessment. The following supplemental documents have been included with the draft risk evaluation to provide transparency on the data the Agency used and how it was used in developing the release assessment:

- *Draft Air Releases for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026d](#)): Includes the data and calculations used to estimate air releases for *trans*-1,2-dichloroethylene.
- *Draft Land Releases for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026p](#)): Includes the data and calculations used to estimate land releases for *trans*-1,2-dichloroethylene.
- *Draft Water Releases for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026aa](#)): Includes the data and calculations used to estimate air releases for *trans*-1,2-dichloroethylene.
- *Draft Repackaging Environmental Release Model trans-1,2-Dichloroethylene* ([U.S. EPA, 2026s](#)): Includes the parameters, calculations, and model release results for the Repackaging OES.
- *Draft Vapor Degreasing Environmental Release Model trans-1,2-Dichloroethylene* ([U.S. EPA, 2026z](#)): Includes the parameters, calculations, and model release results for the Open-top vapor degreasing OES.
- *Draft Aerosol Degreasing Environmental Release Model trans-1,2-Dichloroethylene* ([U.S. EPA, 2026b](#)): Includes the parameters, calculations, and model release results for the Formulation of adhesives and sealants OES.
- *Draft Use of Adhesives Environmental Release Model trans-1,2-Dichloroethylene* ([U.S. EPA, 2026y](#)): Includes the parameters, calculations, and model release results for the Use of adhesives

and sealants OES.

- *Draft Use of Laboratory Chemicals Environmental Release Model for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026o](#)): Includes the parameters, calculations, and model release results for the Use of laboratory chemicals OES.
- *Draft Blowing Agent in Spray Foam Environmental Release Model for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026e](#)): Includes the parameters, calculations, and model release results for the Blowing agent in spray foam OES

4.1 Approach and Methodology

4.1.1 Identify and Describe Occupational Exposure Scenarios Identify Occupational Exposure Scenarios to Assess

The COUs for *trans*-1,2-dichloroethylene are identified in Table 1-1 of the *Draft Risk Evaluation for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)). The first step was to identify the occupational exposure scenario(s) (OESs) associated with the COUs described here. The OES break down a COU into more granular scenarios that are needed because there can be multiple possible scenarios for a COU and the available data and risk associated with each may be different. The difference between a COU and an OES is illustrated in Figure 4-1.

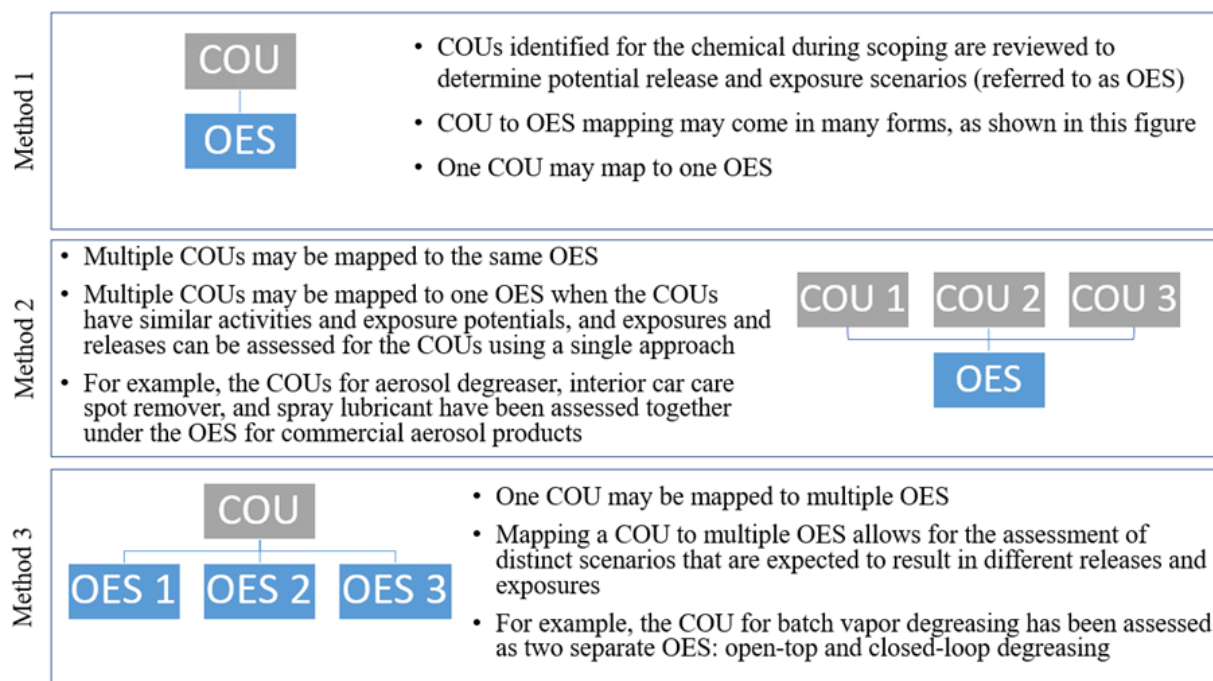


Figure 4-1. Condition of Use to Occupational Exposure Scenario Mapping

EPA followed the logic within Figure 4-1 along with considerations of data and method availability to identify the OES to be assessed for the chemical. Table 4-1 below provides a crosswalk of the 16 OESs that are being assessed for *trans*-1,2-dichloroethylene with the COUs that have been identified.

2002
2003

Table 4-1. Crosswalk of Conditions of Use (COUs) to Assessed Occupational Exposure Scenarios (OESs) for *trans*-1,2-Dichloroethylene

COUs			OESs for Assessment
Life Cycle Stage ^a	Category ^b	Subcategory ^c	
Manufacture	Domestic manufacture	N/A	Manufacturing as Primary Product (OES #1)
			Manufacturing as Byproduct (OES #2)
	Import	N/A	Repackaging (OES #3)
Processing	Processing as a reactant	Intermediate	Processing as a Reactant (OES #4)
	Incorporation into formulation, mixture or reaction product	Solvents (Which become part of product formulation or mixture)	Incorporation into Formulation, Mixture, or Reaction Product (OES #5)
		Solvents (For semiconductor manufacturing)	
	Incorporation into articles	N/A	Blowing Agent in Spray Foam (OES #11)
	Repackaging	N/A	Repackaging (OES #3)
	Recycling	N/A	Waste Handling, Disposal, Treatment, and Recycling (OES #15)
Industrial / Commercial use	Cleaning agent	Vapor degreasing	Vapor Degreasing (OES #6)
		Non-aerosol cleaner/degreaser	Miscellaneous Non-Aerosol Industrial and Commercial Uses (Cleaning and Degreasing Agents, Lubricants and Greases, Mold Release) (OES #7)
		Aerosol spray cleaner/degreaser	Commercial Aerosol Products (Aerosol Degreasing, Aerosol Lubricants, Mold Release) (OES #8)
	Surface modifier	Smoothing fluid in additive manufacturing	Vapor Degreasing (OES #6)
	Anti-adhesive/cohesive	Mold release	Miscellaneous Non-Aerosol Industrial and Commercial Uses (Cleaning and Degreasing Agents, Lubricants and Greases, Mold Release) (OES #7)
			Commercial Aerosol Products (Aerosol Degreasing, Aerosol Lubricants, Mold Release) (OES #8)
	Paints and Coatings	Urethane coatings	Application of Paints and Coatings (OES #9)
	Lubricants and greases	N/A	Commercial Aerosol Products (Aerosol Degreasing, Aerosol Lubricants, Mold Release) (OES #8)
	Adhesion/cohesion promoter	Solvent-based adhesives, sealants, and adhesive accelerants	Application of Adhesives and Sealants (OES #10)

COUs			OESs for Assessment
Life Cycle Stage ^a	Category ^b	Subcategory ^c	
Industrial / Commercial use	Refrigerants	N/A	Refrigerant Flush (<i>OES #13</i>)
	Processing aids	Semiconductor and photovoltaic agents for etching and cleaning processes in electronic articles	Processing Aid in Semiconductor Manufacturing (<i>OES #14</i>)
	Other uses	Specialized detection indicator paints	Miscellaneous Non-Aerosol Industrial and Commercial Uses (Cleaning and Degreasing Agents, Lubricants and Greases, Mold Release) (<i>OES #7</i>)
			Commercial Aerosol Products (Aerosol Degreasing, Aerosol Lubricants, Mold Release) (<i>OES #8</i>)
	Other uses	Laboratory chemical	Laboratory Use (<i>OES #12</i>)
	Propellants, non-motive (Blowing agent)	Polymer foam	Blowing Agent in Spray Foam (<i>OES #11</i>)
Disposal	N/A	N/A	Waste Handling, Disposal, Treatment, and Recycling (<i>OES #15</i>)
Distribution in commerce	N/A	N/A	Distribution in Commerce (<i>OES #16</i>) ^d

^a Life Cycle Stage Use Definitions (40 CFR 711.3)
– “Industrial use” means use at a site at which 1 or more chemicals or mixtures are manufactured (including imported) or processed.
– “Commercial use” means the use of a chemical or a mixture containing a chemical (including as part of an article) in a commercial enterprise providing saleable goods or services.
– “Consumer use” means the use of a chemical or a mixture containing a chemical (including as part of an article, such as furniture or clothing) when sold to or made available to consumers for their use.
– Although EPA has identified both industrial and commercial uses here for purposes of distinguishing scenarios in this document, the Agency interprets the authority over “any manner or method of commercial use” under TSCA section 6(a)(5) to reach both.

^b These categories of conditions of use (COUs) appear in the life cycle diagram, reflect CDR codes, and broadly represent COUs of *trans*-1,2-dichloroethylene in industrial and/or commercial settings.

^c These subcategories reflect more specific COUs of *trans*-1,2-dichloroethylene.

^d Releases and exposures during distribution in commerce are not quantitatively assessed in the draft risk evaluation. Consumer uses are not assigned to OESs but are assessed elsewhere in this draft TSD and the draft risk evaluation.

4.1.2 Estimating Releases for OES – Facility Reported Data

First, EPA attempted to estimate releases using release data reported by facilities to publicly available databases. These sources provided chemical-specific releases from the facility and included key facility identification information that can be used by EPA in the next step of risk evaluation which involves modeling to estimate environmental media concentrations. This is a “top-down” approach for estimating releases in which the release data used is for overall releases from the facility, which can come from multiple individual sources of release within the facility. Because *trans*-1,2-dichloroethylene is not reported in the National Emissions Inventory (NEI), EPA relies on two main data sources for facility-reported release data that are described in more detail below.

4.1.2.1 Toxic Release Inventory (TRI)

Data Used by EPA

The TRI database includes facility-specific information on disposal and other releases of *trans*-1,2-dichloroethylene to air, water, and land ([U.S. EPA, 2022c](#)). The release data were reported in lb/year. EPA downloaded available water, air, and land release data from TRI. EPA's practice for risk evaluations is to analyze the five most recent reporting years for TRI data available at the time the risk evaluation analysis work begins to allow for consideration of trends in release rates. For TRI, release data for the reporting years from 2019 through 2023 were used as follows:

- Air emissions in TRI are reported separately for stack air and fugitive air and occur on-site at the facility.
- Water releases in TRI include both reports of annual direct discharges to surface water and annual indirect discharges to off-site POTWs and wastewater treatment (WWT) facilities.
- Land releases in TRI provide the type of release media for a particular facility, as well as how the chemical is managed through recycling, energy recovery, or treatment.

Methods Facilities Use to Estimate Releases

For each release quantity reported, TRI filers select a "basis of estimate" code to indicate the principal method used to determine the release quantity. TRI provides six bases of estimate codes, which (in no particular order) are continuous monitoring, periodic monitoring, mass balance calculations, published emission factors, site-specific emission factors, and engineering calculations/best engineering judgment. For facilities that use a TRI chemical in multiple operations, the filer may use a combination of methods to calculate the overall release quantity. In such cases, TRI instructs the facility to enter the basis of estimate code for the method that corresponds to the largest portion of the reported release quantity.² Additional details on the basis for the reported release estimate (*e.g.*, calculations, underlying assumptions) are not reported in TRI.

Methods EPA Used to Obtain Data for the Risk Evaluation

EPA obtained 2019 to 2023 TRI data for 1,2-dichloroethylene (CASRN 540-59-0), which includes both *cis*- and *trans*- isomers from EPA's Basic Plus Data Files that collectively contain all the data submitted by facilities on the TRI reporting Form R and Form A for a specific year. The Agency followed a similar approach to estimate air, water, and land releases.

Facilities Required to Report to TRI

A facility is required to report to TRI if it has 10 or more full-time employees; is included in an applicable North American Industry Classification System (NAICS) code; and manufactures, processes, or uses specific chemicals in quantities greater than specified thresholds.³ For 1,2-dichloroethylene, the reporting threshold more than 25,000 lb manufactured or processed, or more than 10,000 lb used during the reporting year. Facilities provide on-site release information using readily available data (including monitoring data) collected pursuant to other provisions of law, or where such data are not readily available, "reasonable estimates" of the amounts released.

Methods EPA Used to Map Facility TRI Data to OES

TRI does not include a text field which provides descriptive information on the activities of the chemical at the facility reporting the release to help with mapping the facility to the appropriate OES. However,

² See TRI Program Guidance on EPA's GuideME website under Reporting Forms and Instructions, Section 5. Quantity of the Toxic Chemical Entering Each Environmental Medium On-Site (Form R).

³ See <https://trimewebmod.epa.gov/cdx-tri-threshold-screening-tool/action/home/view/tri> (accessed July 7, 2026)

there are metadata in the TRI database such as facility-specific information like name, address, NAICS code, and/or TRI use code.

In some cases, there are multiple TRI use codes reported by a given facility. To determine the OES for these facilities, EPA used the CDR, NAICS codes, and internet searches to determine the type of products and operations at the facility.

Release Metrics EPA Calculated from the TRI Release Data

EPA used the reported annual releases directly as reported in TRI. EPA then divided the annual releases over the number of estimated operating days to obtain daily average release estimates. EPA presented the release data as high-end and central tendency estimates in kg/site-yr and kg/site-day. Release estimates are separated by stack and fugitive air emissions, surface water discharges, and land releases.

4.1.2.2 Discharge Monitoring Reports (DMR)

Data Used by EPA

DMR includes facility-specific information on releases of *trans*-1,2-dichloroethylene to water. Under the Clean Water Act (CWA), EPA regulates the discharge of pollutants into receiving waters through the National Pollutant Discharge Elimination System (NPDES). A NPDES permit authorizes facilities to discharge pollutants up to specified limits and requires facilities to monitor their discharges and report the results to EPA and the state regulatory agency in DMRs. As with TRI, EPA used DMR release data for the reporting years from 2019 through 2023.

Overlap with TRI

Both DMR and TRI include facility-reported estimates of annual direct discharges to surface water in lb per year from industrial facilities. In some cases, a facility may report to both programs, leading to partial overlap in facilities and surface water release data.

Methods Used by Facilities to Estimate Their Releases

NPDES permits contain monitoring requirements including the mass (or other measurement specified in the permit) of *trans*-1,2-dichloroethylene allowed in the permit and the volume of effluent discharged from each outfall. Permits specify the type, intervals, and frequency of monitoring. Facilities are required to collect samples and conduct sample analysis using EPA-approved methods specified in the permit. Facilities use measured concentrations or mass of *trans*-1,2-dichloroethylene, along with effluent discharge volume, to estimate an annual release reported to DMR.

Methods Used by EPA to Obtain Data for the Risk Evaluation

EPA makes the reported data publicly available via EPA's Enforcement and Compliance History Online (ECHO) system and EPA's Water Pollutant Loading Tool (Loading Tool). The data collected are annual release data (lb/yr) for a given reporting year.

EPA downloaded DMR from reporting years 2019 through 2023 ([U.S. EPA, 2022b](#)) using ECHO system and the Loading Tool.

Methods Used by EPA to Map Facility DMR Data to an OES

DMR does not include a text field which provides descriptive information on the activities of the chemical at the facility reporting the release to help with mapping the facility to the appropriate OES. However, there are metadata in the DMR data such as facility-specific information on the name, address, NAICS code, and/or Standard Industrial Classification (SIC) code. In some cases, EPA assigned the

OES by reviewing CDR and TRI reports for all chemicals reported by the facility or conducting an internet search of the type of products and operations at the facility.

Release Metrics EPA Calculates from the DMR Data

Where available, EPA used DMR data to estimate annual wastewater discharges, average daily wastewater discharges, and high-end daily wastewater discharges in kg/site-yr and kg/site-day. For DMR, annual discharges are automatically calculated by the Loading Tool based on the sum of the discharges associated with each monitoring period in DMR. Monitoring periods in DMR are set by each facility's NPDES permit and can vary between facilities. Typical monitoring periods in DMR include monthly, bimonthly, quarterly, biannual, and annual reporting.

Treatment of Non-Detects

In instances where a facility reports a period's monitoring results as below the LOD (also referred to as a non-detect or ND) for a pollutant, the Loading Tool applies a hybrid method to estimate the wastewater discharge for the period. The hybrid method sets the values to half of the LOD if there was at least one detected value in the facility's DMRs in a calendar year. If all values were less than the LOD in a calendar year, the annual load is set to zero. EPA included emissions below the LOD in the release estimates. To estimate daily discharges, the Agency divided the annual discharges over the number of estimated operating days.

4.1.3 Estimating Releases for OES – Modeling Approaches

EPA reviewed the reported release data from facilities mapped to OES to determine if there were sufficient release data for the OES. For those OESs that did not have sufficient release data, EPA also conducted environmental release modeling to augment the analysis for the OES.

EPA has documented its rationale for including release modeling and where release modeling was done, the Agency also included the available facility-reported release data for the OES.

EPA's rationale for modeling to estimate releases for *trans*-1,2-dichloroethylene was when the following occurred:

- Releases are expected for an OES but TRI and/or DMR data or release data from systematic review are not available; and
- EPA has a release model available to estimate releases for the OES.

Release Modeling Approach

Release modeling is a "bottom-up" approach for estimating releases. EPA utilizes GSs and ESDs to provide detailed process descriptions that identify sources of releases from the process. Both sources also provide estimation methods for key parameters to estimate magnitude of releases from a facility such as the facility throughput in kg/site-day.

See Appendix A.1 for the standard models that have been previously developed by EPA, which are used to estimate releases for the individual sources of release within the process. The models include loss fraction models as well as models for estimating chemical vapor, land, and water release generation rates. For air releases, EPA uses both box model and near-field modeling approaches to estimate air emission rates from each emission point and from the overall process.

Key Steps in Release Modeling

EPA used the following approach to obtain central tendency and high-end release estimates:

1. Identify release sources and media of release for facilities within the OES.

2. Identify model input parameters from relevant literature sources, GSs, or ESDs. Model input parameters include the estimated number of sites, container size, mass fractions, and *trans*-1,2-dichloroethylene's physical properties. If a range of input values is available for an input parameter, determine the associated distribution of input values.
3. Identify estimation methods to estimate the release from the release source based on relevant GSs or ESDs and other modeling approaches used by EPA for TSCA Risk Evaluations.
4. Conduct a Monte Carlo simulation to calculate the total *trans*-1,2-dichloroethylene release (by environmental media) across all release sources during each iteration of the simulation.
5. Select the 50th percentile and 95th percentile values to estimate the central tendency and high-end releases, respectively.

For each OES in which EPA modeled releases, the Agency performed a Monte Carlo simulation to capture variability in the model input parameters. The simulation used the Latin hypercube sampling method in @Risk Industrial Edition, Version 7.0.0, which generates a distribution of possible values. The Agency performed the model at 100,000 iterations to capture a broad range of possible input values. The model generates statistics, and EPA selected the 50th percentile and 95th percentile to estimate central tendency and high-end releases, respectively.

4.1.4 Consideration of Engineering Controls

Facilities apply engineering controls to reduce the amount of chemicals emitted from their facilities. This can be driven by regulatory requirements such as permits for air and water discharge. EPA considers release controls in its release assessment as follows:

1. **Facility-Reported Release Data** – The releases reported are releases from the facility in the form of surface water discharges, stack air, and fugitive air releases. Engineering controls to reduce the amount of release would have taken place prior to the estimated amount released from the facility; therefore, the Agency does not apply any additional treatment efficiency in the assessment of these releases.
2. **Releases Estimated from Modeling Approaches** – Releases estimated from models represent the loss from the individual release sources that take place for a process within a facility. At this stage, the process losses have not received any treatment that would be expected for facilities releasing into the environment. EPA does apply treatment efficiencies in estimating the environmental releases from these process losses.
 - Modeled process losses to water – EPA applies a wastewater treatment removal efficiency to the process releases assessed as “releases to water” to estimate the surface water discharge.
 - Modeled process losses to incineration – EPA applies a DRE to estimate the resulting releases from incineration as a stack air release.
 - Modeled process losses to fugitive air – fugitive emissions are defined as “those emissions from a stationary source that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening.” This implies some fraction of the emissions are not controlled. EPA does not further apply a control efficiency to modeled process losses to fugitive air.
 - Modeled process losses to stack air – although *trans*-1,2-dichloroethylene is not classified as a hazardous air pollutant under the Clean Air Act, it is still likely that some form of control is applied to stack air emissions. EPA’s current approach is to consider this qualitatively in the assessment, especially when comparing modeled process losses to air with facility-reported air emissions.
 - Modeled process losses to landfill – EPA estimates the process losses that could be

disposed of in a landfill. Features at the landfill that impact environmental releases from the landfill, for example to groundwater, are considered in Section 7 of this draft TSD.

4.1.5 Assess Weight of Scientific Evidence and Assign Confidence Ratings for Each OES

After the release assessment for an OES is completed, EPA assesses the weight of scientific evidence for the OES and assigns a confidence rating.

Evaluating the Weight of Scientific Evidence

EPA evaluated the weight of scientific evidence supporting the environmental release estimates based on the strengths, limitations, and uncertainties associated with the environmental release estimates.

Assigning a Confidence Rating

The conclusion is summarized using confidence descriptors: Robust, Moderate, Slight, or Indeterminate. EPA considers factors including the quantity and quality of the data/information, applicability of the release data to the OES (including considerations of temporal relevance, locational relevance), and the representativeness of the estimate for the whole industry.

4.2 Industrial and Commercial Release Assessment

This section provides the individual release assessments for each of the 16 OESs for *trans*-1,2-dichloroethylene. Each OES section consists of three main parts:

- **Process Details** – Includes the evidence that EPA found for the OES, process information for the role of *trans*-1,2-dichloroethylene in the OES and information on the weight % of *trans*-1,2-dichloroethylene.
- **Facility Estimates** – This includes EPA's estimates for the production volume (PV) in kg/yr of *trans*-1,2-dichloroethylene for the OES, EPA's estimate of the number of sites for *trans*-1,2-dichloroethylene for the OES and the number of operating days/yr for facilities of this OES.
- **Environmental Release Estimates** – This section presents a summary table of the environmental releases for the OES organized by both environmental media and data source.

4.2.1 Manufacturing as a Primary Product – OES #1

4.2.1.1 OES Details

Manufacturing was identified as a condition of use in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene. EPA identified one manufacturing site as a primary product facility from information from the TDCE Consortium ([Exponent, 2023](#)).

trans-1,2-Dichloroethylene can be produced by direct chlorination of acetylene at 40 °C or a technique involving the dehydrochlorination of 1,1,2-trichloroethane at 500 °C. Such commercial preparations are mixtures of *cis*- and *trans*-1,2-dichloroethene; however, the *trans* isomer is preferred in most industrial applications, which has tended to limit sales of the commercially available mixtures. The *trans* isomer is separated from the mixture through fractional distillation ([ATSDR, 2025](#); [Belpoggi et al., 2012](#)). *trans*-1,2-Dichloroethylene is usually shipped in 208-liter (55-gallon) and 112-liter (30-gallon) steel drums ([Snedecor et al., 2004](#)).

In the 2016, 2020, and 2024 CDR, one company, Eagle US 2 LLC (formerly Axiall Corporation) in Westlake, Louisiana, reported manufacturing *trans*-1,2-dichloroethylene at greater than 90% purity ([U.S. EPA, 2026a, 2020a, 2016b](#)). EPA did not identify data on facility operating schedules. Based on *trans*-1,2-dichloroethylene use as a commodity chemical, the Agency assumes manufacturing plants run

7 days/week, 50 weeks/year or 350 days/year.

4.2.1.2 Facility Estimates

The volume in 2016 was approximately 3 million lb, while the volume was claimed CBI (confidential business information) in 2020 and 2024. The national aggregate production volume of *trans*-1,2-dichloroethylene in 2020 and 2024 was reported as 1 million to less than 10 million lb and 1 million to less than 5 million lb ([U.S. EPA, 2026a](#), [2020a](#), [2016b](#)), respectively. EPA has not identified any other manufacturers of *trans*-1,2-dichloroethylene that produce the chemical as a primary product. Information in the test order indicated that activities occurred either daily or were periodic without greater specificity. EPA assumes manufacturing plants run 7 days/week, 50 weeks/year or 350 days/year. Additionally, the Agency assumes the number of release days per year will be equal to the number of operating days at the facility.

4.2.1.3 Environmental Release Estimates

Surface water, fugitive air, stack air, and land emissions data were available for this OES from 2019 to 2023 DMR, 2019 to 2023 TRI.

The TDCE Consortium Test Order Summary Report provided the company name and facility location of the member that manufactures *trans*-1,2-dichloroethylene as a primary product at the chemical manufacturing facility ([Exponent, 2023](#)).

The facility-provided data on release emissions. EPA estimated the minimum, maximum, 50th, and 95th percentile release metrics for annual emissions (kg/site-yr) using the data points. EPA also calculated daily release estimates (kg/site-day) using facility-reported operating information where available or a default assumption of 350 days/yr.

Annual and daily release estimates are presented in Table 4-2. The facility data already accounts for engineering controls. In 2021, the facility (Westlake US 2 LLC) reported a maximum of 791 kg to DMR and 13 kg to TRI. This is the same facility that reported high DMR releases of 1,2-dichloroethane for several of the years, and it was determined that those releases were related to storm events.

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Table 4-2. Summary of Environmental Releases of *trans*-1,2-Dichloroethylene During Manufacturing as a Primary Product

Environmental Media	Estimated Yearly Release (kg/site-yr)				Number of Release Days ^a	Daily Release (kg/site-day)		Number of Facilities	Number of Data Points ^b	Source
	Minimum	Maximum	Central Tendency	High-End		Central Tendency	High-End			
Surface water	5.9	15	12	15	350	3.5E-2	4.2E-02	1	5	TRI
Surface water	0.46	791	150	710		0.43	2.0	1	4	DMR
Fugitive air	2.1E03	7.0E03	2.3E03	6.5E03		6.6	19	1	5	TRI
Stack air	24	500	220	490		0.62	1.4	1	5	TRI
Land ^c	4.5E-03	1.6	0.11	1.5		3.2E-04	4.2E-03	1	5	TRI
DMR = Discharge Monitoring Report; TRI = Toxics Release Inventory Central tendency estimates correspond to the 50th percentile of data; high-end estimates correspond to the 95th percentile ^a A default of 350 days per year was applied. ^b Data points represent the total number of reports submitted during the years included in the assessment. Because a single facility may report multiple times across the assessed years, the number of data points can exceed the number of facilities. The minimum, maximum, central tendency, and high-end release metrics were calculated based on these data points. ^c Land releases for this OES were reported for the following category: 237 OFF-SITE – RCRA SUBTITLE C LANDFILLS										

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4.2.2 Manufacturing as a Byproduct – OES #2

4.2.2.1 OES Details

trans-1,2-Dichloroethylene is often produced as a byproduct in the chlorination of compounds and recycled as an intermediate for the synthesis of more useful chlorinated ethylenes.

trans-1,2-Dichloroethylene can be formed by continuous oxychlorination of ethylene by use of a cupric chloride–potassium chloride catalyst, as the first step in the manufacture of vinyl chloride ([Snedecor et al., 2004](#); [Mertens, 2000](#)). Approximately, 1.25 lb of mixed chlorinated organic liquids are unintentionally produced per 100 lb of ethylene dichloride manufactured ([VI, 2020](#)).

One site, Geon Oxy Vinyl, in the 2024 CDR, reported that *trans*-1,2-dichloroethylene had a maximum concentration of 1 to 30% ([U.S. EPA, 2026a](#)).

4.2.2.2 Facility Estimates

The national aggregate production volume of *trans*-1,2-dichloroethylene in 2020 and 2024 was reported as 1,000,000 to less than 10,000,000 lb and 1,000,000 to less than 5,000,000 lb ([U.S. EPA, 2026a, 2020a, 2016b](#)), respectively. However, EPA could not determine how much was manufactured as a byproduct.

Using information in CDR and TRI, EPA identified nine facilities that manufacture *trans*-1,2-dichloroethylene as a byproduct. The identities and assigned OESs of facilities that reported the release information used in this section are contained in the documents: *Draft Air Releases for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026d](#)), *Draft Land Releases for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026p](#)), and *Draft Water Releases for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026aa](#)).

EPA assumed that the manufacturing plants producing *trans*-1,2-dichloroethylene as a byproduct run 7 days/week, 50 weeks/year or 350 days/year. EPA assumed the number of release days per year will be equal to the number of operating days at the facility.

4.2.2.3 Environmental Release Estimates

Surface water, fugitive air, stack air, and land emissions data were available for this OES from 2019 to 2023 TRI. Byproduct facilities were identified using TRI use codes indicating byproduct manufacturing.

Each facility provided one or more data points on release emissions. EPA estimated the minimum, maximum, 50th, and 95th percentile release metrics for annual emissions (kg/site-yr) using the data points. EPA also calculated daily release estimates (kg/site-day) using a default assumption of 350 days/yr.

Annual and daily release estimates are presented in Table 4-3. The facility data shown already account for release controls and their associated efficiencies.

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Table 4-3. Summary of Environmental Releases of *trans*-1,2-Dichloroethylene During Manufacturing as a Byproduct

Environmental Media	Estimated Yearly Release (kg/site-yr)				Number of Release Days ^a	Daily Release (kg/site-day)		Number of Facilities	Number of Data Points ^b	Source
	Minimum	Maximum	Central Tendency	High-End		Central Tendency	High-End			
Transfer to non-POTW	21	37	36	37	350	0.10	0.10	1	5	TRI
Fugitive air	0	380	8.6	210		2.5E-02	0.61	9	45	TRI
Stack air	0	160	0.5	79		1.4E-03	0.23	9	45	TRI
Land ^c	0.91	4.9E03	2.5E03	4.7E03		7.1	13	1	2	TRI
TRI = Toxics Release Inventory Central tendency estimates correspond to the 50th percentile of data, and high-end estimates correspond to the 95th percentile. ^a A default of 350 days per year was applied. ^b Data points represent the total number of reports submitted during the years included in the assessment. Because a single facility may report multiple times across the assessed years, the number of data points can exceed the number of facilities. The minimum, maximum, central tendency, and high-end release metrics were calculated based on these data points. ^c Land releases for this OES were reported for the following category: 236 OFF-SITE – OTHER LANDFILLS										

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4.2.3 Repackaging – OES #3

4.2.3.1 Process Description

Repackaging was identified as a use in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene as reported in the 2012 and 2016 CDR ([U.S. EPA, 2019a](#)).

Chemicals such as *trans*-1,2-dichloroethylene may be imported into the United States in bulk via water, air, land, and intermodal shipments ([Tomer and Kane, 2015](#)). These shipments take the form of oceangoing chemical tankers, railcars, tank trucks, and intermodal tank containers. Chemicals shipped in bulk containers may be repackaged into smaller containers for resale, such as drums or bottles. Domestically manufactured commodity chemicals may be shipped within the United States in liquid cargo barges, railcars, tank trucks, tank containers, intermediate bulk containers (IBCs)/totes, and drums. Both imported and domestically manufactured commodity chemicals may be repackaged by wholesalers for resale; for example, repackaging bulk packaging into drums or bottles. The type and size of container will vary depending on customer requirements. In some cases, QC samples may be taken at import and repackaging sites for analyses. Some import facilities may only serve as storage and distribution locations, and repackaging/sampling may not occur at all import facilities. EPA does not expect *trans*-1,2-dichloroethylene to be repackaged every day at repackaging plants; therefore, the Agency assumes repackaging plants use the chemical 6 days/week, 50 weeks/year or 300 days/year.

In the 2016 CDR, Unistar Chemical Inc. reported importing a formulation containing at least 90% *trans*-1,2-dichloroethylene ([U.S. EPA, 2019a](#)).

4.2.3.2 Facility Estimates

There were no reports of repackaged *trans*-1,2-dichloroethylene in 2016, 2020, and 2024 CDR and all reports of importation indicated that the chemical was never present at the site ([U.S. EPA, 2026a](#), [2020a](#), [2016b](#)). Therefore, EPA estimated the total production volume of *trans*-1,2-dichloroethylene imported or repackaged using the CDR reporting threshold limits of either 25,000 lb (11,340 kg) or 5% of a site's reported PV, whichever value was smaller. The Agency considered every site that reported using *trans*-1,2-dichloroethylene to CDR. EPA assumed that sites that claimed their production volume as CBI imported and repackaged 25,000 lb of *trans*-1,2-dichloroethylene annually. The total production volume for this OES was estimated as 75,000 lb/yr (34,019 kg/yr).

Although EPA did find sites that reported repackaging 1,2-dichloroethylene to TRI, the Agency understands that the repackaging occurs after the *trans*-1,2-dichloroethylene is incorporated into a formulation or mixture and will therefore categorize the sites under the Incorporation into Formulation, Mixture, or Reaction Product OES instead of the above OES.

EPA did not identify data on facility operating schedules. The Agency does not expect *trans*-1,2-dichloroethylene to be repackaged every day at repackaging plants. EPA used probabilistic modeling to estimate releases from repackaging plants and estimated annually that facilities use the chemical a minimum of 24 days and a maximum of 119 days.

4.2.3.3 Environmental Release Estimates – Modeled

Rationale for Modeling

EPA did not map any sites to repackaging in programmatic data. Due to the lack of programmatic data available for this OES, EPA estimated releases for repackaging of *trans*-1,2-dichloroethylene using the models, approaches, and media of release described in the July 2022 Chemical Repackaging – Generic

Scenario for Estimating Occupational Exposures and Environmental Releases ([U.S. EPA, 2022a](#)).

Modeled Release Sources

Modeled release sources included:

1. Transfer operation losses to air from unloading *trans*-1,2-dichloroethylene,
2. Product sampling waste disposed to incineration or landfill,
3. Open surface losses to air during product sampling,
4. Import container residue released to incineration or landfill,
5. Open surface losses to air during container cleaning,
6. Equipment cleaning releases to incineration or landfill,
7. Open surface losses to air during equipment cleaning, and
8. Transfer operation losses to air from packaging *trans*-1,2-dichloroethylene into containers.

Modeling Approach

EPA used model equations and parameters from the Chemical Repackaging – Generic Scenario for Estimating Occupational Exposures and Environmental Releases ([U.S. EPA, 2022a](#)). The Agency performed a Monte Carlo simulation to estimate variability in the model input parameters. The facility annual throughput of *trans*-1,2-dichloroethylene was capped at the TRI processing threshold of 25,000 lb/yr because facilities exceeding this threshold would be expected to report to TRI, and no such reports were identified. The simulation used the Latin hypercube sampling method in @Risk Industrial Edition, Version 8.0.0, which generates a distribution of possible values. The Agency performed the model at 100,000 iterations to capture a broad range of possible values. EPA selected the 50th and 95th percentile to estimate releases.

Key Modeling Parameters

Key modeling parameters used for this OES are presented in Table 4-4. These parameters are applicable to all release sources. Refer to Appendix A.3 for a full list of the model equations and input parameters used in the repackaging model.

Table 4-4. Key Modeling Parameters Used to Model Environmental Releases from Repackaging of *trans*-1,2-Dichloroethylene

Modeling Parameter	Variable Type	Value(s)
Production Volume of <i>trans</i> -1,2-dichloroethylene for this OES	CDR-Derived Value	11,340 kg/yr
Import Container Volume	Triangular Distribution	20–100 gallons; mode of 55 gallons
Container Volume	Triangular Distribution	5–20 gallons; mode of 5 gallons

Environmental Release Estimates

Releases are estimated for each of the release sources listed above, then combined by media. Table 4-5 summarizes the estimated release results for repackaging. The high-end values are the 95th percentile of the respective simulation output and the central tendencies are the 50th percentile. The number of release days are also a result of the simulation output and are dependent on the facility throughput and number of import containers received. The *trans*-1,2-dichloroethylene facility throughput was capped at the *trans*-1,2-dichloroethylene production volume.

Table 4-5. Summary of Modeled Environmental Releases for the Repackaging of *trans*-1,2-Dichloroethylene

Environmental Media	Release Control Efficiency Applied ^a	Annual Release (kg/site-yr)		Minimum and Maximum Number of Release Days ^b	Daily Release (kg/site-day)	
		Central Tendency	High-End		Central Tendency	High-End
Fugitive or stack air	None	15	24	24–119	0.35	0.63
Uncertain Media (Total)	None	275	320		6.4	10
If Landfill	None	275	320		6.4	10
If Incineration	99.99%	2.7E–02	3.2E–02		6.4E–04	1.0E–03

^a Regulations at 40 CFR part 63, Subpart EEE – National Emission Standards for Hazardous Air Pollutants from Hazardous Waste Combustors, require all hazardous waste combustors (incinerators, cement kilns, lightweight aggregate kilns, solid fuel boilers, liquid fuel boilers, and hydrochloric acid production furnaces) to achieve a DRE of 99.99% for each principal organic hazardous constituent (POHC) including *trans*-1,2-dichloroethylene. It is important to note that the incineration DRE should only be applied to OES involving industrial sites and not commercial sites.

^b EPA assumes that the number of operating days is equivalent to the number of drums imported per year (*i.e.*, one drum repackaged per day) but not to exceed 250 operating days per year. The minimum and maximum number of release days presented in this table is based on the number of days that were simulated and are not representative of the central tendency or high-end release estimates. Annual totals may not add up exactly due to rounding.

4.2.4 Processing as a Reactant – OES #4

4.2.4.1 OES Details

Processing as a reactant was identified as a condition use in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene as reported in the 2016 CDR ([U.S. EPA, 2016a](#)). One facility in 2024 CDR also reported processing as a reactant as an industrial use ([U.S. EPA, 2026a](#)).

Processing as a reactant or intermediate is the use of *trans*-1,2-dichloroethylene as a feedstock in the production of another chemical via a chemical reaction in which *trans*-1,2-dichloroethylene is consumed to form the product. EPA did not find specific container information for *trans*-1,2-dichloroethylene used as a reactant; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in tank trucks or rail cars received directly from the manufacturing sites. *trans*-1,2-Dichloroethylene is one of the major feedstock chemicals used in the production of carbon tetrachloride, perchloroethylene and hydrochloric acid ([Dow Chemical, 1988](#)). Other alternative processes may exist; however, no additional specific information was found. In the 2024 CDR, one facility, Geon Oxy Vinyl La Porte Plant in La Porte, TX, reported processing the *trans*-1,2-dichloroethylene that it produced as a byproduct as a reactant. Olin Blue Cube in Freeport Texas also uses *trans*-1,2-dichloroethylene that they manufacture and process it as a reactant.

EPA identified a safety data sheet from Westlake Chemical with recommended use as intermediate, containing 0 to 2% *trans*-1,2-dichloroethylene ([Westlake Vinyls Company L.P., 2015](#)). The Geon Oxy Vinyl La Porte Plant reported a maximum concentration of 1 to 30% *trans*-1,2-dichloroethylene for its use of *trans*-1,2-dichloroethylene as an intermediate ([U.S. EPA, 2026a](#)).

4.2.4.2 Facility Estimates

In the 2024 CDR, one facility, Geon Oxy Vinyl in Laporte, Texas, reported use of *trans*-1,2-

dichloroethylene as an intermediate in the manufacture of all other basic organic chemicals ([U.S. EPA, 2026a](#)), however it claimed the PV as CBI ([U.S. EPA, 2026a](#)). EPA assumes that a fraction of the production volume goes towards this use. Using information from TRI, EPA identified 9 facilities that potentially process *trans*-1,2-dichloroethylene as a reactant. These nine facilities are the same as the facilities that were identified as manufacturers of *trans*-1,2-dichloroethylene as a byproduct, because process facilities frequently reprocess byproducts as reactants into new products. The identities and assigned OESs of facilities that reported the release information used in this section are contained in the documents: *Draft Air Releases for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026d](#)), *Draft Land Releases for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026p](#)), and *Draft Water Releases for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026aa](#)).

Based on *trans*-1,2-dichloroethylene being a commodity chemical, EPA assumes manufacturing plants producing *trans*-1,2-dichloroethylene as a byproduct run 7 days/week, 50 weeks/year or 350 days/year.

4.2.4.3 Environmental Release Estimates

Surface water, fugitive air, stack air, and land emissions data were available for this OES from 2019 to 2023 TRI.

Each facility provided one or more data points on release emissions. EPA estimated the minimum, maximum, 50th, and 95th percentile release metrics for annual emissions (kg/site-yr) using the data points. EPA calculated daily release estimates (kg/site-day) using facility-reported operating information where available, or a default assumption of 350 days/yr.

Annual and daily release estimates are presented in Table 4-6. The facility data shown already account for release controls and their associated efficiencies.

2444

Table 4-6. Summary of Environmental Releases of *trans*-1,2-Dichloroethylene During Processing as a Reactant

Environmental Media	Estimated Yearly Release (kg/site-yr)				Number of Release Days ^a	Daily Release (kg/site-day)		Number of Facilities	Number of Data Points ^b	Source
	Minimum	Maximum	Central Tendency	High-End		Central Tendency	High-End			
Transfer to non-POTW	21	37	36	37	350	0.10	0.10	1	5	TRI
Fugitive air	0	380	8.6	210		2.5E-02	0.61	9	45	TRI
Stack air	0	160	0.5	79		1.4E-03	0.23	9	45	TRI
Land	0.91	4,900	2,500	4,700		7.1	13	1	2	TRI
POTW = publicly owned treatment works; TRI = Toxics Release Inventory Central tendency estimates correspond to the 50th percentile of data, and high-end estimates correspond to the 95th percentile. ^a A default of 350 days per year was applied. ^b Data points represent the total number of reports submitted during the years included in the assessment. Because a single facility may report multiple times across the assessed years, the number of data points can exceed the number of facilities. The minimum, maximum, central tendency, and high-end release metrics were calculated based on these data points. ^c Land releases for this OES were reported for the following category: 236 OFF-SITE – OTHER LANDFILLS										

2445

4.2.5 Incorporation into Formulation, Mixture, or Reaction Product – OES #5

4.2.5.1 OES Details

Incorporation into formulation, mixture, or reaction product was identified as a condition use in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene as reported in the 2016 CDR ([U.S. EPA, 2016a](#)). Three facilities in 2024 CDR also Reported Processing – Incorporation into Formulation, Mixture, or Reaction Product ([U.S. EPA, 2026a](#)).

Incorporation into formulation, mixture or reaction product refers to the process of mixing or blending of several raw materials to obtain a product or mixture. *trans*-1,2-Dichloroethylene can be incorporated into solvents for cleaning or degreasing, solvents which become part of a product formulation or mixture, adhesives and sealants, foam blowing additives, as a carrier solvent in other product formulations, propellant and blowing agents in plastic product manufacturing and flexible polyurethane foam manufacturing, laboratory chemicals, refrigerant/heat transferring fluids, foam sealant/adhesives, lubricants, and mold release agents (([U.S. EPA, 2019a](#); [Wilsonart, 2017](#); [Axiall, 2016](#)), [EPA-HQ-OPPT-2018-0465-0009](#)). In the 2016 CDR, three companies, including Air Products & Chemicals Inc in Carlsbad, CA, Axiall Corporation in Westlake, Louisiana, and Greenchem in West Palm Beach, Florida, reported use of *trans*-1,2-dichloroethylene for incorporation into formulations. In the 2016 and 2020 CDR, Eagle US 2 LLC (formerly Axiall Corporation) and Greenchem reported incorporation into formulation of solvents (for cleaning and degreasing) ([U.S. EPA, 2020a, 2016b](#)). Microcare Corporation, which sells fiber optic cleaning products, sells a product called CleanBlast™, which contains at least 60% *trans*-1,2-dichloroethylene and is used to clean dust, lint, polishing grit, oil, and fingerprints ([MicroCare, 2018](#)).

One company in the 2016 CDR also reported use of *trans*-1,2-dichloroethylene as a reactant in the manufacture of plating agents and surface treating agents. At least one company markets *trans*-1,2-dichloroethylene as “a source of pure hydrochloric acid through a controlled decomposition process in the electronics industry manufacturing and etching of silicon chips” ([Axiall, 2016](#)).

Formulation processes specific to *trans*-1,2-dichloroethylene were not identified; however, several OECD ESDs provide general process descriptions for some of these types of products. For example, adhesive formulation involves mixing together volatile and non-volatile chemical components in sealed, unsealed or heated processes. Sealed processes are most common for adhesive formulation because many adhesives are designed to set or react when exposed to ambient conditions ([OECD, 2009a](#)). Lubricant formulation typically involves the blending of two or more components, including liquid and solid additives, together in a blending vessel ([OECD, 2004](#)). EPA did not find specific container information for *trans*-1,2-dichloroethylene used in formulation; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in tank trucks or rail cars received directly from the manufacturing sites.

EPA identified numerous product SDSs reporting *trans*-1,2-dichloroethylene with a variety of concentrations. The products are listed in Appendix A.

4.2.5.2 Facility Estimates

In the 2024 CDR, multiple facilities reported manufacturing or importing *trans*-1,2-dichloroethylene use in incorporation into formulation, mixture or reaction product. However, the PVs are claimed as confidential business information (CBI).

Four of the five facilities that were identified using information provided by the TDCE Consortium Test Order Summary Report reported release information to TRI. Two additional previously unidentified sites reported release information to TRI. The identities and assigned OESs of facilities that reported the release information used in this section are contained in the documents: *Draft Air Releases for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026d](#)), *Draft Land Releases for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026p](#)), and *Draft Water Releases for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026aa](#)).

The TDCE Consortium Test Order Summary Report ([Exponent, 2023](#)) provided process frequency information for 5 facilities in this OES, but each facility provided a unique response including: daily, weekly, 18 times per month (when occurring), no response, and 24-48 days per year. EPA assumes processing plants run 5 days/week, 50 weeks/year or 250 days/year, as a result of this range of frequencies.

4.2.5.3 Environmental Release Estimates

Surface water, fugitive air, stack air, and land emissions data were available for this OES from 2019 to 2023 TRI. Six facilities provided data points on release emissions. EPA estimated the minimum, maximum, 50th, and 95th percentile release metrics for annual emissions (kg/site-yr) using the data points. EPA calculated daily release estimates (kg/site-day) using a default assumption of 250 days/yr.

Annual and daily release estimates are presented in Table 4-7. The facility data shown already account for release controls and their associated efficiencies.

Table 4-7. Summary of Environmental Releases of *trans*-1,2-Dichloroethylene During Incorporation into Formulation, Mixture, or Reaction Product

Environmental Media	Estimated Yearly Release (kg/site-yr)				Number of Release Days ^a	Daily Release (kg/site-day)		Number of Facilities	Number of Data Points ^b	Source
	Minimum	Maximum	Central Tendency	High-End		Central Tendency	High-End			
Transfer to POTW	0.45	0.45	0.45	0.45	250	1.8E-03	1.8E-03	1	2	TRI
TRI – Form A	227	227	227	227		0.91	0.91	1	1	TRI
Fugitive air	0	670	61	650		0.24	2.6	6	26	TRI
Stack air	0	1,500	2.3	1,300		9.1E-03	5.2	6	26	TRI
Land	160	370	200	350		0.81	1.4	1	3	TRI
TRI = Toxics Release Inventory Central tendency estimates correspond to the 50th percentile of data, and high-end estimates correspond to the 95th percentile. ^a A default of 250 days per year was applied. ^b Data points represent the total number of reports submitted during the years included in the assessment. Because a single facility may report multiple times across the assessed years, the number of data points can exceed the number of facilities. The minimum, maximum, central tendency, and high-end release metrics were calculated based on these data points. ^c Land releases for this OES were reported for the following category: 236 OFF-SITE – OTHER LANDFILLS										

4.2.6 Vapor Degreasing – OES #6

4.2.6.1 OES Details

Vapor degreasing was identified as a use in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene.

trans-1,2-Dichloroethylene is a component in vapor degreasing formulations used as an alternative to chlorofluorocarbons, perchloroethylene and trichloroethylene ([EPA-HQ-OPPT-2018-0465-0006](#)). A commenter ([EPA-HQ-OPPT-2019-0131-0042](#)) provided descriptions of their use of *trans*-1,2-dichloroethylene used as a nonflammable solvent for cleaning hydraulic load control system components, which the commenter also indicated was a critical use, further informing EPA's understanding of this condition of use. This OES also includes use as a smoothing fluid in additive manufacturing as identified in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene.

A comment from 3M indicates that *trans*-1,2-dichloroethylene-containing products are typically distributed to customers in jugs, pails, and 55-gallon drums, though larger volume containers are available up to 300 gallons ([3M, 2019](#)).

Vapor degreasing may take place in batches. In batch machines, each load (parts or baskets of parts) is loaded into the machine after the previous load is completed. EPA assessed releases from open top vapor degreasers (OTVDs). OTVDs may be operated with or without enclosures. The Agency received information from the TDCE Consortium Test Order Summary Report ([Exponent, 2023](#)) about two facilities that used vapor degreasers, which required the workers to open and close a lid when inserting and removing pieces to be cleaned.

In batch OTVDs, a vapor cleaning zone is created by heating the liquid solvent in the OTVD causing it to volatilize. Workers manually load or unload fabricated parts directly into or out of the vapor cleaning zone. The tank usually has chillers along the side of the tank to prevent losses of the solvent to the air. However, these chillers are not able to eliminate 100% of emissions ([NEWMOA, 2001](#)). Figure 4-2 illustrates a standard OTVD.

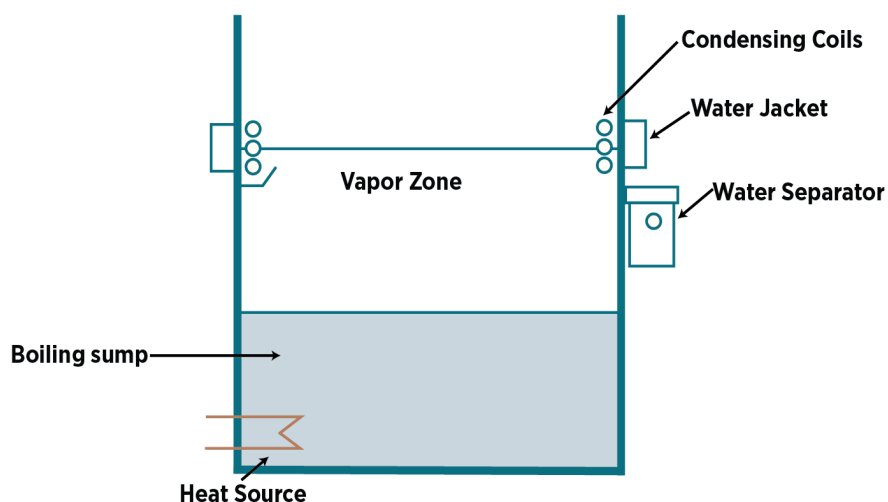


Figure 4-2. Open Top Vapor Degreaser

OTVDs with enclosures operate the same as standard OTVDs, except that the OTVD is enclosed on all sides during degreasing. The enclosure is opened and closed to add or remove parts to/from the machine, and solvent is exposed to the air when the cover is open. Enclosed OTVDs may be vented directly to the atmosphere or first vented to an external carbon filter and then to the atmosphere ([U.S. EPA and ICF Consulting](#)). Figure 4-3 illustrates an OTVD with an enclosure. The dotted lines represent the optional carbon filter that may or may not be used with an enclosed OTVD.

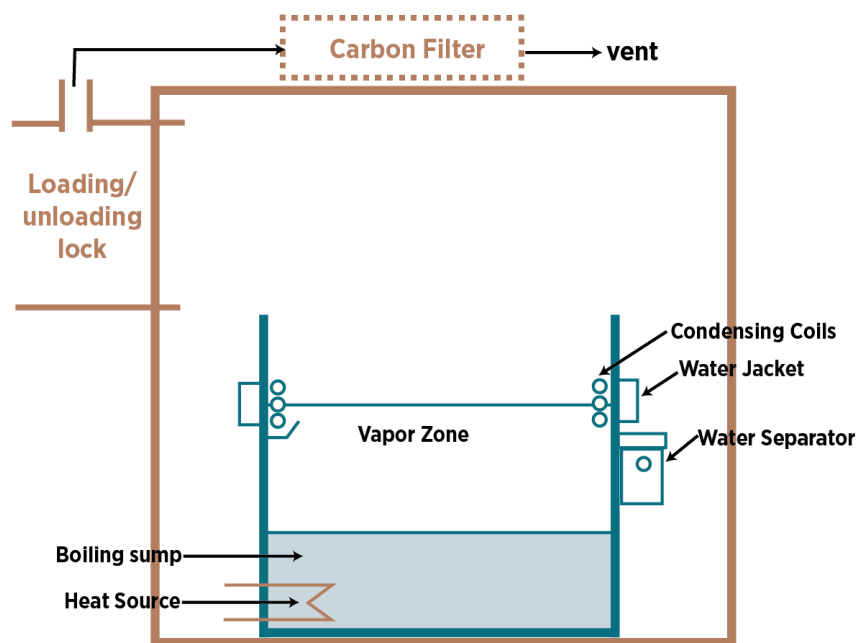


Figure 4-3. Open Top Vapor Degreaser with Enclosure

The ESD on the Use of Vapour Degreasers states that primary vapor degreasing solvents are typically supplied at 80 to 99% (typically >90%) ([OECD, 2021](#)). EPA identified products for vapor degreasers containing *trans*-1,2-dichloroethylene at concentrations of 20 to 100% ([3M, 2019](#); [NuGeneration Technologies LLC, 2018](#); [Axiall, 2016](#)). An SDS for *trans*-1,2-dichloroethylene (60–100% purity) indicates recommended use as an agent ([MicroCare, 2018](#)) that is used for smoothing 3D-printed plastic parts.

4.2.6.2 Facility Estimates

EPA did not identify chemical-specific data on throughputs or facility operating schedules, therefore, the Agency used default values suggested in the December 2021 Emission Scenario Document on the Use of Vapour Degreasers ([OECD, 2021](#)) to model releases for this scenario. The annual solvent use rates range from 78 kg product/site-yr to 79,120 kg product/site-yr. EPA then estimated chemical-specific throughputs by multiplying these product repackaging rates by the expected *trans*-1,2-dichloroethylene concentrations listed in Section 4.2.6.1, resulting in estimated throughputs ranging from 77 to 54,626 kg *trans*-1,2-dichloroethylene/site-yr.

EPA did not identify any sites in DMR or TRI that use products containing *trans*-1,2-dichloroethylene for vapor degreasing. As a result, the Agency modeled releases for this scenario and calculated the number of sites as a model output. The estimated number of sites for this scenario range from 1 to 1,021 sites with a median of 40 and is dependent on the production volume (PV) used in the model.

The TDCE Consortium Test Order Summary Report ([Exponent, 2023](#)) provided process frequency information for 2 facilities in this OES of 255 and 350 days per year that indicated that employees needed to open a lid to insert and remove the parts being cleaned. In accordance with the Emission Scenario Document on the Use of Vapour Degreasers ([OECD, 2021](#)), EPA assumes batch open-top vapor degreasing operations occur 296 days/year.

4.2.6.3 Environmental Release Estimates – Modeled Data

EPA did not identify programmatic released data for this OES. Therefore, the Agency estimated releases for the open-top vapor degreasing using the models and approaches described in the December 2021 Emission Scenario Document on the Use of Vapour Degreasers ([OECD, 2021](#)).

Modeled Release Sources

Modeled release sources included:

1. Release to incineration or landfill from cleaning of transport containers,
2. Release to air during vapor degreasing operations,
3. Release to water from vapor degreasing wastewater, and
4. Release to incineration from cleaning degreasing machine and disposing waste solvent.

Modeling Approach

EPA estimated releases using the model equations and parameters described in the December 2021 Emission Scenario Document on the Use of Vapour Degreasers ([OECD, 2021](#)). EPA performed a Monte Carlo simulation to estimate variability in the model input parameters. The simulation used the Latin hypercube sampling method in @Risk Industrial Edition, Version 8.0.0, which generates a sample of possible values. The Agency performed the model at 100,000 iterations to capture a broad range of possible values. EPA selected the 50th and 95th percentile to estimate releases.

Key Modeling Parameters

The key modeling parameters used for this OES are presented in Table 4-8 below. Refer to Appendix A.4 for a full list of input parameters used in the model.

Table 4-8. Key Modeling Parameters Used to Model Environmental Releases from Vapor Degreasing

Modeling Parameter	Variable Type	Value(s)
Production volume for <i>trans</i> -1,2-dichloroethylene for this OES	ESD-derived value	79,120 kg/yr
Solvent annual use rate	ESD-derived distribution	Fit beta distribution with a minimum of 78 kg/site-yr to a maximum of 79,120 kg/site-yr with $\alpha_1 = 0.49815$ and $\alpha_2 = 9.5451$
Unloading saturation factor	ESD-derived distribution	Triangular distribution from 0.5–1.0 with the mode at 0.5
Daily volume of wastewater discharged	ESD-derived distribution	Uniform distribution from 2–20 gal/day
Loss fraction for vapor degreaser	ESD-derived distribution	Triangular distribution from 0.0084–1.0 with the mode at 0.81
ESD = emissions scenario document		

Environmental Releases

Releases are estimated for each of the release sources listed above, then combined by media. Table 4-9 below summarizes the estimated release results during vapor degreasing. The high-end values are the

2613 95th percentile of the respective simulation output and the central tendencies are the 50th percentile. The
2614 appendix contains the model equations and input parameters used in the Monte Carlo simulation for this
2615 COU.

2616

Table 4-9. Summary of Modeled Environmental Releases for the Vapor Degreasing of *trans*-1,2-Dichloroethylene

Environmental Media	Release Control Efficiency Applied ^a	Annual Release (kg/site-yr)		Number of Release Days	Daily Release (kg/site-day)	
		Central Tendency	High-End		Central Tendency	High-End
Fugitive or stack air	None	1,100	9,500	296	3.6	32
Uncertain media (wastewater treatment, hazardous landfill or incineration)	None	430	600		1.4	2.0
If Wastewater Treatment	73%	120	160		0.39	0.55
If Hazardous Landfill	None	430	600		1.4	2.0
If Incineration	99.99%	4.3E-02	6.0E-02		1.4E-04	2.0E-04
Incineration	99.99%	1.6E-02	0.59		5.3E-05	2.0E-03
Water	73%	18	31		0.060	0.10
^a Regulations at 40 CFR part 63, Subpart EEE – National Emission Standards for Hazardous Air Pollutants from Hazardous Waste Combustors, require all hazardous waste combustors (incinerators, cement kilns, lightweight aggregate kilns, solid fuel boilers, liquid fuel boilers, and hydrochloric acid production furnaces) to achieve a destruction removal efficiency (DRE) of 99.99% for each principal organic hazardous constituent (POHC), including <i>trans</i> -1,2-dichloroethylene. It is important to note that the incineration DRE should only be applied to occupational exposure scenarios (OESs) involving industrial sites and not commercial sites. Annual totals may not add up exactly due to rounding.						

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4.2.7 Misc. Non-Aerosol Industrial and Commercial Uses (Cleaning and Degreasing Agents, Lubricants and Greases, Mold Release) – OES #7

4.2.7.1 OES Details

Cleaning and degreasing agents, lubricants and greases, and mold releasers were identified as uses in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene. *trans*-1,2-dichloroethylene can be incorporated into solvents for cleaning or degreasing, lubricants, and mold release agents (([Axiall, 2016](#)), [EPA-HQ-OPPT-2018-0465-0009](#)).

A commenter ([EPA-HQ-OPPT-2019-0131-0042](#)) provided descriptions of their use (both aerosol and non-aerosol) of *trans*-1,2-dichloroethylene used as a nonflammable solvent for cleaning prior to installation of strain gages for instrumentation on test articles and in electrical fabrication and instrumentation installation to remove flux and other debris from electronic components for human-rated space vehicle hardware and other high performance applications, which the commenter also indicated was a critical use, further informing EPA's understanding of this condition of use. Another commenter ([EPA-HQ-OPPT-2018-0465-0031](#)) indicated cleaning degreasing use in both aerosol and non-aerosol forms, but specific methods were not described. EPA assumes that non-aerosol use may include dip cleaning and/or wipe cleaning.

In dip cleaning processes, the parts to be cleaned are first placed in a basket. Workers will then open the lid of a tank containing solvent and submerge the basket into the tank ([National Electrical Manufacturers Association, 2017](#); [Xiaofei et al., 2000](#)). Once the basket of parts is submerged in the tank, the lid of the tank is closed and the parts soak in the cleaning solution. Sonication or some other form of agitation of the parts may be used to aid in the cleaning process. The basket containing the parts is then lifted from the tank and the parts may be air-dried or may be transferred to a tank containing water to rinse the parts of any residual solvent or solvent-solubilized oil remaining on the surfaces of the parts.

Wipe cleaning involves first wetting towels or rags with cleaning solution or spraying, pouring, or brushing the cleaning solution onto the surfaces to be cleaned. Spray products are deployed from non-pressurized containers, such as bottles, and use a spray nozzle to discharge the liquid at a high velocity to atomize the liquid into fine droplets. Some spray applications use an atomizing gas, such as air, to aid in the atomization of the liquid ([U.S. EPA, 2016d](#)). Workers then manually wipe surfaces clean with towels and rags ([Bader et al., 2006](#)). Any residual cleaning solution on the wiped surfaces is expected to volatilize. The dirty towels and rags may be disposed of entirely or laundered so they may be reused.

EPA did not find specific container information for *trans*-1,2-dichloroethylene used as a solvent for cleaning and degreasing; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in drums or smaller containers received from the formulator. *trans*-1,2-Dichloroethylene is used in solvents for cleaning and degreasing, which is subsequently disposed.

A commenter, AIA, described the use of *trans*-1,2-dichloroethylene as a solvent in silicone-based lubricants in the aerospace industry ([EPA-HQ-OPPT-2018-0465-0006](#)). EPA did not find specific container information for *trans*-1,2-dichloroethylene used as a lubricant or grease; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in drums or smaller containers received from the manufacturer or repackager.

SDSs reported *trans*-1,2-dichloroethylene use in mold release agents, ranging from 25 to 80% in formulation ([Inc, 2018](#); [Chemical, 2016a, b](#)). EPA did not find specific container information for *trans*-1,2-dichloroethylene used as an anti-adhesive agent; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in drums or smaller containers received from the manufacturer or repackager.

4.2.7.2 Facility Estimates

EPA did not identify production volume information for the use of *trans*-1,2-dichloroethylene as a non-aerosol cleaning and degreasing agents, lubricants and greases, or mold release products. One facility, Embecta – Holdredge (the site was previously operated by Beckton Dickinson) of Holdredge, NE provided a total of five data points on release emissions to TRI. Four additional facilities were identified using information provided by the TDCE Consortium Test Order Summary Report ([Exponent, 2023](#)), however EPA does not have release information for these sites. EPA expects this OES to occur 5 days/week, 50 weeks/year or 250 days/year.

4.2.7.1 Environmental Release Estimates

EPA used the TRI information reported by one facility (Embecta – Holdredge) to estimate the minimum, maximum, 50th, and 95th percentile release metrics for annual emissions (kg/site-yr) using the data points. EPA calculated daily release estimates (kg/site-day) using a default assumption of 250 days/yr.

Annual and daily release estimates are presented in Table 4-10 below. The facility data shown already account for release controls and their associated efficiencies.

Table 4-10. Summary of Environmental Releases for Non-Aerosol Degreasing with *trans*-1,2-Dichloroethylene

Environmental Media	Estimated Yearly Release (kg/site-yr)				Number of Release Days ^a	Daily Release (kg/site-day)		Number of Facilities	Number of Data Points ^b	Source
	Minimum	Maximum	Central Tendency	High-End		Central Tendency	High-End			
Fugitive air	6,800	1.3E04	7,100	1.3E04	250	28	51	1	5	TRI
Central tendency estimates correspond to the 50th percentile of data, and high-end estimates correspond to the 95th percentile.										
^a A default of 250 days per year was applied.										
^b Data points represent the total number of reports submitted during the years included in the assessment. Because a single facility may report multiple times across the assessed years, the number of data points can exceed the number of facilities. The minimum, maximum, central tendency, and high-end release metrics were calculated based on these data points.										

4.2.8 Commercial Aerosol Products (Aerosol Degreasing, Aerosol Lubricants, Mold Release) – OES #8

4.2.8.1 OES Details

Aerosol degreasing, lubricants and greases, and mold releasers were identified as uses in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene. *trans*-1,2-dichloroethylene can be incorporated into solvents for cleaning or degreasing, lubricants, and mold release agents (([U.S. EPA, 2019a](#); [Wilsonart, 2017](#); [Axiall, 2016](#)), [EPA-HQ-OPPT-2018-0465-0009](#)).

Aerosol degreasing is a process that uses an aerosolized solvent spray, typically applied from a pressurized can, to remove residual contaminants from fabricated parts. A propellant is used to aerosolize the formulation, allowing it to be sprayed onto substrates. The aerosol droplets bead up on the fabricated part and then drip off, carrying away any contaminants and leaving behind a clean surface. Similarly, aerosol lubricant products use an aerosolized spray to help free frozen parts by dissolving rust and leave behind a residue to protect surfaces against rust and corrosion.

A commenter ([EPA-HQ-OPPT-2019-0131-0042](#)) provided descriptions of their use (both aerosol and non-aerosol) of *trans*-1,2-dichloroethylene used as a nonflammable solvent for cleaning prior to installation of strain gages for instrumentation on test articles and in electrical fabrication and instrumentation installation to remove flux and other debris from electronic components for human-rated space vehicle hardware and other high performance applications, which the commenter also indicated was a critical use, further informing EPA's understanding of this condition of use.

Multiple additional commenters, including ITW Contamination Control, the AIA, and 3M, described the use of *trans*-1,2-dichloroethylene as an aerosol solvent cleaner ([EPA-HQ-OPPT-2018-0465-003](#); [EPA-HQ-OPPT-2018-0465-006](#); [EPA-HQ-OPPT-2018-0465-009](#)).

One example of a commercial setting with aerosol degreasing operations is repair shops, where service items are cleaned to remove any contaminants that would otherwise compromise the service item's operation. Internal components may be cleaned in place or removed from the service item, cleaned, and then re-installed once dry ([U.S. EPA, 2014b](#)). EPA did not find specific container information for *trans*-1,2-dichloroethylene used as an aerosol product; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in drums or smaller containers received from the manufacturer or repackager.

An SDS reported use *trans*-1,2-dichloroethylene in a cleaning aid and lubricant, between 15 and 40% ([Rainbow Technology Corporation, 2019](#)). The product data sheet indicates that it is used as a spray cleaner/degreaser in various applications ([Rainbow Technology Corporation](#)). Therefore, this use may be similar to aerosol degreasing uses. EPA did not find specific container information for *trans*-1,2-dichloroethylene used as a lubricant or grease; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in drums or smaller containers received from the manufacturer or repackager.

3M offers four aerosol-formatted industrial cleaning products which contain 15 to 75% *trans*-1,2-dichloroethylene. The aerosol-formatted products are distributed to 3M customers in the form of carbon dioxide-pressurized, 12-ounce, handheld aerosol cans. EPA also identified SDSs that identify the use of *trans*-1,2-dichloroethylene in aerosol cleaners and degreasers ([Company, 2019](#); [Corporation, 2018](#); [CRC Industries Inc., 2017a, b, c, d, e](#); [Associates, 2016](#); [Axiall, 2016](#); [Illinois Tool Works Inc, 2014](#); [Unistar Chemical Inc, 2003](#)).

SDSs reported *trans*-1,2-dichloroethylene use in mold release agents, ranging from 25 to 80% ([Inc, 2018](#); [Chemical, 2016a, b](#)). Separately, a product data sheet for an aerosol cleaning aid and lubricant also indicated potential use as a mold release agent ([Rainbow Technology Corporation, 2019](#)); therefore, aerosol use is possible. EPA did not find specific container information for *trans*-1,2-dichloroethylene used as an anti-adhesive agent; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in drums or smaller containers received from the manufacturer or repackager.

4.2.8.2 Facility Estimates

EPA did not identify production volume information for the use of *trans*-1,2-dichloroethylene as an aerosol degreaser. The Agency did not identify any facilities using programmatic data from DMR, or TRI. EPA modeled the releases from one generic site using *trans*-1,2-dichloroethylene as an aerosol degreaser during automotive maintenance and repair activities based upon information from California Air Resources Board (CARB) ([2000](#)). Two facilities were identified using information provided by the TDCE Consortium Test Order Summary Report ([Exponent, 2023](#)); however, EPA does not have release information for these sites. EPA expects this OES to occur 5 days/week, 50 weeks/year or 250 days/year.

4.2.8.3 Environmental Release Estimates – Modeled Data

Rationale for Modeling

EPA did not identify programmatic release data for this OES. Therefore, EPA estimated releases for the commercial aerosol uses of *trans*-1,2-dichloroethylene using the models and approaches described in Appendix A.5.

Modeled Release Sources

Modeled release sources included the following:

1. Aerosol Degreasing Spray Losses.

EPA estimated releases using the model equations and parameters described in Appendix A.5. The Agency performed a Monte Carlo simulation to estimate variability in the model input parameters. The facility annual throughput of *trans*-1,2-dichloroethylene was capped at the maximum annual site use threshold of 34,019.43 kg/yr identified within the Emission Scenario Document. The simulation used the Latin hypercube sampling method in @Risk Industrial Edition, Version 8.0.0, which generates a distribution of possible values. The Agency performed the model at 100,000 iterations to capture a broad range of possible values. EPA selected the 50th and 95th percentile to estimate releases.

The key modeling parameters used for this OES are presented below in Table 4-11. Refer to Appendix A.5 for a full list of input parameters used in the model.

Table 4-11. Key Modeling Parameters Used to Model Environmental Releases from Commercial Aerosol Uses of *trans*-1,2-Dichloroethylene

Modeling Parameter	Variable Type	Value(s)
Concentration of <i>trans</i> -1,2-dichloroethylene used	Concentrations from product information	Discreet distribution ranging from 1–100% by weight
Amount of degreaser used per application	Servicing Parameters from CARB Data	152 g degreaser per application
Number of degreaser applications per brake	Brake Servicing Parameters from CARB Data	3 or 4 degreaser applications per brake

Modeling Parameter	Variable Type	Value(s)
Number of Brakes per Job	Brake Servicing Parameters from CARB Data	2 or 4 brakes per job

Environmental Releases

Releases are estimated for each of the release sources listed above, then combined by media. Table 4-12 summarizes the estimated release results during the use of commercial aerosol products. The high-end values are the 95th percentile of the respective simulation output and the central tendencies are the 50th percentile. Appendix A.5 contains the model equations and input parameters used in the Monte Carlo simulation for this COU.

2774 **Table 4-12. Summary of Modeled Environmental Releases for the Aerosol Degreasing of *trans*-1,2-Dichloroethylene**

Modeled Scenario	Environmental Media	Release Control Efficiency Applied ^a	Annual Release (kg/site-yr) ^a		Number of Release Days	Daily Release (kg/site-day)	
			Central Tendency	High-End		Central Tendency	High-End
One facility	Fugitive air	None	660	1,400	250	2.6	5.5
^a Annual release totals may not precisely match the daily release totals exactly due to rounding.							

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4.2.9 Application of Paints and Coatings – OES #9

4.2.9.1 OES Details

Urethane coatings was identified as a use in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene.

Application processes specific to *trans*-1,2-dichloroethylene were not identified. Several OECD ESDs and EPA generic scenarios provide general process descriptions and worker activities for industrial and commercial uses. The ESD on Radiation Curable Coatings, Inks, and Adhesives indicates that, before application onto substrates, paint and coating formulations may be diluted and are then charged into application equipment (OECD, 2011, 6568745). Typical coating applications include manual application with roller or brush, air spray systems, airless and air-assisted airless spray systems, electrostatic spray systems, electrodeposition/electrocoating and auto deposition, dip coating, curtain coating systems, roll coating systems, and supercritical carbon dioxide systems (OECD, 2011, 6568745). After application, solvent-based coatings typically undergo a drying stage in which the solvent evaporates from the coating (OECD, 2011, 6568745).

EPA did not find specific container information for *trans*-1,2-dichloroethylene used as a solvent; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in drums or smaller containers received from the manufacturer or repackager.

A safety data sheet for *trans*-1,2-dichloroethylene (55–65% purity) indicates recommended use as a urethane conformal coating by aerosol spray application ([Chemical, 2016a](#)).

4.2.9.2 Facility Estimates

EPA did not identify production volume information for the use of *trans*-1,2-dichloroethylene in paints and coatings. The Agency did not identify any facilities using programmatic data from DMR and TRI. As a result, EPA modeled releases for this scenario and calculated the number of sites as a model output. The estimated number of sites for this scenario range from 1 to 494,000 sites with a median of 291 and is dependent upon the PV used in the model. EPA expects this OES to occur 5 days/week, 50 weeks/year or 250 days/year.

4.2.9.3 Release Assessment

Rationale for Modeling

EPA did not identify programmatic release data for this OES. Therefore, the Agency estimated releases from the use of *trans*-1,2-dichloroethylene in paints and coatings using the models and approaches described in the ESD on use of adhesives ([OECD, 2015](#)).

Modeled Release Sources

Modeled release sources include the following:

1. Release to incineration or landfill from container residue losses,
2. Release to air from open surface losses during container cleaning,
3. Release to air from transfer operation losses during unloading liquid chemicals,
4. Release to incineration or landfill during equipment cleaning,
5. Release to air during equipment cleaning, and
6. Release to air from evaporative losses during curing/drying.

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Modeling Approach

EPA used model equations and parameters from the Emission Scenario Document on the Use of Adhesives ([OECD, 2015](#)), because EPA lacked information on the throughput of paints used in commercial and industrial facilities. EPA performed a Monte Carlo simulation to estimate variability in the model input parameters. The simulation used the Latin hypercube sampling method in @Risk Industrial Edition, Version 8.0.0, which generates a sample of possible values. The Agency performed the model at 100,000 iterations to capture a broad range of possible values. EPA selected the 50th and 95th percentile to estimate releases.

Key Modeling Parameters

The key modeling parameters used for this OES are presented in Table 4-13. Refer to Appendix A.6 for a full list of input parameters used in the model.

Table 4-13. Key Modeling Parameters Used to Model Environmental Releases from Application of Paints and Coatings

Modeling Parameter	Variable Type	Value(s)
Production Volume for <i>trans</i> -1,2-dichloroethylene for this OES	GS-Derived Value	534,120 kg/yr
Operating Days	GS-Derived Value	49–251 days/yr
Annual facility adhesive product use rate	GS-Derived Value	Triangular Distribution: 1.0E03 to 1.0E6 kg/site-yr; Mode: 1.4E05
Concentration of <i>trans</i> -1,2-dichloroethylene used	Concentrations from product information	Discreet distribution ranging from 1–70% by weight

Environmental Releases

Releases are estimated for each of the release sources listed above, then combined by media. Table 4-14 summarizes the estimated release results during the application of paints and coatings. The high-end values are the 95th percentile of the respective simulation output and the central tendencies are the 50th percentile. The appendix contains the model equations and input parameters used in the Monte Carlo simulation for this OES.

Table 4-14. Summary of Modeled Environmental Releases of *trans*-1,2-Dichloroethylene During Application of Paints and Coatings

Environmental Media	Release Control Efficiency Applied ^a	Annual Release (kg/site-yr)		Number of Release Days ^b		Daily Release (kg/site-day)	
		Central Tendency	High-End	Central Tendency	High-End	Central Tendency	High-End
Fugitive or stack air	None	1,800	170,000	50	250	10	1,200
Uncertain Media (Hazardous Landfill or Incineration)	None	63	6,600			0.36	42
If Hazardous Landfill	None	63	6,600			0.36	42
If Incineration	99.99%	6.3E–03	0.66			3.6E–05	4.2E–03

Environmental Media	Release Control Efficiency Applied ^a	Annual Release (kg/site-yr)		Number of Release Days ^b		Daily Release (kg/site-day)	
		Central Tendency	High-End	Central Tendency	High-End	Central Tendency	High-End
^a Regulations at 40 CFR part 63, Subpart EEE – National Emission Standards for Hazardous Air Pollutants from Hazardous Waste Combustors, require all hazardous waste combustors (incinerators, cement kilns, lightweight aggregate kilns, solid fuel boilers, liquid fuel boilers, and hydrochloric acid production furnaces) to achieve a DRE of 99.99% for each principal organic hazardous constituent (POHC) including <i>trans</i> -1,2-dichloroethylene. It is important to note that the incineration DRE should only be applied to OES involving industrial sites and not commercial sites.							
^b EPA assumes that the number of operating days is equivalent to the number of drums imported per year (<i>i.e.</i> , one drum repackaged per day) but not to exceed 250 operating days per year. The number of release days presented in this table is based on simulation outputs for the annual release divided by the daily release (grouped by high-end or central tendency estimate), rounded to the closest integer. Annual totals may not add up exactly due to rounding.							

4.2.10 Adhesives and Sealants – OES #10

4.2.10.1 OES Details

The use of *trans*-1,2-dichloroethylene in solvent-based adhesives and sealants was identified in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene.

trans-1,2-Dichloroethylene-specific adhesive or sealant uses were not identified. The OECD ESD for Use of Adhesives ([OECD, 2013](#)) provides general process descriptions and worker activities for industrial adhesive uses, which may include application by spray, brush, or roll coating.

Both batch processing and dedicated-line facilities employ basically the same process flow. Incoming coating formulation raw materials are blended in mix tanks or drums with high- or variable-speed dispersers. The dedicated-line facilities typically formulate a coating from resins (*e.g.*, natural or synthetic rubbers), solvents, and additives. Batch processors often mix purchased blends with performance enhancing additives or use and apply coatings premixed by a supplier. Only a small percentage of the coatings used by a batch processor is mixed from scratch. After the coatings have been mixed, they are pumped via a manifold system to the appropriate coating application system. Both industry segments use the same types of application equipment, including direct and reverse roll coaters and gravure cylinders. While a dedicated-line facility may have a cylinder library consisting of 10 gravure cylinders (1 for each coating thickness), the batch processor might have a library consisting of several hundred gravure cylinders, each one dedicated to a certain coating thickness for a specific customer. Similarly, a dedicated-line facility limits itself to a single type of substrate (*e.g.*, film) with varying thicknesses, weights, and/or widths. A batch processor uses a variety of substrates, often including films, papers, foils, and foams. The substrate webs are loaded onto an unwinder. The substrate is guided by idling rolls to a coating application station where the appropriate coating is applied. Once the coating has been applied, it enters an oven (typically zoned) for drying. The dried substrate is then ready for the second coating, laminating, or winding. Following its final rewind, the coated, and possibly laminated, web is slit according to customer specifications (if necessary), packaged, and shipped ([Nunez et al., 1996](#)).

EPA did not find specific container information for *trans*-1,2-dichloroethylene used as an adhesive or sealant; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in drums or smaller containers received from the manufacturer or repackager.

One commenter, Wilsonart, provided EPA with an SDS of their WA NF742/NF743 Canister Adhesive, which contains 40 to 70% *trans*-1,2-dichloroethylene (Wilsonart, 2017). Another commenter, Permabond LLC, provided EPA with a SDS of their Permabond ASC10 adhesive accelerator, which contains 5-10% *trans*-1,2-dichloroethylene (Permabond Engineering Adhesives, 2018).

4.2.10.1 Facility Estimates

EPA did not identify production volume information for the use of *trans*-1,2-dichloroethylene in adhesives and sealants. The Agency did not identify any facilities using programmatic data from DMR and TRI. As a result, EPA modeled releases for this scenario and calculated the number of sites as a model output. The estimated number of sites for this scenario range from 1 to 494,000 sites with a median of 291 and is dependent upon the PV used in the model. EPA expects this OES to occur 5 days/week, 50 weeks/year or 250 days/year. One source identified by EPA stated that EB and UV printing operations were performed for 4,000 hours/year (Nunez et al., 1996).

4.2.10.2 Release Assessment

Rationale for Modeling

EPA did not identify programmatic release data for this OES. Therefore, EPA estimated releases from the use of *trans*-1,2-dichloroethylene in adhesives and sealants using the models and approaches described in the emission scenario document on use of adhesives (OECD, 2015).

Modeled Release Sources

Modeled release sources included the following:

1. Release to incineration or landfill from container residue losses,
2. Release to air from open surface losses during container cleaning,
3. Release to air from transfer operation losses during unloading liquid chemicals,
4. Release to incineration or landfill during equipment cleaning,
5. Release to air during equipment cleaning, and
6. Release to air from evaporative losses during curing/drying.

Modeling Approach

EPA used model equations and parameters from the ESD on the Use of Adhesives (OECD, 2015). EPA performed a Monte Carlo simulation to estimate variability in the model input parameters. The simulation used the Latin hypercube sampling method in @Risk Industrial Edition, Version 8.0.0, which generates a distribution of possible values. The Agency performed the model at 100,000 iterations to capture a broad range of possible values. EPA selected the 50th and 95th percentile to estimate releases.

Key Modeling Parameters

The key modeling parameters used for this OES are presented in Table 4-15. Refer to Appendix A.6 for a full list of input parameters used in the model.

Table 4-15. Key Modeling Parameters Used to Model Environmental Releases from Application of Adhesives and Sealants

Modeling Parameter	Variable Type	Value(s)
Production Volume for <i>trans</i> -1,2-dichloroethylene for this OES	GS-derived value	534,120 kg/yr
Operating Days	GS-derived value	49–251 days/yr
Annual facility adhesive product use rate	GS-derived value	Triangular Distribution: 1.0E03 to 1.0E6 kg/site-yr; Mode:

Modeling Parameter	Variable Type	Value(s)
		1.4E05
Concentration of <i>trans</i> -1,2-dichloroethylene used	Concentrations from product information	Discreet distribution ranging from 1% to 70% by weight

Environmental Releases

Releases are estimated for each of the release sources listed above, then combined by media. Table 4-16 summarizes the estimated release results during the application of adhesives and sealants. The high-end values are the 95th percentile of the respective simulation output and the central tendencies are the 50th percentile. The appendix contains the model equations and input parameters used in the Monte Carlo simulation for this COU.

Table 4-16. Summary of Modeled Environmental Releases of *trans*-1,2-Dichloroethylene for Adhesives and Sealants

Environmental Media	Release Control Efficiency Applied ^a	Annual Release (kg/site-yr)		Number of Release Days ^b		Daily Release (kg/site-day)	
		Central Tendency	High-End	Central Tendency	High-End	Central Tendency	High-End
Fugitive or stack air	None	1,800	1.7E05	50	250	10	1,200
Uncertain Media (Hazardous Landfill or Incineration)	None	63	6,600			0.36	42
If Hazardous Landfill	None	63	6,600			0.36	42
If Incineration	99.99%	6.3E−03	0.66			3.6E−05	4.2E−03
^a Regulations at 40 CFR part 63, Subpart EEE – National Emission Standards for Hazardous Air Pollutants from Hazardous Waste Combustors, require all hazardous waste combustors (incinerators, cement kilns, lightweight aggregate kilns, solid fuel boilers, liquid fuel boilers, and hydrochloric acid production furnaces) to achieve a DRE of 99.99% for each principal organic hazardous constituent (POHC) including <i>trans</i> -1,2-dichloroethylene. It is important to note that the incineration destruction removal efficiency (DRE) should only be applied to OES involving industrial sites and not commercial sites.							
^b EPA assumes that the number of operating days is equivalent to the number of drums imported per year (<i>i.e.</i> , 1 drum repackaged per day) but not to exceed 250 operating days per year. The number of release days presented in this table is based on simulation outputs for the annual release divided by the daily release (grouped by high-end or central tendency estimate), rounded to the closest integer. Annual totals may not add up exactly due to rounding.							

4.2.11 Blowing Agent in Spray Foam – OES #11

4.2.11.1 OES Details

The use of *trans*-1,2-dichloroethylene in polyurethane foam building insulation was identified in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene.

Spray polyurethane foam is typically installed using two-part systems where the “B” or polyol side reacts with the “A” or isocyanates side. The 2004 Draft Generic Scenario for Use of Additives in Foamed Plastics indicates that workers may potentially be exposed during transferring components from shipping containers, operation/supervision of the foam mix head or dispenser, during foam production, and transfer or handling of newly foamed articles ([U.S. EPA, 2004c](#)). For on-site spray foam insulation, the Application of Spray Polyurethane Foam Insulation Generic Scenario, workers may potentially be

exposed during exposed during transferring components from shipping containers, spray application, foam thickness verification and foam trimming ([U.S. EPA, 2021b](#)).

EPA did not find specific container information for *trans*-1,2-dichloroethylene used for polyurethane foam manufacturing; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in drums or smaller containers received from the manufacturer or repackager. The “B” side of the package of some spray polyurethane formulations have concentrations of *trans*-1,2-dichloroethylene that range between 1 and 5% by weight ([Demilec Inc, 2017a, b](#); [Covestro LLC, 2016](#); [Demilec Inc, 2015](#)). EPA also identified SDSs for *trans*-1,2-dichloroethylene used as a blowing agent in specialty foam, foam adhesive, and sealant products ([DAP Foam Inc., 2018a, c](#); [NLM, 2018a](#); [Axiall, 2016](#)).

4.2.11.2 Facility Estimates

EPA did not identify production volume information for the use of *trans*-1,2-dichloroethylene as a blowing agent in spray foam. The Agency also did not identify any facilities using programmatic data from DMR and TRI. EPA modeled the releases for one site using *trans*-1,2-dichloroethylene as a blowing agent during foam spraying and expects polyurethane foam manufacturing to occur 5 days/week, 50 weeks/year or 260 days/year.

4.2.11.3 Release Assessment

Rationale for Modeling

EPA did not identify programmatic released data for this OES. Therefore, the Agency estimated releases from the use of *trans*-1,2-dichloroethylene as a blowing agent in spray foam using the models and approaches described in the generic scenario for application of spray polyurethane foam insulation ([U.S. EPA, 2021b](#)).

Modeled Release Sources

Modeled release sources include the following:

1. Release to air from transfer operation losses during unloading,
2. Release to water, landfill, or incineration from container residue losses,
3. Release to air from evaporative losses during container cleaning,
4. Release to landfill, or incineration from equipment cleaning residue,
5. Release to air from losses during application, and
6. Release to landfill from trimming wastes.

Modeling Approach

EPA used model equations and parameters from the Application of Spray Polyurethane Foam Insulation Generic Scenario ([U.S. EPA, 2021b](#)). The Agency performed a Monte Carlo simulation to estimate variability in the model input parameters. The simulation used the Latin hypercube sampling method in @Risk Industrial Edition, Version 8.0.0, which generates a distribution of possible values. The Agency also performed the model at 100,000 iterations to capture a broad range of possible values. EPA selected the 50th and 95th percentile to estimate releases.

Key Modeling Parameters

The key modeling parameters used for this OES are presented in Table 4-17. Refer to Appendix A.7 for a full list of input parameters used in the model.

Table 4-17. Key Modeling Parameters Used to Model Environmental Releases as a Blowing Agent During the Use of Spray Foam

Modeling Parameter	Variable Type	Value(s)
Production Volume for <i>trans</i> -1,2-dichloroethylene for this OES	GS-derived value	12 kg/yr
Concentration of <i>trans</i> -1,2-dichloroethylene used	Concentrations from product information	1–5% by weight

Environmental Releases

Releases are estimated for each of the release sources listed above, then combined by media. Table 4-18 summarizes the estimated release results from the use of *trans*-1,2-dichloroethylene as a blowing agent in spray foam. The high-end values are the 95th percentile of the respective simulation output and the central tendencies are the 50th percentile. Appendix A.7 contains the model equations and input parameters used in the Monte Carlo simulation for this OES.

Table 4-18. Summary of Modeled Environmental Releases of *trans*-1,2-Dichloroethylene During Use of Blowing Agent in Spray Foam

Environmental Media	Release Control Efficiency Applied ^a	Annual Release (kg/site-yr)		Number of Release Days ^b		Daily Release (kg/site-day)	
		Central Tendency	High-End	Central Tendency	High-End	Central Tendency	High-End
Fugitive or stack air	None	1.9	3.1	3	3	0.65	1.0
Uncertain media (wastewater, hazardous landfill, or incineration)	None	0.91	1.4			0.30	0.46
If wastewater treatment	73%	0.25	0.37			8.2E–02	0.12
If hazardous landfill	None	0.91	1.4			0.30	0.46
If Incineration	99.99%	9.5E–05	1.4E–04			3.0E–05	4.6E–05

^a Regulations at 40 CFR part 63, Subpart EEE – National Emission Standards for Hazardous Air Pollutants from Hazardous Waste Combustors, require all hazardous waste combustors (incinerators, cement kilns, lightweight aggregate kilns, solid fuel boilers, liquid fuel boilers, and hydrochloric acid production furnaces) to achieve a destruction removal efficiency (DRE) of 99.99% for each principal organic hazardous constituent (POHC) including *trans*-1,2-dichloroethylene. It is important to note that the incineration DRE should only be applied to OES involving industrial sites and not commercial sites.

^b EPA assumes that the number of operating days is equivalent to the number of drums imported per year (*i.e.*, one drum repackaged per day) but not to exceed 250 operating days per year. The number of release days presented in this table is based on simulation outputs for the annual release divided by the daily release (grouped by high-end or central tendency estimate), rounded to the closest integer. Annual totals may not add up exactly due to rounding.

4.2.12 Laboratory Use – OES #12

4.2.12.1 OES Details

The use of *trans*-1,2-dichloroethylene in laboratory chemical was identified in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene.

A commenter ([EPA-HQ-OPPT-2019-0131-0042](#)) provided descriptions of their use of *trans*-1,2-dichloroethylene in testing of candidate alternative cleaning solvents for human-rated space vehicle hardware and other high-performance applications and laboratory use including such applications as

analytical standards, research, equipment calibration, sample preparation, which the commenter also indicated was a critical use, further informing EPA's understanding of this condition of use.

The Use of Laboratory Chemicals Generic Scenario identified potential for worker exposures during transferring *trans*-1,2-dichloroethylene from shipping containers, container cleaning, equipment cleaning, laboratory analyses, and disposal of waste chemicals ([U.S. EPA, 2023b](#)).

EPA did not find specific container information for *trans*-1,2-dichloroethylene used as a laboratory chemical; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in drums or smaller containers received from the manufacturer or repackager. *trans*-1,2-dichloroethylene is used in these laboratory applications and then disposed of with other laboratory wastes.

Multiple SDSs indicate a recommended use as a laboratory chemical for *trans*-1,2-dichloroethylene at concentrations of 0.47 to greater than 98% ([LLC, 2018](#); [Santa Cruz Biotechnology Inc, 2018](#); [Thermo Fisher Scientific, 2018](#)). However, specific laboratory use activities are unknown.

4.2.12.2 Facility Estimates

EPA did not identify production volume information for the use of *trans*-1,2-dichloroethylene as a laboratory chemical. EPA did not identify any facilities using programmatic data from DMR and TRI. As a result, EPA modeled releases for this scenario and calculated the number of sites as a model output. The estimated number of sites for this scenario range from 9 to 18,400 sites with a median of 84 and is dependent upon the PV used in the model. EPA expects this OES to occur 5 days/week, 50 weeks/year or 250 days/year.

4.2.12.3 Release Assessment

Rationale for Modeling

EPA did not identify programmatic release data for this OES. Therefore, EPA estimated releases from the use of *trans*-1,2-dichloroethylene as a laboratory chemical using the models and approaches described in the Laboratory Chemical Generic Scenario ([U.S. EPA, 2023b](#)).

Modeled Release Sources

Modeled release sources included the following:

1. Release to air from transfer operation losses during unloading liquid chemicals,
2. Release to incineration or landfill from container residue losses,
3. Release to air from open surface losses during container cleaning,
4. Release to incineration or landfill during equipment cleaning,
5. Release to air from open surface losses during equipment cleaning,
6. Release to air from losses during laboratory analyses, and
7. Release to incineration or landfill from disposal of laboratory waste.

Modeling Approach

EPA estimated releases for use of laboratory chemicals using the model equations and parameters described in the Revised Draft Generic Scenario on the Use of Laboratory Chemicals ([U.S. EPA, 2023b](#)). EPA performed a Monte Carlo simulation to estimate variability in the model input parameters. The simulation used the Latin hypercube sampling method in @Risk Industrial Edition, Version 8.0.0, which generates a sample of possible values. The Agency performed the model at 100,000 iterations to capture a broad range of possible values. EPA selected the 50th and 95th percentile to estimate releases.

Key Modeling Parameters

The key modeling parameters used for this OES are presented in Table 4-19. Refer to Appendix A.8 for a full list of input parameters used in the model.

Table 4-19. Key Modeling Parameters Used to Model Environmental Releases from Use as a Laboratory Chemical

Modeling Parameter	Variable Type	Value(s)
Production Volume	CDR-derived value	11,340 kg/yr
Operating Days	Discrete distribution	174–260 days/yr
Facility Laboratory Chemical Throughput	GS-derived value	0.50–4,000 mL/site-day
Product Concentration	Discrete distribution	20–100% by weight
Container Volume	GS-derived value	1.0 gallons

Releases are estimated for each of the release sources listed above, then combined by media. Table 4-20 summarizes the estimated release results for the use of laboratory chemicals. The high-end values are the 95th percentile of the respective simulation output and the central tendencies are the 50th percentile.

Table 4-20. Summary of Modeled Environmental Releases of *trans*-1,2-Dichloroethylene During Laboratory Use

Environmental Media	Release Control Efficiency Applied ^a	Annual Release (kg/site-yr)		Number of Release Days ^b		Daily Release (kg/site-day)	
		Central Tendency	High-End	Central Tendency	High-End	Central Tendency	High-End
Fugitive or stack air	None	9.5	26	235	258	4.1E–02	0.11
Uncertain media (hazardous landfill or incineration)	None	125	600			0.54	2.6
If hazardous landfill	None	125	600			0.54	2.6
If incineration	99.99%	1.3E–02	6.0E–02			5.4E–05	2.6E–04

^a Regulations at 40 CFR part 63, Subpart EEE – National Emission Standards for Hazardous Air Pollutants from Hazardous Waste Combustors, require all hazardous waste combustors (incinerators, cement kilns, lightweight aggregate kilns, solid fuel boilers, liquid fuel boilers, and hydrochloric acid production furnaces) to achieve a destruction removal efficiency (DRE) of 99.99% for each principal organic hazardous constituent (POHC) including *trans*-1,2-dichloroethylene. It is important to note that the incineration DRE should only be applied to OES involving industrial sites and not commercial sites.

^b EPA assumes that the number of operating days is equivalent to the number of drums imported per year (*i.e.*, one drum repackaged per day) but not to exceed 250 operating days per year. The number of release days presented in this table is based on simulation outputs for the annual release divided by the daily release (grouped by high-end or central tendency estimate), rounded to the closest integer. Annual totals may not add up exactly due to rounding.

4.2.13 Refrigerant Flush – OES #13

4.2.13.1 Process Description

EPA identified *trans*-1,2-dichloroethylene in refrigerants as a use in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene. In 2016, EPA added a refrigerant to be manufactured by Chemours and sold under the brand name Opteon XP30 (R-514a) to its list of acceptable additional

substitutes for use in the refrigeration and air conditioning sector ([U.S. EPA, 2016c](#)).

The refrigerant is used in low-pressure commercial and industrial centrifugal chillers, which are typically installed in office buildings and contains up to 25.3% *trans*-1,2-dichloroethylene ([The Chemours Company FC LLC, 2019](#)). EPA also identified a safety data sheet for an air conditioning or refrigeration system flush treatment, which is poured through the refrigeration piping to clean and then collected and disposed of, containing between 50 and 60% *trans*-1,2-dichloroethylene ([ACE, 2015](#)). EPA did not find specific container information for *trans*-1,2-dichloroethylene used as a refrigerant; however, the Agency expects *trans*-1,2-dichloroethylene to arrive as a neat liquid in drums or smaller containers received from the manufacturer or repackager.

4.2.13.2 Facility Estimates

EPA did not identify production volume information for the use of *trans*-1,2-dichloroethylene as a refrigerant. EPA did not identify any sites that reported data to DMR and TRI that were the result of this OES and used analogous data from one a site that used *trans*-1,2-dichloroethylene as a miscellaneous non-aerosol product. EPA expects use in refrigerants and refrigerant system flushes to occur 5 days/week, 50 weeks/year or 250 days/year.

4.2.13.3 Release Assessment

Fugitive air emissions data were available for this OES from 2019 to 2023 TRI using analogous data from the miscellaneous non-aerosol industrial and commercial uses OES. EPA expected this data to be the most representative of releases for this OES.

EPA used the data from one facility, Embecta – Holdredge to estimate the minimum, maximum, 50th, and 95th percentile release metrics for annual emissions (kg/site-yr) using the data points. EPA calculated daily release estimates (kg/site-day) using a default assumption of 250 days/yr.

Annual and daily release estimates are presented in Table 4-21. The facility data shown already account for release controls and their associated efficiencies.

Table 4-21. Summary of Environmental Releases of *trans*-1,2-Dichloroethylene from its Use as a Refrigerant or Refrigerant Flush

Environmental Media	Estimated Yearly Release (kg/site-yr)				No. of Release Days ^a	Daily Release (kg/site-day)		No. of Facilities	No. of Data Points ^b	Source
	Minimum	Maximum	Central Tendency	High-End		Central Tendency	High-End			
Fugitive air	6,800	1.3E4	7,100	1.3E04	250	28	51	1	5	TRI
TRI = Toxics Release Inventory Central tendency estimates correspond to the 50th percentile of data, and high-end estimates correspond to the 95th percentile. ^a A default of 250 days per year was applied. ^b Data points represent the total number of reports submitted during the years included in the assessment. Because a single facility may report multiple times across the assessed years, the number of data points can exceed the number of facilities. The minimum, maximum, central tendency, and high-end release metrics were calculated based on these data points.										

4.2.14 Processing Aid in Semiconductor Manufacturing – OES #14

4.2.14.1 Process Description

The use of *trans*-1,2-dichloroethylene is as a processing aid in semiconductor manufacturing was provided in a comment from the Semiconductor Industry Association (SIA).

trans-1,2-Dichloroethylene is used in oxide furnaces operating at atmospheric pressure at a temperature range of 700 to 1,200 °C. The chemical is delivered as a liquid via nitrogen (N₂) push gas from a 20L quartz-lined stainless-steel container in a bulk fill cabinet to refill a sealed quartz container with PVC coating in each tool. N₂ carrier gas is then bubbled through liquid in the quartz container to flow it into the furnace tube. *trans*-1,2-Dichloroethylene is fully transformed in the process into hydrogen chloride (HCl) and other inorganic chlorides. According to SIA, several engineering controls are in place during use of *trans*-1,2-dichloroethylene. Manufacturing tools are equipped with exhaust, interlocks to prevent exposure during processing, a once-through closed path system, and pre-open cleaning procedures ([EPA-HQ-OPPT-2018-0465-0036](#)).

trans-1,2-Dichloroethylene is supplied to semiconductor sites in hermetically sealed 1.5-liter quartz source containers with PVC coating and 20-liter quartz-lined stainless steel bulk containers. The container is equipped with special valves featuring a locking nut-assembly and built-in quartz plunger which breaks the seal after the container has been installed into the tool and the valves opened. The design of the chemical container results in no potential for exposure during installation or removal from the process tool. Empty containers are returned to the manufacturer for reprocessing and refilling ([EPA-HQ-OPPT-2018-0465-0036](#)).

The product is supplied as 99.99% *trans*-1,2-dichloroethylene.

4.2.14.2 Facility Estimates

EPA did not identify production volume information for the use of *trans*-1,2-dichloroethylene as a processing aid in semiconductor manufacturing. EPA did not identify any facilities using programmatic data from DMR and TRI. The emission scenario document on chemical vapour deposition in the semiconductor industry ([\(OECD\), 2015](#)) suggests that there were 922 semiconductor manufacturing facilities in the United States in 2011 (this is the information reasonably/currently available).

4.2.14.3 Release Assessment

EPA does not expect releases of *trans*-1,2-dichloroethylene to the environment from its use in semiconductor manufacturing, due to its arrival in hermetically sealed containers and its use as a reactant in closed systems. As the depleted containers of *trans*-1,2-dichloroethylene are returned to the manufacturer for reprocessing, EPA is assessing releases from this OES to occur at the manufacturer's facility.

One facility, Versum Materials US LLC of Carlsbad, California, provided a total of 12 data points on release emissions to TRI. EPA estimated the minimum, maximum, 50th, and 95th percentile release metrics for annual emissions (kg/site-yr) using the data points. EPA calculated daily release estimates (kg/site-day) using a default assumption of 250 days/yr. Annual and daily release estimates are presented in Table 4-22. The facility data shown account for release controls and their associated efficiencies.

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Table 4-22. Summary of Environmental Releases of *trans*-1,2-Dichloroethylene During Use in Semiconductor Manufacturing

Environmental Media	Estimated Yearly Release (kg/site-yr)				Number of Release Days ^a	Daily Release (kg/site-day)		Number of Facilities	Number of Data Points ^b	Source
	Minimum	Maximum	Central Tendency	High-End		Central Tendency	High-End			
Transfer to POTW	0.45	0.45	0.45	0.45	250	1.8E-03	1.8E-03	1	2	TRI
Fugitive air	2.3	2.3	2.3	2.3		9.1E-03	9.1E-03	1	5	TRI
Stack air	2.3	4.5	4.5	4.5		1.8E-02	1.8E-02	1	5	TRI
POTW = publicly owned treatment works; TRI = Toxics Release Inventory Central tendency estimates correspond to the 50th percentile of data, and high-end estimates correspond to the 95th percentile. ^a A default of 250 days per year was applied. ^b Data points represent the total number of reports submitted during the years included in the assessment. Because a single facility may report multiple times across the assessed years, the number of data points can exceed the number of facilities. The minimum, maximum, central tendency, and high-end release metrics were calculated based on these data points.										

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4.2.15 Waste Handling, Disposal, Treatment, and Recycling – OES #15

4.2.15.1 Process Description

Waste handling, disposal, and treatment was identified as a use in the Scoping Document Conditions of Use Table for *trans*-1,2-dichloroethylene.

Waste streams containing *trans*-1,2-dichloroethylene are recycled on-site and are then re-introduced into the facility's process waste stream. The presence of *trans*-1,2-dichloroethylene in the reuse of produced water is included in the disposal condition of use.

Each of the conditions of use of *trans*-1,2-dichloroethylene may generate waste streams of the chemical that are collected and transported to third-party sites for disposal, treatment, or recycling, which is done both on- and off-site. Industrial sites that treat or dispose onsite wastes that they themselves generate will be assessed in each condition of use assessment, as appropriate. Wastes of *trans*-1,2-dichloroethylene that are generated during a condition of use and sent to a third-party site for treatment, disposal, or recycling may include the following:

- Wastewater: *trans*-1,2-dichloroethylene may be contained in wastewater discharged to POTW or other, non-public treatment works for treatment. Industrial wastewater containing *trans*-1,2-dichloroethylene discharged to a POTW may be subject to EPA or authorized NPDES state pretreatment programs. The assessment of wastewater discharges to POTWs and non-public treatment works of *trans*-1,2-dichloroethylene is included in each of the condition of use assessments in Sections 4.2.1 through 4.2.14.
- Solid Wastes: Solid wastes are defined under RCRA (40 CFR 261.2) as any material that is discarded by being: abandoned; inherently waste-like; a discarded military munition; or recycled in certain ways (certain instances of the generation and legitimate reclamation of secondary materials are exempted as solid wastes under RCRA). Solid wastes may subsequently meet RCRA's definition of hazardous waste by either being listed as a waste at 40 CFR 261.30 to 261.35 or by meeting waste-like characteristics as defined at 40 CFR 261.20 to 261.24. Solid wastes that are hazardous wastes are regulated under the more stringent requirements of Subtitle C of RCRA.
trans-1,2-dichloroethylene is a U-listed hazardous waste under code U079 under RCRA; therefore, discarded, unused pure and commercial grades of *trans*-1,2-dichloroethylene are regulated as a hazardous waste under RCRA (40 CFR 261.33(f)).
- Wastes Exempted as Solid Wastes under RCRA: Certain conditions of use of *trans*-1,2-dichloroethylene may generate wastes of *trans*-1,2-dichloroethylene that are exempted as solid wastes under 40 CFR 261.4(a). For example, the generation and reclamation of hazardous secondary materials of *trans*-1,2-dichloroethylene may be exempt as a solid waste.

Municipal Waste Incineration

Energy recovering municipal waste combustors (MWCs) typically operate at large facilities with an enclosed tipping floor and a deep waste pit. Capacities generally range from about 250 to over 1,000 tons per day. Waste is not handled directly by workers: trucks dump into the pit or onto the floor, where a frontend loader pushes it into the pit. An overhead crane with a grapple transfers waste to a hopper, and hydraulic rams feed it continuously into the combustion unit at a controlled rate. The crane operator mixes waste in the pit for consistent composition and heating value and removes hazardous or problematic items.

Facilities processing refuse-derived fuel (RDF) perform on-site sorting, shredding, and inspection to recover recyclables and remove hazardous or unwanted materials. Sorting is largely automated using mechanical separation (e.g., trommel and disk screens, magnetic separators). After processing, the material is sent to a storage pit or conveyed directly to the combustion hopper.

Tipping-floor operations can generate dust, but air from the enclosed floor is continuously drawn into the furnace by forced-draft fans, serving as primary combustion air and reducing odors. Dust and lint are typically captured by filters or other air-cleaning devices to protect air-heating coils and help dry higher-moisture feed ([Kitto and Stultz, 1992](#)).

Hazardous Waste Incineration

Commercial hazardous waste incinerators commonly use a two-stage design—a rotary kiln followed by an afterburner—to handle both solid and liquid wastes. Liquids are pumped and atomized through nozzles for efficient combustion, while solids are fed to the kiln as loose materials via a gravity hopper or in drums/containers on a conveyor ([Environmental Technology Council \(ETC\), 2018](#); [Heritage, 2018](#)). Hazardous waste is typically received by truck or rail and inspected upon arrival; liquid receiving areas include a dock, pumphouse, and storage, and solids are moved by conveyor systems ([Environmental Technology Council \(ETC\), 2018](#); [Kitto and Stultz, 1992](#)). Smaller units (e.g., municipal or hospital infectious/hazardous waste incinerators) often require more direct handling; batch-loaded units involve placing waste on the grate before operation, sometimes by manually dumping or shoveling from containers.

Municipal Waste Landfill

Municipal solid waste (MSW) landfills are engineered facilities that receive household waste and other non-hazardous solid wastes (e.g., industrial and commercial). They are regulated under RCRA Subtitle D, and states may adopt more stringent requirements. Core standards include location restrictions, composite liners with leachate collection and removal, operating practices, groundwater monitoring, closure and post-closure care, corrective action provisions, and financial assurance.

MSW may first be consolidated at transfer stations for temporary storage before transport to landfills or other treatment/disposal facilities. Certain wastes that would otherwise be hazardous can be disposed of at non-Subtitle C landfills if they are specifically exempt or conditionally excluded (e.g., household waste, certain special wastes) and meet applicable federal/state criteria.

Hazardous Waste Landfill

Hazardous waste landfills are engineered sites for the final disposal of non-liquid hazardous wastes. They must meet stringent design standards, including double liners, double leachate collection/removal systems, leak detection, run-on/runoff and wind-dispersal controls, and a construction quality assurance program ([U.S. EPA, 2018](#)). Closure and post-closure requirements include installing a final cover and ongoing monitoring and maintenance to protect groundwater and nearby surface waters. These facilities are regulated under 40 CFR [Parts 264/265, Subpart N](#).

Remediation or Monitoring

Frequently when EPA was reviewing DMR entries, EPA was unable to determine why NPDES permits were testing for the presence of *trans*-1,2-dichloroethylene. Sometimes, an internet search of the NPDES permit number indicated that the industrial had been decommissioned in the past but that the past owners of the site were still responsible for maintaining groundwater remediation efforts and monitoring the current discharges to surface waters. EPA categorized these DMR reports as Remediation or Monitoring.

EPA did not identify data on facility operating schedules. EPA cannot estimate the number of days that *trans*-1,2-dichloroethylene is discharged from POTWs; therefore, the Agency assumes that the chemical is discharged every day of operation which equates to 365 days/year of operation.

4.2.15.2 Release Assessment

Surface water, fugitive air, stack air, and land emissions data were available for this OES from 2019 to 2023 DMR and 2019 to 2023 TRI. The identities and assigned OESs of facilities that reported the release information used in this section are contained in the documents: *Draft Air Releases for trans*-1,2-*Dichloroethylene* ([U.S. EPA, 2026d](#)), *Draft Land Releases for trans*-1,2-*Dichloroethylene* ([U.S. EPA, 2026p](#)), and *Draft Water Releases for trans*-1,2-*Dichloroethylene* ([U.S. EPA, 2026aa](#)). Each facility provided one or more data points on release emissions. EPA estimated the minimum, maximum, 50th, and 95th percentile release metrics for annual emissions (kg/site-yr) using the data points. EPA calculated daily release estimates (kg/site-day) using facility-reported operating information where available, or a default assumption of 350 days/yr.

Facilities may report to multiple programmatic data sources (*e.g.*, a facility may report to both TRI and DMR for surface water discharges). Differences in program reporting thresholds and NPDES permit requirements may result in different numbers of facilities across programs. Annual and daily release estimates are presented in Table 4-23. The facility data shown already account for release controls and their associated efficiencies.

Table 4-23. Summary of Environmental Releases of *trans*-1,2-Dichloroethylene from Waste Handling, Disposal, Treatment, and Recycling

Environmental Media	Estimated Yearly Release (kg/site-yr)				Number of Release Days ^a	Daily Release (kg/site-day)		Number of Facilities	Number of Data Points ^b	Source
	Minimum	Maximum	Central Tendency	High-End		Central Tendency	High-End			
Surface water – from POTW	4.7E-04	2.7E04	1.6	28	365	4.5E-03	7.6E-02	109	264	DMR
Surface water – from non-POTW WWT	3.6E-05	2.9	2.2E-02	1.1		6.1E-05	2.9E-03	14	36	DMR
Surface water – from landfill	7.0E-04	0.14	3.7E-02	0.14		1.0E-04	3.9E-04	4	18	DMR
Surface water – from remediation or monitoring	6.7E-09	86	3.9E-02	4.3		1.1E-04	1.2E-02	198	656	DMR
Stack air – fuel use	0.23	0.45	0.45	0.45	350	1.3E-03	1.3E-03	1	3	TRI
Fugitive air – nonfuel use	4.5E-03	39	0.19	30		5.4E-04	8.7E-02	6	19	TRI
Stack air – nonfuel use	0	0.23	4.5E-02	0.22		1.3E-04	6.1E-04	6	19	TRI
Land – nonfuel use	4.5E-03	1.5	0.45	1.3		1.3E-03	3.8E-03	5	7	TRI
DMR = Discharge Monitoring Report; TRI = Toxics Report Inventory Central tendency estimates correspond to the 50th percentile of data, and high-end estimates correspond to the 95th percentile. ^a Information on operating days is typically reported by facilities to NEI. Sites that were mapped to the manufacturing as a byproduct OES reported operating days ranging from 350–365 days/year. For sites that did not report operating days information, a default of 350 days per year was applied. ^b Data points represent the total number of reports submitted during the years included in the assessment. Because a single facility may report multiple times across the assessed years, the number of data points can exceed the number of facilities. The minimum, maximum, central tendency, and high-end release metrics were calculated based on these data points. ^c Land releases for this OES were reported for the following categories: 195 TOTAL OTHER ON-SITE LANDFILLS 230 OFF-SITE – UNDERGROUND INJECTION – CLASS 1 WELLS 236 OFF-SITE – OFF-SITE – OTHER LANDFILLS 237 OFF-SITE – RCRA SUBTITLE C LANDFILLS										

4.2.16 Distribution in Commerce – OES #16

EPA did not quantitatively assess exposures for an OES of Distribution in Commerce. Activities associated with loading and unloading chemical products were assessed as part of each COU's OES. It is possible that *trans*-1,2-dichloroethylene may go through a third party for temporary storage/warehousing before distribution to users. If repackaging takes place at these facilities involving transfer from larger to smaller containers, EPA assessed this under the OES of repackaging. Transport containers are not expected to be opened during transport between producing and receiving sites. EPA expects all the *trans*-1,2-dichloroethylene containing products to be transported in a closed system such that there is negligible potential for releases. Therefore, no occupational exposures are reasonably expected to occur and no separate assessment was performed for estimating releases and exposures from distribution in commerce. Speculative exposures that may result from irregular and unpredictable accidental spills during transport are not assessed by EPA in TSCA Risk Evaluations.

4.3 Weight of Scientific Evidence Conclusions for Release Assessment

Section 4.1 described the methodology and approaches that EPA used to estimate environmental releases for industrial and commercial activities for *trans*-1,2-dichloroethylene. Details of the execution of the methods and the results of environmental releases estimates obtained for each OES are covered in Section 4.2. EPA's confidence in the release assessments for the OES can vary based on the assessment approach, evidence available, the quality of the data and inputs for model parameters, and the strengths, limitations, assumptions, and key sources of uncertainties.

EPA assesses these factors to determine a weight of scientific evidence rating for the release assessment for the OES and assigns ratings using the descriptors of robust, moderate, slight, or indeterminant, according to EPA's 2021 Draft Systematic Review Protocol ([U.S. EPA, 2021c](#)). The ratings help to characterize the release assessment and are part of the inputs to the risk determination that EPA makes for the OES.

4.3.1 Overall Confidence in Release Estimates by OES

Weight of scientific evidence ratings for the environmental release estimates for each OES, including details on the basis EPA used to determine the rating, are provided in Table 4-24.

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Table 4-24. Weight of Scientific Evidence Conclusions in Release Estimates

OES	Weight of Scientific Evidence Conclusion in Release Estimate	Confidence Rating
Manufacturing as a Primary Product	Evidence Found: For this OES, EPA had release information from air, land, and water from TRI, and water from DMR. Strengths: Water releases are assessed using reported releases from 2019–2023 DMR and TRI. These databases received a high data quality rating in systematic review. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. Based on reporting thresholds, TRI captures the highest throughput sites. Since releases are related to throughput, this increases confidence that the highest emitters are captured in this assessment. Air releases are assessed using reported releases from 2019–2023 TRI. Limitations/Assumptions/Uncertainties: Factors that decrease the overall confidence for the water estimates include the uncertainty in the accuracy of reported releases and the significant difference between the TRI release to water and DMR release for the same facility. Factors that decrease the overall confidence for the air and land release estimates include the uncertainty in the accuracy of reported releases. Weight of Scientific Evidence Conclusion: EPA identified 1 facility in the United States that manufactures <i>trans</i>-1,2-dichloroethylene as a primary product and used the release data from this facility, which are rated high in systematic review. Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides a moderate to robust confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.	Moderate-to-Robust
Manufacturing as a Byproduct	Evidence Found: For this OES, EPA had release information from air, land, and water from TRI. Strengths: TRI received a high data quality rating in systematic review. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. Based on reporting thresholds, TRI captures the highest throughput sites. Since releases are related to throughput, this increases confidence that the highest emitters are captured in this assessment. TRI contains reports from nine facilities for this OES. Limitations/Assumptions/Uncertainties: Factors that decrease the overall confidence for the release estimates include the uncertainty in the accuracy of reported releases. EPA made assumptions on the number of operating days to estimate daily releases because EPA did not find such information. Weight of Scientific Evidence Conclusion: As the release data were rated high in systematic review, EPA has concluded that the weight of scientific evidence for this assessment provides a moderate to robust confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.	Moderate-to-Robust
Repackaging	Evidence Found: For this OES, EPA did not identify any release information from programmatic data. Therefore, releases to the environment are assessed using the GS on Chemical Repackaging, which has a high data quality rating from the systematic review process (U.S. EPA, 2022a). EPA used EPA/OPPT models	Slight-to-Moderate

OES	Weight of Scientific Evidence Conclusion in Release Estimate	Confidence Rating
	combined with Monte Carlo modeling to estimate releases to the environment, with media of release assessed using assumptions from the GS and EPA/OPPT models. Strengths: A strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential releases values is more likely than a discrete value to capture actual releases at sites. Limitations/Assumptions/Uncertainties: The Agency believes the primary limitation to be the uncertainty in the representativeness of values toward the true distribution of potential releases. In addition, EPA lacks <i>trans</i>-1,2-dichloroethylene repackaging throughput data; therefore, throughput estimates are based on the Chemical Repackaging GS and CDR reporting thresholds. EPA assumed that the media of release for repackaging waste is to hazardous waste landfill or incineration, per the GS. Weight of Scientific Evidence Conclusion: Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides a slight to moderate confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.	
Processing as a Reactant	Evidence Found: For this OES, EPA had release information from air, land, and water from TRI. Strengths: TRI received a high data quality rating in systematic review. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. Based on reporting thresholds, TRI captures the highest throughput sites. Since releases are related to throughput, this increases confidence that the highest emitters are captured in this assessment. TRI contains reports from nine facilities for this OES. Limitations/Assumptions/Uncertainties: Factors that decrease the overall confidence for the release estimates include the uncertainty in the accuracy of reported releases. EPA made assumptions on the number of operating days to estimate daily releases because EPA did not find such information. Weight of Scientific Evidence Conclusion: As the release data are rated high in systematic review, EPA has concluded that the weight of scientific evidence for this assessment provides a moderate to robust confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.	Moderate-to-Robust
Incorporation into Formulation, Mixture, or Reaction Product	Evidence Found: For this OES, EPA had release information from air, land, and water from TRI. Strengths: TRI received a high data quality rating in systematic review. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. Based on reporting thresholds, TRI captures the highest throughput sites. Since releases are related to throughput, this increases confidence that the highest emitters are captured in this assessment. TRI contains reports from six facilities for this OES. Limitations/Assumptions/Uncertainties: Factors that decrease the overall confidence for the release estimates	Moderate-to-Robust

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OES	Weight of Scientific Evidence Conclusion in Release Estimate	Confidence Rating
	include the uncertainty in the accuracy of reported releases. EPA made assumptions on the number of operating days to estimate daily releases because EPA found a range of operating days. Weight of Scientific Evidence Conclusion: As the release data are rated high in systematic review, EPA has concluded that the weight of scientific evidence for this assessment provides a moderate to robust confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.	
Vapor Degreasing	Evidence Found: For this OES, EPA did not identify any release information from programmatic data. Therefore, releases to the environment are assessed using the ESD on the Use of Vapour Degreasers, which has a high data quality rating from the systematic review process (U.S. EPA, 2022a). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, with media of release assessed using assumptions from the GS and EPA/OPPT models. Strengths: A strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential releases values is more likely than a discrete value to capture actual releases at sites. Limitations/Assumptions/Uncertainties: The Agency believes the primary limitation to be the uncertainty in the representativeness of values toward the true distribution of potential releases. In addition, EPA lacks <i>trans</i>-1,2-dichloroethylene vapor degreasing throughput data; therefore, throughput estimates are based on the Use of Vapour Degreasers ESD. The high-end throughput estimate exceeds the TRI reporting threshold and a facility operating at this level would need to report its releases to TRI. EPA assumed that the media of release of vapor degreasing waste is to air, wastewater treatment, hazardous waste landfill or incineration, per the GS. Weight of Scientific Evidence Conclusion: Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides a slight to moderate confidence in the central tendency estimate of releases in consideration of the strengths and limitations of reasonably available data, as it is below the TRI reporting threshold.	Slight-to-Moderate
Misc. Non-Aerosol Industrial and Commercial Uses (Cleaning and Degreasing Agents, Lubricants and Greases, Mold Release)	Evidence Found: For this OES, EPA had release information from air from TRI. Strengths: Air releases are assessed using reported releases from 2019–2023 TRI. This database received a high data quality rating in systematic review. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. Based on reporting thresholds, TRI captures the highest throughput sites. Since releases are related to throughput, this increases confidence that the highest emitters are captured in this assessment. Limitations/Assumptions/Uncertainties: Factors that decrease the overall confidence is that no releases to water or land were found. It is not known whether facilities in this OES would be expected to have non-fugitive air releases. It is also not known how representative this single facility is of a diverse OES.	Moderate

OES	Weight of Scientific Evidence Conclusion in Release Estimate	Confidence Rating
	Weight of Scientific Evidence Conclusion: Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides a slight-moderate confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.	
Commercial Aerosol Products (Aerosol Degreasing, Aerosol Lubricants, Mold Release)	Evidence Found: For this OES, EPA did not identify any release information from programmatic data. Therefore, releases to the environment are assessed using the aerosol degreasing model. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, with media of release assessed using assumptions from the GS and EPA/OPPT models. Strengths: A strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential releases values is more likely than a discrete value to capture actual releases at sites. Limitations/Assumptions/Uncertainties: The Agency believes the primary limitation to be the uncertainty in the representativeness of values toward the true distribution of potential releases. In addition, EPA lacks <i>trans</i>-1,2-dichloroethylene aerosol degreaser throughput data; therefore, throughput estimates are based on the CARB(2000) Weight of Scientific Evidence Conclusion: Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides a slight to moderate confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.	Moderate
Application of Paints and Coatings	Evidence Found: For this OES, EPA did not identify any release information from programmatic data. Therefore, releases to the environment are assessed using a model based upon the OECD ESD for Use of Adhesives (OECD, 2013), which has a high data quality rating from the systematic review process. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, with media of release assessed using assumptions from the GS and EPA/OPPT models. Strengths: A strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential releases values is more likely than a discrete value to capture actual releases at sites. Limitations/Assumptions/Uncertainties: The Agency believes the primary limitation to be the uncertainty in the representativeness of values toward the true distribution of potential releases. In addition, EPA lacks <i>trans</i>-1,2-dichloroethylene adhesive and sealant throughput data; therefore, throughput estimates are based on the ESD. The high-end throughput estimate exceeds the TRI reporting threshold and a facility operating at this level would need to report its releases to TRI. EPA assumed that the media of release of adhesive and sealant waste is to air, hazardous landfill, and/or incineration per the OECD ESD for Use of Adhesives (OECD, 2013). Weight of Scientific Evidence Conclusion: Based on this information, EPA has concluded that the weight of	Slight-to-Moderate

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OES	Weight of Scientific Evidence Conclusion in Release Estimate	Confidence Rating
	scientific evidence for this assessment provides a slight to moderate confidence in the central tendency estimate of releases in consideration of the strengths and limitations of reasonably available data, as it is below the TRI reporting threshold.	
Adhesives and Sealants	Evidence Found: For this OES, EPA did not identify any release information from programmatic data. Therefore, releases to the environment are assessed using a model based upon the OECD ESD for Use of Adhesives (OECD, 2013), which has a high data quality rating from the systematic review process. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, with media of release assessed using assumptions from the GS and EPA/OPPT models. Strengths: A strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential releases values is more likely than a discrete value to capture actual releases at sites. Limitations/Assumptions/Uncertainties: The Agency believes the primary limitation to be the uncertainty in the representativeness of values toward the true distribution of potential releases. In addition, EPA lacks <i>trans</i>-1,2-dichloroethylene adhesive and sealant throughput data; therefore, throughput estimates are based on the ESD. The high-end throughput estimate exceeds the TRI reporting threshold and a facility operating at this level would need to report its releases to TRI. EPA assumed that the media of release of adhesive and sealant waste is to air, hazardous landfill, and/or incineration per the OECD ESD for Use of Adhesives (OECD, 2013). Weight of Scientific Evidence Conclusion: Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides a slight to moderate confidence in the central tendency estimate of releases in consideration of the strengths and limitations of reasonably available data, as it is below the TRI reporting threshold.	Slight-to-Moderate
Blowing Agent in Spray Foam	Evidence Found: For this OES, EPA did not identify any release information from programmatic data. Therefore, releases to the environment are assessed using the Use of Blowing Agent in Spray Foam Model, which has a high data quality rating from the systematic review process (U.S. EPA, 2021b). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, with media of release assessed using assumptions from the GS and EPA/OPPT models. Strengths: A strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential releases values is more likely than a discrete value to capture actual releases at sites. Limitations/Assumptions/Uncertainties: The Agency believes the primary limitation to be the uncertainty in the representativeness of values toward the true distribution of potential releases. In addition, EPA lacks <i>trans</i>-1,2-dichloroethylene blowing agent in spray foam throughput data; therefore, throughput estimates are based on the Application of Spray Polyurethane Foam Insulation – Generic Scenario (U.S. EPA, 2021b). EPA assumed that the media of release of blowing agent in spray foam waste is to air, hazardous landfill, and/or incineration per	Slight-to-Moderate

OES	Weight of Scientific Evidence Conclusion in Release Estimate	Confidence Rating
	the generic scenario. Weight of Scientific Evidence Conclusion: Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides a slight to moderate confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.	
Laboratory Use	Evidence Found: For this OES, EPA did not identify any release information from programmatic data. Therefore, releases to the environment are assessed using the Draft GS on the Use of Laboratory Chemicals, which has a high data quality rating from the systematic review process (U.S. EPA, 2023b). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment. Strengths: A strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential releases values is more likely than a discrete value to capture actual releases at sites. Limitations/Assumptions/Uncertainties: The Agency believes the primary limitation to be the uncertainty in the representativeness of values toward the true distribution of potential releases. In addition, EPA lacks <i>trans</i>-1,2-dichloroethylene laboratory chemical throughput data; therefore, throughput estimates are based on stock solution throughputs from the Draft GS on the Use of Laboratory Chemicals. EPA assumed that the media of release for disposal of laboratory waste is to hazardous waste landfill or incineration, per the GS. Weight of Scientific Evidence Conclusion: Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides a slight to moderate confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.	Slight-to-Moderate
Refrigerant Flush	Evidence Found: For this OES, EPA had analogous air release information from the miscellaneous non-aerosol OES from TRI. Strengths: Air releases are assessed using reported releases from 2019–2023 TRI. This database received a high data quality rating in systematic review. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. Based on reporting thresholds, TRI captures the highest throughput sites. Since releases are related to throughput, this increases confidence that the highest emitters are captured in this assessment. Limitations/Assumptions/Uncertainties: Factors that decrease the overall confidence is that no releases to water or land were found. It is not known whether facilities in this OES would be expected to have non-fugitive air releases. It is also not known how representative this single analogous facility is of this OES. Weight of Scientific Evidence Conclusion: Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides a slight-moderate confidence in the estimate of releases in	Slight-to-Moderate

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OES	Weight of Scientific Evidence Conclusion in Release Estimate	Confidence Rating
	consideration of the strengths and limitations of reasonably available data.	
Processing Aid in Semiconductor Manufacturing	Evidence Found: For this OES, EPA had release information from air and transfer to POTW from TRI. Strengths: TRI received a high data quality rating in systematic review. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. Based on reporting thresholds, TRI captures the highest throughput sites. Since releases are related to throughput, this increases confidence that the highest emitters is captured in this assessment. TRI contains reports from the one facility for this OES that EPA knows creates the product. Limitations/Assumptions/Uncertainties: Factors that decrease the overall confidence for the release estimates include the uncertainty in the accuracy of reported releases. EPA made assumptions on the number of operating days to estimate daily releases because EPA did not find such information. Weight of Scientific Evidence Conclusion: In conclusion, as the release data are rated high in systematic review, EPA has concluded that the weight of scientific evidence for this assessment provides a moderate to robust confidence in the estimate of releases in consideration of the strengths and limitations of reasonably available data.	Moderate
Waste Handling, Disposal, Treatment, and Recycling	Evidence Found: For this OES, EPA had release information for air and land from TRI and for water from DMR. Strengths: Water releases for sites are assessed using reported releases from 2019–2023 DMR. A strength of using DMR data and the Pollutant Loading Tool is that the tool calculates an annual pollutant load by integrating monitoring period release reports provided to the EPA and extrapolating over the course of the year. Air releases for sites are assessed using reported releases from 2019–2023 TRI. Based on reporting thresholds, TRI captures the highest throughput sites. Since releases are related to throughput, this increases confidence that the highest emitters are captured in this assessment. Limitations/Assumptions/Uncertainties: The DMR approach assumes average quantities, concentrations, and hydrologic flows for a given period are representative of other times of the year. EPA made assumptions on the number of operating days to estimate daily releases. Factors that decrease the confidence for this OES include the uncertainty in the accuracy of reported releases, and the limitations in representativeness to all sites because TRI may not capture all relevant sites. Weight of Scientific Evidence Conclusion: Although there is uncertainty of whether the databases capture all sites releasing to each medium, the release data are rated medium to high in systematic review and provide releases directly from a wide number of facilities. Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides a moderate to robust estimate of releases in consideration of	Moderate-to-Robust

OES	Weight of Scientific Evidence Conclusion in Release Estimate	Confidence Rating
	the strengths and limitations of reasonably available data.	
Distribution in Commerce	EPA did not quantitatively assess exposures for an OES of Distribution in Commerce. Activities associated with loading and unloading chemical products were assessed as part of each COU's OES. It is possible that <i>trans</i>-1,2-dichloroethylene may go through a third party for temporary storage/warehousing before distribution to users. If repackaging takes place at these facilities involving transfer from larger to smaller containers, EPA assessed this under the OES of repackaging. Transport containers are not expected to be opened during transport between producing and receiving sites. EPA expects all the <i>trans</i>-1,2-dichloroethylene containing products to be transported in a closed system such that there is negligible potential for releases. Therefore, no occupational exposures are reasonably expected to occur and no separate assessment was performed for estimating releases and exposures from distribution in commerce. Speculative exposures that may result from irregular and unpredictable accidental spills during transport are not assessed by EPA in TSCA Risk Evaluations. <i>Weight of Scientific Evidence Conclusion:</i> Based on this information, EPA has concluded that the weight of scientific evidence for this assessment provides a robust estimate of releases.	
COU = condition of use; DMR = Discharge Monitoring Report; OES = occupational exposure scenario; POTW = publicly owned treatment works; TRI = Toxics Release Inventory; WWT = wastewater treatment		

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5 AMBIENT AIR PATHWAY EXPOSURE ASSESSMENT

EPA expects ambient air to be a potential exposure pathway for *trans*-1,2-dichloroethylene. *trans*-1,2-Dichloroethylene is released from industrial facilities as uncontrolled fugitive releases such as process equipment leaks, process vents, building windows, building doors, and roof vents. It is also released from industrial facilities as stack releases, which may be either uncontrolled (*e.g.*, direct releases out a stack) or controlled with a pollution control device (*e.g.*, baghouse, scrubber, thermal oxidizer). Once released to ambient air, *trans*-1,2-dichloroethylene can move off-site into the surrounding areas where human populations may be exposed through inhalation. The ambient air exposure assessment focuses on exposures to a subset of the general population living near industrial facilities that are releasing *trans*-1,2-dichloroethylene to the ambient air in Section 5.2.

5.1 Monitoring Information

5.1.1 Air Quality System (AQS) Monitoring Dataset (2018–2025)

Available ambient air monitoring data from the AQS for the period 2018-2025 is summarized below. In 2020, data was collected at 2,498 AQS sites. Monitor locations are determined in a cooperative process beginning with federal minimum siting requirements followed by state, local, and tribal monitoring plans which are submitted to the EPA. The goals of monitoring vary by network and parameter (for example, a monitor may be sited to provide population exposure, determine background pollution levels, for pollution source surveillance, make near roadway assessments, meet permit requirements, etc.). The *trans*-1,2-dichloroethylene AQS data includes 26 states' monitoring information. All data points from AQS, which EPA relied upon for this ambient air pathway exposure assessment for *trans*-1,2-dichloroethylene is provided in the supplemental file, *Draft Air Quality System Data 2018-2025 for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026c](#)).

The evaluated AQS archive dataset included 35,403 reported concentrations between 2018-2025 from 178 monitoring stations in the United States. A high percentage of sites (81% or 28,676) reported *trans*-1,2-dichloroethylene concentrations as zero⁴. The air monitoring samples were collected from each site several times per month. Some of the concentrations listed above zero come from the same site, but many of the concentrations above zero span across several monitoring stations in more than 20 states.

Overall, there were 6,741 reported values across the entire AQS archive dataset evaluated for *trans*-1,2-dichloroethylene. The reported monitored concentrations ranged from 0 to 34.89 µg/m³, with the average mean reported concentration at 0.030 µg/m³. The highest modeled concentrations for both stack and fugitive outdoor for the TRI facilities were estimated to be 32.49 µg/m³, which is similar to the monitoring data from AQS.

EPA summarized AQS monitoring data in this section to contextualize exposures and potential impacts on the general population or terrestrial species. However, because the monitoring data cannot be used to evaluate contributions from TSCA sources, EPA chose to use TRI release data to model exposures. The highest modeled outdoor concentrations for total releases (stack and fugitive aggregated) for the TRI facilities are 32.49 µg/m³, which are within the same magnitude of the monitoring data from AQS (maximum value of 34.89 µg/m³).

⁴ Air Quality System dataset does not report the method detection limit (MDL) or samples as below MDL (<MDL) or non detects (NDs); these values are reported as zeros.

5.2 Modeling Approaches and Estimates for Ambient Air Concentrations

EPA conducted a screening analysis to model TRI facility and EPA estimated generic scenario releases to model concentrations of *trans*-1,2-dichloroethylene in ambient air for the ambient air pathway exposure assessment. This draft risk evaluation used a screening-level analysis as shown in Section 5.2.1.

5.2.1 Screening Level Analysis

The screening analysis used EPA's Integrated Indoor/Outdoor Air Calculator ([IIOAC](#)) Model to estimate both mean (50th percentile) and high-end (95th percentile) daily and annual average concentrations of a chemical in the ambient air at two finite distances (100 and 1,000 m) and one area distance (100–1,000 m) from the releasing facility. The IIOAC Model outputs are based on results from a suite of pre-run scenarios within the American Meteorological Society/Environmental Protection Agency Regulatory Model ([AERMOD](#)) using a variety of meteorological and land-use settings.

While the pre-run scenarios include a variety of meteorological and land-use settings, the IIOAC Model is limited by the parameterizations utilized for those pre-run scenarios (meteorologic data, stack heights, distances, exposed population, etc.). Additional information on IIOAC can be found in the user guide ([U.S. EPA, 2019d](#)).

The results from IIOAC informed a screening-level assessment of general population exposures near industrial sources, identifying facilities and conditions of use (COUs) that may warrant refined modeling in a higher-tier analysis.

EPA Estimated Generic Scenarios

For the EPA estimated generic scenarios, EPA used the high-end (95th percentile) for the EPA estimated daily releases of *trans*-1,2-dichloroethylene for all OESs listed in Table 5-2 as direct inputs to the IIOAC model. These EPA estimated releases are based on production volumes from facilities that manufacture, process, repack, or dispose of *trans*-1,2-dichloroethylene. Since the release type is unknown, under the methodology used, EPA assumed the entire release was either all fugitive or all stack releases and models the entire release as each type. While this assumption captures the highest release for both stack and fugitive, it limits the analysis to exposure from an individual release type, which may overestimate ambient concentrations of *trans*-1,2-dichloroethylene.

TRI Facility Releases

EPA selected the highest TRI reported stack and fugitive releases across all facility data between 2019 to 2023, which has an operating scenario representing industrial facilities releasing *trans*-1,2-dichloroethylene to the ambient air operating 24 hours/day, 7 days/week. This is a conservative assumption for this screening-level estimate, in which, facilities are constantly releasing *trans*-1,2-dichloroethylene every day and every hour throughout the year. See Table 5-3 for more details.

Because *trans*-1,2-dichloroethylene is volatile, it has the potential to volatilize from surface soils based on its low Henry's Law constant and is not expected to be present in land-applied biosolids, EPA does not evaluate deposition from ambient air to water or soil in this screening-level analysis.

5.2.1.1 Methods and Inputs

IIOAC can model a variety of user defined input parameters and exposure scenarios, including varying release scenarios/patterns, release types, release durations, urban/rural settings (topography), and meteorological conditions. Modeled concentration outputs from IIOAC for each release type are then summed together by facility and year to give a "total" exposure from both release types at each distance

evaluated for each facility. EPA modeled stack and fugitive releases using the default parameters integrated within the IIOAC, along with a user-defined length and width for fugitive releases shown in Table 5-1.

Table 5-1. IIOAC Default Input Parameters for Stack and Fugitive Air Releases

Stack Release Parameters	Value	Fugitive Release Parameters	Value
Stack height (m)	10	Length (m)	10
Stack diameter (m)	2	Width (m)	10
Exit velocity (m/sec)	5	Angle (°)	0
Exit temperature (K)	300	Release height (m)	3.05

For this assessment, modeled air concentrations from IIOAC are based on the following:

1. EPA estimated releases for EPA estimated generic scenarios for the OESs listed in Table 5-2 (no NEI/TRI release data reported). The release frequencies were more closely aligned with the specific OES. See Table 5-2 for the specific numbers of days per year by OES.
2. EPA selected the highest TRI reported stack and fugitive releases across all facility data between 2019 to 2023, which has an operating scenario representing industrial facilities releasing *trans*-1,2-dichloroethylene to the ambient air operating 24 hours/day, 7 days/week. This is a conservative assumption for this screening-level estimate, in which, facilities are constantly releasing *trans*-1,2-dichloroethylene every day and every hour throughout the year. The release data from TRI includes both *cis* and *trans* for 1,2-dichloroethylene. The TRI data is combined for ease of reporting from facilities. This may result in an over-estimate of releases. See Table 5-3 for highest stack and fugitive releases by facility.

Application of the meteorology patterns from the Lake Charles, Louisiana (south coastal), meteorological station to every facility (regardless of the facility's geographic location), and assumption of a "rural" land designation for fugitive releases and "urban" land designation for stack releases for every facility. These designations of meteorology and land settings are recommended in the IIOAC user guide ([U.S. EPA, 2019d](#)) because they are the most conservative location, which can be modeled in IIOAC. These assumptions result in conservative air concentrations that are appropriate for a screening-level assessment.

Table 5-2. EPA Estimated Releases for Generic Scenarios for *trans*-1,2-Dichloroethylene

Exposure Scenario Name	Release Types	Releases (kg/site/day)	Release Frequency (days/year)
Vapor Degreasing – 95th Release	Stack or Fugitive	31.9	296
Use of Adhesives – 95th Release	Stack or Fugitive	1,177.4	250
Use as a Blowing Agent in Spray Foam – 95th Release	Stack or Fugitive	1.02	260
Laboratory Chemicals – 95th Release	Stack or Fugitive	0.11	258
Aerosol Degreasing – 95th Release	Stack or Fugitive	5.49	250
Import-Repackaging – 95th Release	Stack or Fugitive	0.63	119

Table 5-3. Highest TRI Stack and Fugitive Facility Releases

TRI Facility Name	Release Types	Releases (kg/site/day)	Release Frequency (days/year)
3M Chemical Operations Cordova Facility	Stack	3.989	365
Embecta – Holdrege	Fugitive	35.89	365
	Total Releases	39.88	365

The facility-reported information for the maximum single fugitive and stack releases used for the screening-level modeling do not align either spatially or temporally. EPA assumes these releases occur from a single facility, at the same time, and the same year. This results in highly conservative, upper-bound exposure concentrations (and associated risk estimates) appropriate for a screening-level analysis and ensures higher releases and exposures (and associated risk estimates) are not missed. This also provides EPA high confidence the exposures (and associated risk estimates) are health protective.

5.2.1.2 Modeled Concentrations and Findings

IIOAC provides output values for daily-average and annual-average mean (50th percentile) and high-end (95th percentile) ambient air concentrations in circular rings at two finite distances (100 and 1,000 meters) and one area distance (100–1,000 m) from releasing facilities. These distances are also referred to as “fenceline,” “outer-boundary” and “community average,” respectively, in IIOAC. The daily-average values are obtained by adding all modeled hourly concentrations for each day evaluated.

The annual average is a 365-day rolling average of each daily average value across the 5 years of meteorological data modeled in IIOAC. Since releases were modeled in IIOAC based on the assumption that facilities are releasing *trans*-1,2-dichloroethylene to the ambient air with a steady, continuous release over time, operating 24 hours/day, with varying days per year of releases based on the generic scenarios as shown in Table 5-2, the daily-average and annual-average concentrations are equal.

The 95th percentile concentration at each distance ring (100, 100–1,000, and 1,000 m) is the 95th percentile modeled concentration across the entire distribution of modeled concentrations at each distance per facility per reporting year. Generally, for the finite distances, the 95th percentile represents a downwind concentration at a modeled exposure point where a resident lives downwind of the industrial release, considering a non, site-specific estimate for dispersion and dilution. Additional information on IIOAC Model outputs can be found in the user guide ([U.S. EPA, 2019d](#)).

Table 5-4 presents both the 50th and the 95th modeled annual concentrations from the stack releases for each OES. The mean (50th percentile) modeled concentrations ranged from 8.14 to 46.6 µg/m³ across all generic scenario OESs. The 95th percentile ambient air modeled concentrations across all generic scenario OESs and modeled distances ranged from 9.41 to 74.2 µg/m³ with the highest modeled concentration at 100 m. Highest modeled concentrations were associated with the OES: Use of Adhesives. For full IIOAC modeling results, see the supplemental file: *Draft Integrated Indoor Outdoor Air Calculator (IIOAC) Exposure and Risk Analysis for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026n](#)).

Table 5-4. IIOAC-Modeled Annual Concentrations from EPA Estimated Generic Scenario Stack Releases

Occupational Exposure Scenario (OES)	Maximum 50th Percentile Modeled Concentration (µg/m ³)			Maximum 95th Percentile Modeled Concentration (µg/m ³)		
	Distance			Distance		
	100 m	100–1,000 m	1,000 m	100 m	100–1,000 m	1,000 m
Vapor Degreasing	1.48	0.483	0.261	2.13	0.555	0.291
Use of Adhesives	46.6	15.1	8.14	74.2	18.7	9.41
Use as a Blowing Agent in Spray Foam	4.21E-02	1.37E-02	7.38E-03	6.56E-02	1.66E-02	8.45E-03
Laboratory Chemicals	4.62E-03	1.50E-03	8.09E-04	7.22E-03	1.83E-03	9.28E-04
Aerosol Degreasing	2.17E-01	7.02E-02	3.79E-02	3.46E-01	8.70E-02	4.39E-02
Import-Repackaging	1.19E-02	3.83E-03	2.06E-03	2.61E-02	6.18E-03	2.82E-03

Table 5-5 presents both the 50th and the 95th modeled annual concentrations from the fugitive releases for each OES. The mean (50th percentile) modeled concentrations ranged from 5.43×10^{-3} to 1270 µg/m³. The 95th percentile ambient air modeled concentrations across all OESs, reporting years and modeled distances ranged from 6.61×10^{-3} to 1460 µg/m³ with the highest modeled concentration at 100 m. The highest modeled concentrations were associated with the OES: Use of Adhesives. For full IIOAC modeling results, see the supplemental file: *Draft Integrated Indoor Outdoor Air Calculator (IIOAC) Exposure and Risk Analysis for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026n](#)).

Table 5-5. IIOAC-Modeled Annual Concentrations from EPA-Estimated Generic Scenario Fugitive Releases

Occupational Exposure Scenario (OES)	Maximum 50th Percentile Modeled Concentration (µg/m ³)			Maximum 95th Percentile Modeled Concentration (µg/m ³)		
	Distance			Distance		
	100 m	100–1,000 m	1,000 m	100 m	100–1,000 m	1,000 m
Vapor Degreasing	40.7	1.75	4.61	45.8	5.30	2.11
Use of Adhesives	1,270	54.6	66.5	1.46E03	1,670	66.5
Use as a Blowing Agent in Spray Foam	1.15	4.95E-02	0.13	1.31	0.15	6.02E-02
Laboratory Chemicals	0.13	1.43E-02	5.43E-03	0.14	1.65E-02	6.61E-03
Aerosol Degreasing	5.91	0.25	0.67	6.79	0.78	0.31
Import-Repackaging	0.3	3.63E-02	1.38E-02	0.39	0.45	1.73E-02

EPA also modeled the highest stack and fugitive TRI release in IIOAC. The purpose of considering the highest estimated fugitive and stack concentrations individually was to inform whether one or both release types are driving general population exposures to *trans*-1,2-dichloroethylene. The purpose of considering total concentrations was to characterize total exposure of the general population to *trans*-1,2-dichloroethylene.

Table 5-6 summarizes the highest daily and annual average modeled concentrations from the screening-level analysis for TRI facilities. Table 5-7 summarizes the highest daily and annual average modeled concentrations for the generic scenarios. The highest modeled concentrations from this screening analysis and associated findings occurred at 100 m from the modeled release point.

Table 5-6. Comparison: Modeled TRI Facility Daily and Annual Average Concentrations

Release Type	Highest Modeled Outdoor Air Concentrations ($\mu\text{g}/\text{m}^3$)	
	Daily Average	Annual Average
Fugitive	32.2	32.2
Stack	0.286	0.286
Total Concentrations	32.5	32.5

Table 5-7. Comparison: Modeled EPA Estimated Generic Scenario Stack and Fugitive Daily and Annual Average Concentrations

OES Type	Highest Modeled Outdoor Air Concentrations (100m) ($\mu\text{g}/\text{m}^3$)			
	Stack Daily Average	Stack Annual Average	Fugitive Daily Average	Fugitive Annual Average
Vapor Degreasing	2.63	2.13	56.5	45.8
Use of Adhesives	108.0	74.2	2,130	1,460
Use as a Blowing Agent in Spray Foam	9.20E-02	6.56E-02	1.84	1.31
Laboratory Chemicals	1.02E-02	7.22E-03	0.204	0.144
Aerosol Degreasing	0.504	0.346	9.91	6.79
Import-Repackaging	8.00E-02	2.61E-02	1.21	0.394

Conclusions from the Screening Level Analysis

In this ambient air screening-level analysis, EPA modeled the highest stack and fugitive facility TRI releases, and six EPA estimated generic scenario releases with the IIOAC Model to generate concentrations. The highest stack and fugitive TRI industrial releases of trans-1,2-dichloroethylene to the ambient air did not result in non-cancer acute or chronic margin of exposures (MOEs) below the respective benchmarks. Therefore, EPA determined additional, refined analysis are not necessary.

This is based on the conservative aspects of the screening-level analysis and the finding that none of the conservative, upper bounding modeled daily or annual average concentrations from the screening-level analysis resulted in calculated risk estimates (MOEs) below the relative benchmark for acute or chronic non-cancer effects. If the modeled daily and annual average concentrations did not result in calculated risk estimates (MOEs) less than the relative benchmark for acute and chronic non-cancer effects, then lower or less conservative, non-bounding modeled daily average concentrations are also not expected to result in calculated risk estimates (MOEs) less than the relative benchmark.

All calculated MOEs for GS releases were above the respective acute and chronic non-cancer benchmarks, except for the GS COU Use of adhesives. The generic scenario releases are expected to be a high-end scenario. There are several reasons to assume high-end:

- The data from the GSs are based on total production volume for all chemicals used in the facilities and does not distinguish *trans*-1,2-dichloroethylene from all other chemicals.
- The GSs do not consider engineering controls for these facilities.
- The GSs cannot attribute emissions to either stack or fugitive.
- The inputs into the IIOAC Model were 95% of releases versus using the mean.
- None of the TRI facility releases were above the benchmark using the IIOAC Model.
- The TRI releases include both *cis*- and *trans*-1,2-dichloroethylene, which is a high-end assumption and scenario.
- The 100 m release point may also be within facility boundaries.
- The GS includes high-end release estimates, which are orders of magnitude higher than reported releases from TRI facilities.
- Application of the meteorology patterns from the Lake Charles, Louisiana (south coastal), meteorological station to every facility (regardless of the facility's geographic location), and assumption of a "rural" land designation for fugitive releases and "urban" land designation for stack releases for every facility. These designations of meteorology and land settings are recommended in the IIOAC user guide ([U.S. EPA, 2019d](#)) for when conservative estimates are desired. These assumptions result in conservative air concentrations that are appropriate for a screening-level assessment and, therefore, likely overestimate emissions and potential exposure to the general population.

Therefore, EPA determined additional, refined analyses are not necessary for most OESs. The Agency did not conduct additional refined analyses for the Application of Adhesive and Sealants OES because the GSs do not have the necessary information required to refine with HEM (i.e. facility information, local met data). For more information on the GS for the Application of Adhesive and Sealants, see Section 4.2.10.

5.3 Environmental Exposures from Ambient Air

The same ambient air concentrations presented in Section 5.2.1.2 are used for both general population and environmental exposure (e.g. plants and terrestrial mammals). EPA considered exposures to *trans*-1,2-dichloroethylene via the ambient air pathway for terrestrial plants by direct contact exposure and for terrestrial mammalian wildlife by inhalation. As outlined in Section 5.2.1, EPA estimated concentrations of *trans*-1,2-dichloroethylene in ambient air from stack releases (Table 5-4) and fugitive emissions (Table 5-5) using the EPA's Integrated Indoor-Outdoor Air Calculator (IIOAC) ([U.S. EPA, 2019d](#)). The *Draft Risk Evaluation for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)) evaluated ambient air exposures for mammals by inhalation and terrestrial plants for each OES based on the estimated ambient air concentrations (both 50th and 95th percentile predicted concentrations) from stack and fugitive emissions for 100 m distance from the facility, which represents the highest anticipated exposure and a conservative estimate of risk. The highest reported release at 100 m was the 95th percentile of exposure from a facility specific fugitive release from the OES of Use of Adhesives at 100m.

5.4 Conclusions and Weight of Scientific Evidence

Based on the physical and chemical properties of *trans*-1,2-dichloroethylene described in Section 2, the fate and transport properties (Section 3) (including persistence in air and volatilization from surface soils), reported releases to ambient air described in Section 4, and available ambient air monitoring data, inhalation is expected to be a primary route of exposure of the general population to *trans*-1,2-

dichloroethylene.

Because EPA used the IIOAC-modeled results as a screening-level analysis to see if one or more facilities/COUs may result in exposure (and associated risk) concerns, the Agency used the IIOAC-modeled concentration results to derive screening-level acute and chronic non-cancer estimates. The screening-level risk estimates are used to inform whether a higher-tier/more refined exposure analysis is warranted.

Inhalation exposure of the general population via the ambient air pathway resulting from TRI industrial releases of *trans*-1,2-dichloroethylene to the ambient air did not show modeled concentrations for acute or chronic non-cancer effects below the benchmark. Therefore, EPA determined additional, refined analyses are not necessary.

This is based on the conservative aspects of the screening-level analysis and the finding that none of the conservative, upper bound modeled daily or annual average concentrations from the Tier 1 analysis resulted in calculated risk estimates (MOEs) less than the relative benchmark for acute or chronic non-cancer effects. If the modeled daily and annual average concentrations did not result in calculated risk estimates (MOEs) less than the relative benchmark for acute and chronic non-cancer effects, then lower or less conservative, non-bounding modeled daily average concentrations are also not expected to result in calculated risk estimates (MOEs) less than the relative benchmark.

Inhalation exposure of the general population via the ambient air pathway resulting from generic scenario fugitive and stack modeled releases of *trans*-1,2-dichloroethylene to the ambient air did not result in calculated risk estimates (MOEs) less than the relative benchmark for both acute and chronic non-cancer effects for any of the OESs between 100-1000 m and at 1000 m. However, results below the benchmark were shown for chronic non-cancer effects for both high-end and mean at 100m for 1 OES: Use of adhesives. None of the other GS OESs resulted in MOEs higher than the benchmark at any of the distances modeled. See Section 5.2.1.2 for additional explanation as to why this particular EPA estimated generic scenario would have low confidence.

With GSs, there are no data associated with specific facilities. Therefore, moving onto a more refined scenario like HEM would not be possible. EPA determined additional, refined analyses are not necessary. For more information on the GS Use of Adhesives, see Section 4.2.10.

TRI Dataset

EPA has robust confidence in the use of facility-reported release data from TRI as model inputs. Modeled results using the TRI dataset were used to derive exposure concentrations at distances from releasing facilities where individuals and ecological organisms reside for many years. The use of release data across multiple years of data provides a comprehensive ambient air exposure assessment and helps ensure higher release years are not missed which provides added confidence to EPA's use of modeled concentrations to characterize exposures. Furthermore, use of actual reported TRI releases provides added confidence that modeled concentrations and exposures are representative of exposures from facility-reported releases and not hypothetical.

There are several assumptions, strengths, limitations, and uncertainties associated with the TRI dataset. One strength of the TRI-reported releases is they are industry reported releases which are required by statute and submitted annually. Additionally, the TRI-reported releases generally capture the highest releasing facilities across the nation due to certain reporting requirements within the statute and applicable regulations. Since TRI releases are reported annually, the 6 years of TRI release data

evaluated for *trans*-1,2-dichloroethylene provide greater confidence that higher years of release are not missed and maintains a higher level of health protection. This adds confidence that the TRI dataset captures the facilities with the greatest impact on ambient concentrations, exposures, and risks.

AQS Dataset

EPA presented monitoring data from the AQS. When EPA-modeled concentrations are compared to AQS monitoring data, modeled concentrations are within the same order of magnitude as monitored concentrations, and this is supported through the findings of ([Padilla et al., 2024](#)) that nationwide comparisons of measured concentrations of 79 HAPS were higher than modeled concentrations in 74% of comparisons over all monitors, chemicals, and years assessed. This finding supports the conclusion that EPA's modeling estimates are unlikely to be underestimates of ambient concentrations of *trans*-1,2-dichloroethylene, which further strengthens EPA's reliance on modeled concentrations to derive risk estimates. This confidence statement is consistent with the 2021 Draft Systematic Review Protocol ([U.S. EPA, 2021c](#)). The highest modeled outdoor concentrations for total releases (stack and fugitive aggregated) for the TRI facilities are 32.49 ug/m³, which are within the same magnitude of the monitoring data from AQS (maximum value of 34.89 ug/m³).

Taken together, the various modeling and monitoring lines of evidence considered by EPA in this general population exposure assessment for *trans*-1,2-dichloroethylene give the Agency robust confidence in its characterization of general population exposures.. EPA has robust confidence as described above to demonstrate that the EPA methodologies and models used for this general population *trans*-1,2-dichloroethylene assessment do not overestimate exposures via the ambient air pathway.

IIOAC Modeling Tool

The approach and methodology presented in this assessment replicates previously peer-reviewed approaches and methods that underwent public comment and incorporates recommendations by peer reviewers and public comments to provide a more comprehensive exposure assessment. As such, EPA has robust confidence in the IIOAC modeling used in this assessment to evaluate high-end, conservative, health-protective exposure scenarios to inform whether there are exposures (and associated risk estimates) of concern that warrant more refined analyses.

Strengths of this ambient air exposure assessment include use of actual environmental release data from multiple years that are reported by industry, as required by statute, and undergoes repeatable quality assurance quality control reviews ([U.S. EPA, 2025b](#)). These release data are used as direct inputs to two separate EPA peer-reviewed models (IIOAC and AERMOD) to estimate concentrations at several distances from releasing facilities where individuals may reside for many years.

Although IIOAC was used as a screening tool, a general limitation of IIOAC is that the modeling is based on pre-run scenarios within AERMOD. As such, default input parameters for IIOAC are confined to those input parameters utilized for those pre-run AERMOD scenarios and cannot be changed, including default stack parameters, 2011 to 2015 meteorological data, and the lack of site-specific information like building dimensions, stack heights, elevation, and land use.

Based on overall confidence levels for the input data and for the modeling tools, EPA has robust confidence in this ambient air assessment. EPA has robust confidence as described above to demonstrate that the EPA methodologies and models used for this general population *trans*-1,2-dichloroethylene assessment do not overestimate exposures via the ambient air pathway.

6 SURFACE WATER AND SEDIMENT PATHWAY ASSESSMENT

For the evaluation of surface water and aquatic sediment, EPA reviewed available monitoring data and modeled facility-specific and generic scenario releases to surface water. The Agency searched peer-review literature, gray literature and databases of environmental monitoring data to obtain concentrations of *trans*-1,2-dichloroethylene in ambient surface water, aquatic sediments and drinking water (Section 6.1). While it is often difficult to directly compare monitored values to potential modeled releases since measured concentrations are commonly not temporally or geographically coincident to known chemical releases, these monitoring data are used to provide, where possible, contextual and supporting information to modeled releases that constitute the bulk of analysis in the surface water and sediment pathways.

EPA modeled *trans*-1,2-dichloroethylene concentrations in surface water resulting from facility-specific and generic scenario releases from COUs (COUs presented in Table 4-1). Seven OESs supporting the COUs had facility-specific release information reported to TRI and DMR databases that were used for modeling, while potential water releases for two OESs were estimated from generic scenarios (see Section 4 for discussion of generic scenarios) (Table 6-1).

Table 6-1. Modeled Facility-Specific Release and Generic Scenario Release Occupational Exposure Scenarios (OESs) for the Surface Water Pathway

<i>Facility-Specific Release OESs</i>
Manufacturing
Manufacturing as a Byproduct
Processing – Incorporation into Formulation, Mixture or Reaction Product
Waste Handling, Treatment, and Disposal (Landfill)
Waste Handling, Treatment, and Disposal (Non-POTW WWT)
Waste Handling, Treatment, and Disposal (POTW)
Waste Handling, Treatment, and Disposal (Remediation or Monitoring)
<i>Generic Scenario Release OESs</i>
Blowing Agent in Spray Foam
Vapor Degreasing

Section 6.2.1 presents the approach and results of EPA-modeled surface water concentrations from both reported facility releases and estimated facility releases from generic scenarios. Section 6.2.2 presents the approach and results of EPA-modeled drinking water concentrations and Section 6.3 presents the evaluation of aquatic sediment.

Exposures to both the general population and environmental populations were then evaluated. General population exposure via dermal exposure to surface water while swimming is described in Section 6.4.1, oral exposure to surface water while swimming in Section 6.4.2, drinking water in Section 6.4.3, and fish ingestion in Section 6.4.4; and exposures to the environmental populations described in Section 6.5.

6.1 Measured Concentrations

6.1.1 Measured Concentrations in Surface Water

Surface water concentration results were acquired from the [Water Quality Portal](#) (accessed July 28, 2026), which represents the largest repository by scope and duration with nationwide coverage for the years of 2015 to 2025 and houses publicly available water quality data from the U.S. Geological Survey (USGS), EPA, and state, Tribal, and local agencies. Sampling programs were generally not designed to target specific chemical occurrences (timing, frequency, site selection) or COUs, and sampling frequency is typically sporadic in nature. For the years 2015 to 2025, a total of 1,094 *trans*-1,2-dichloroethylene samples from 255 locations were retrieved from 21 states with the highest number of samples coming from North Dakota, Utah, California, and Washington (Figure 6-1; Figure 6-2). *trans*-1,2-dichloroethylene samples were across a range of detection limits from 0.025 to 10 µg/L. Of the 1,094 samples, only 83 reported detectable concentrations of *trans*-1,2-dichloroethylene at or above their respective detection limits with concentrations and ranged from 0.037 to 1 µg/L with a median and 95th percentile value of 0.2 µg/L. All but two of the surface water samples with a detectable concentration came from multiple locations over multiple years at the Palermo Wellfield Superfund site in Washington state. Two other samples from Texas ranged from 0.037 to 0.043 µg/L Full details of retrieved surface water samples are available in *Draft Surface Water and Sediment Monitoring Data for trans-1,2-Dichloroethylene* supplemental file ([U.S. EPA, 2026v](#)).

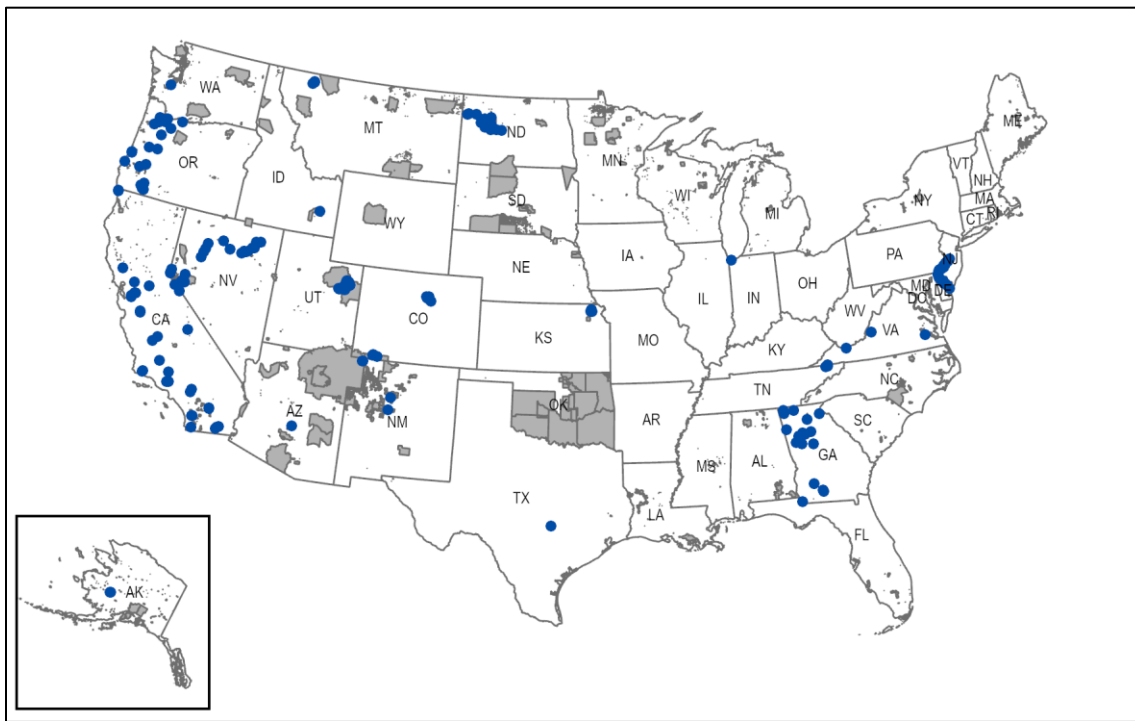


Figure 6-1. Surface Water Sampling Locations for *trans*-1,2-Dichloroethylene Retrieved from the Water Quality Portal (2015–2025)

American Indian/Alaska Native/Native Hawaiian (AIANNH) tribal boundaries are shaded in gray as found at U.S. Census Bureau⁵. Note: American Samoa, Guam, Hawaii, N. Mariana Islands, Puerto Rico, and the U.S. Virgin Islands not shown because the WQP does not contain *trans*-1,2-dichloroethylene surface water monitoring for these locations.

⁵ Available at:

<https://www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2025&layergroup=American+Indian+Area+Geography> (accessed July 28, 2026).

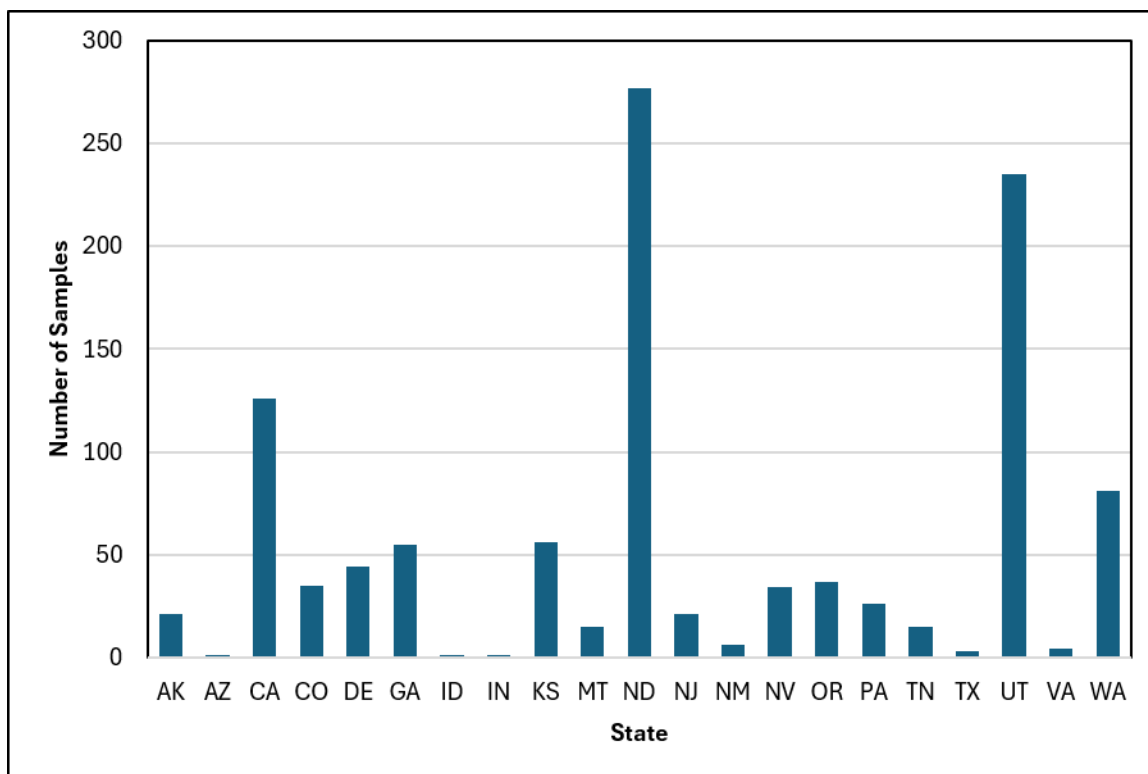


Figure 6-2. Number of Retrieved Surface Water Samples per State as Reported in the Water Quality Portal (2015–2025)

6.1.2 Measured Concentrations in Sediment

Sediment concentration results were acquired from the Water Quality Portal (WQP) (Available at: www.waterqualitydata.us; accessed July 7, 2026). Sampling programs were generally not designed to target specific chemical occurrences (timing, frequency, site selection) or COUs and sampling frequency is typically sporadic in nature. A review of WQP data from 2015 to 2025 provided limited evidence of measured concentrations in sediment. A total of 351 *trans*-1,2-dichloroethylene samples from 151 locations were retrieved from the WQP with a range of detection limits from 0.96 to 110,000 µg/kg for individual samples (Table 6-2). Greater than 90% of the samples were collected as part of the EPA Great Lakes National Program (n = 318) for a variety of sampling locations throughout the Great Lakes region. The Great Lakes National Program Office maintains a monitoring program across the Great Lakes to measure changes in water quality over time.⁶ For all samples, values were recorded at or below the reported detection limit indicating that monitored concentrations are uniformly low. Full details of retrieved sediment samples are available in the *Draft Surface Water and Sediment Monitoring Data for trans-1,2-Dichloroethylene* supplemental file ([U.S. EPA, 2026v](#)).

⁶ More information about EPA's Great Lakes National Program Office monitoring program available at: <https://www.epa.gov/great-lakes-monitoring/great-lakes-water-quality-monitoring-program-0> (accessed July 28, 2026)

Table 6-2. Measured Concentrations of *trans*-1,2-Dichloroethylene in Sediment Samples Obtained from the Water Quality Portal (WQP): 2015–2025

Year(s)	Reporting Organization	Samples	Reported Values
2015, 2020, 2021	EPA Great Lakes National Program, Great Lakes (136 locations)	318	Estimated value and/or under reported DL or QL of 5.2–110,000 µg/kg or 1 µg/L ^b depending on sample
2021	Palermo Wellfield Superfund Site, WA (5 locations)	5	All listed as <DL of 0.96–4.8 µg/kg, depending on sample
2019	USGS TX Water Center, TX (9 locations)	28	All listed as < DL of 89–410 µg/kg, depending on sample

DL = detection limit; QL = quantification limit
^a Data downloaded from the WQP (www.waterqualitydata.us) on January 12, 2026; full details available in the *Draft Surface Water and Sediment Monitoring Data for trans-1,2-Dichloroethylene* supplemental file ([U.S. EPA, 2026v](#)).
^b Concentrations reported as µg/L are more consistent with saturation or unconsolidated sediments.

6.1.3 Measured Concentrations in Drinking Water

trans-1,2-Dichloroethylene is a regulated drinking water contaminant and included in the periodic six-year review (SYR) monitoring efforts under the Safe Drinking Water Act (SDWA). The most recent data are available from 2024 for the fourth iteration of the review (SYR 4) and presents *trans*-1,2-dichloroethylene monitoring data from 2012 to 2019 collected from public water systems (PWS) nationwide ([U.S. EPA, 2024](#)). Data collected from 52,194 PWSs reported that 175 systems (0.34% of all systems) representing a potential of more than 3.9 million people (1.44% of all population served) had at least a single detection of *trans*-1,2-dichloroethylene with a range of detected concentrations from 0.25 to 5.2 µg/L (5th to 95th percentile; no mean value reported) given a minimum reporting level (MRL) for *trans*-1,2-dichloroethylene of 0.5 µg/L. This detection frequency is similar to previous six-year review cycles which showed PWS detection frequencies of 0.53% (SYR 1, 1993–1997); 0.19% (SYR 2, 1998–2005); and 0.27% (SYR 3, 2006–2011). None of the systems with a detection in the SYR 4 cycle had a detection greater than the maximum contaminant level (MCL) of 100 µg/L and is consistent with previous reporting cycles showing no systems with detections exceeding the MCL. This methodology employed by the SYR of reporting occurrences represents a conservative approach based on whether a system has at least one detection or at least one detection with a concentration greater than the MCL ([U.S. EPA, 2024](#)).

6.1.4 Measured Concentrations in Tissues of Aquatic Organisms

There are limited data available on *trans*-1,2-dichloroethylene concentrations in fish and invertebrates. Data are reported for other chlorinated solvents; however, was used to inform the exposure assessment. For other chlorinated solvents, a study in Lake Pontchartrain in Louisiana found 1,2-dichloroethane concentrations of 9.5×10^{-2} µg/g ww (wet weight) in oysters (*Crassostrea virginica*; N=5) and 1.0×10^{-3} to 1.5×10^{-3} µg/g ww in clams (*Rangia cuneata*; sample size and LOD not reported; ([Ferrario et al., 1985](#))). Other similar chlorinated solvents, including 1,1,1-trichloroethane, 1,1-dichloroethane, and trichloroethylene, reported concentrations of 6.0×10^{-4} to 0.31 µg/g ww in oysters (*C. virginica* and *C. gigas*; N=5 or not reported) and 8.0×10^{-4} to 0.16 µg/g ww in clams (*R. cuneata* and *Tapes japonica*; sample size not reported, ND for 1,1-dichloroethane), in the same Lake Pontchartrain study as well as in a study in Japan (limit of quantitation [LOQ] = 1.0×10^{-4} µg/g or not reported) ([Gotoh et al., 1992](#); [Ferrario et al., 1985 28993](#)). A study in coastal Japan reported a concentration of 0.28 µg/g ww 1,2-dichloroethane in mussels (*Mytilus edulis*; N=2), and similar concentration (0.28 µg/g ww; n = 2) of 1,1,2,2-tetrachloroethane (non-detects [ND] and limit of detection [LOD] not reported; ([Yasuhara and](#)

[Morita, 1987](#)). No reasonably available data on *trans*-1,2-dichloroethylene concentrations in fish tissue were identified; however, data in fish muscle and liver tissue for other chlorinated solvents ranged from 5.1×10^{-4} to 4.9×10^{-3} $\mu\text{g/g ww}$ for 1,1,1-trichloroethane ($n = 9\text{--}20$; $\text{LOD} = 6 \times 10^{-6}$ $\mu\text{g/g ww}$) and 3.6×10^{-4} to 2.9×10^{-2} $\mu\text{g/g ww}$ for trichloroethylene ($n = 6\text{--}20$; $\text{LOD} = 2 \times 10^{-5}$ $\mu\text{g/g ww}$) (ND not reported) ([Roose and Brinkman, 1998](#)). One study in Oslo, Norway, tested for but did not detect 1,2-dichloroethane and trichloroethylene in fish livers (cod [*Gadus morhua*]), fish fillets (perch [*Perca fluviatilis*] and roach [*Rutilus rutilus*]), whole fish (perch, ruffe [*Acerina cernua*] and minnow [*Phoxinus phoxinus*]), blue mussels [*Mytilus edulis*], snails [*Littorina sp.*], shrimp [*Pandalus borealis*], krill [*Meganyctiphanes norvegica*], and crayfish [*Astacus astacus*]; detection limit of 2.0×10^{-2} $\mu\text{g/g dw}$ (dry weight) ([COWI AS, 2018](#)).

6.2 Modeling Approach and Estimates for Surface Water and Drinking Water Concentrations

6.2.1 Surface Water Concentrations

trans-1,2-Dichloroethylene is known to be released to surface waters from industrial operations and wastewater treatment plant facilities as covered under COUs. EPA modeled facility-specific identified releases and potential generic scenario releases associated with relevant OESs of *trans*-1,2-dichloroethylene to surface water based on both reported facility-specific releases to the TRI and DMR databases between 2019 and 2023 as well as estimated generic scenario releases based on OES. The modeled surface water concentrations were used to evaluate different exposure scenarios for both the general population (drinking water, oral and dermal exposure while swimming; Sections 6.4.3, 6.4.2, and 6.4.1) and to environmental biota (Section 6.5). Differences in modeling approaches between facility-specific and generic scenario releases are described below for facility-specific releases in Section 6.2.1.1 and generic scenarios in Section 6.2.1.2, but begins with common elements across both approaches.

Estimation of surface water and sediment concentrations followed a tiered approach, where the level of tiering is determined by estimated exposures and calculated risk estimates to the general population and environmental biota at each tier. These calculated exposures and risk estimates at each tier are used to inform whether additional, more refined analyses are necessary or warranted for each evaluated pathway. If preliminary risks are identified for either the general human population or environmental biota at lower tiers of analysis, evaluation of exposure and risk moves to higher tier analyses and possible refinement. Lower tier analyses tend to provide more high-end estimates of exposure and risk that are intended to be protective of the general population and environmental biota, whereas higher tier analyses may involve the use of more complex models, refined exposure scenarios, and/or review of potential inputs that aim to provide better characterization and representation of potential exposures and risks.

For the general population, EPA relies on calculated risk estimates (MOEs or extra cancer risks) that are based on the points of departure (PODs) and benchmarks presented in the *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)) and associated risk equations and calculations presented in the *Draft Risk Evaluation for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)). General population non-cancer endpoints are informed by the calculated margins of exposure (MOEs) and their relationship to human health hazard values and defined benchmark MOEs. Exposure scenarios resulting in MOEs less than benchmark for non-cancer endpoints are refined. As presented in the *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)), carcinogenic effects from *trans*-1,2-Dichloroethylene are not

expected. Therefore, given the finding of no cancer hazard, exposure and preliminary risk estimates are only being considered for non-cancer endpoints for this chemical.

For environmental populations, provisional risk estimates are informed by calculated risk quotients (RQs) that are derived from identified concentrations of concern (COCs) to exposed environmental populations. A RQ is defined as the predicted environmental concentration divided by the hazard threshold or COC. RQs exceeding 1 were identified as scenarios needing review and potential higher tier analysis and refinement. More discussion on these approaches and human health and environmental hazard values is found in *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026m](#)) and *Draft Risk Evaluation for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)). Ultimately, any refinement or higher tiering of analysis are designed to ensure potential exposures (and associated risks) are not missed and are representative of the environmental or general populations.

Initial modeling of surface water concentrations for both facility-specific and generic scenario approaches employed the equations within the E-FAST 2014 model ([U.S. EPA, 2007](#)), but were conducted outside of the downloadable tool with full results for general population and environmental populations available in supporting supplementary files (*Draft Surface Water Concentration Modeling and Environmental Exposure for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026w](#)) and *Draft General Population Surface Water Exposure Estimates for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026k](#))). The E-FAST 2014 model requires minimal input parameters and has undergone extensive peer review by experts inside and outside of EPA ([U.S. EPA, 2007](#)). E-FAST 2014 is a model that estimates chemical concentrations in water to which aquatic life might be exposed using upper percentile and/or mean exposure parametric values. Other assumptions and uncertainties in the model and input data, including ways it may be underestimating or overestimating exposure are discussed below. Benefits of employing these approaches outside of the E-FAST tool include increased flexibility, efficiency and repeatability. Importantly, this approach allows for incorporation of the National Hydrography Dataset Plus (NHDPlus V2.1) dataset ([U.S. EPA and U.S. Geological Survey, 2016](#)), which has newer and more relevant hydrologic flow information and more granular surface water body delineation than was included in the older, underlying, E-FAST software (the EPA original Reach File 1 dating back to 1984). The description and use of this newer hydrologic information is described in detail in Section 6.2.1.1.1. With this approach, facility-specific and generic scenario modeling can be conducted using a similar methodology and logic to the E-FAST 2014 tool, but with updated hydrologic flow information that improves confidence in the accuracy of the estimated surface water concentrations, and for facility-specific modeling, better linkages between the facility releases and their reported receiving water body.

Inputs necessary to estimate surface water concentrations across both approaches include the amount of chemical released to wastewater, the number of release days, removal of the chemical due to wastewater treatment, and receiving water body streamflow. For the initial Tier 1 assessment, estimated surface water concentrations represent conservative, higher-end concentrations at the point of discharge and do not incorporate physical, chemical, and environmental fate properties or hydrologic transport that may impact downstream concentrations.

A key input when modeling surface water concentrations for these different exposure scenarios is the flow of the receiving water body, with different hydrologic flow rates used for different exposure scenarios. The 30Q5 flows (*i.e.*, the lowest 30-day average flow that occurs in a 5-year period) are used to estimate intermediate human exposure through swimming or recreational contact. The annual average flow represents long-term flow rates, but a harmonic mean provides a more conservative estimate and is preferred for assessing potential chronic human exposure via drinking water. For aquatic or ecological

exposure, a 7Q10 flow (*i.e.*, the lowest 7-day average flow that occurs [on average] over a 10-year period) is used to estimate exceedances of concentrations of concerns for aquatic life ([U.S. EPA, 2007](#)). Different approaches are used to estimate these flows dependent on whether the releasing facility is identified from the TRI and DMR databases or estimated as a generic scenario and described below.

6.2.1.1 Facility-specific Releases

6.2.1.1.1 Tier 1 Approach and Estimates of Surface Water Concentration

Annual releases of *trans*-1,2-dichloroethylene to surface waters from regulated facility discharges were retrieved from the TRI and DMR public data records for the 2019 to 2023 reporting period (Figure 6-3). Annual releases generated for facility-specific releases were converted to daily releases based on two release patterns with different numbers of operating days. One release pattern used estimated facility operating days for each OES as described in Section 4.1.4 and the second used a 21-day operating day scenario. The former scenario assumes releases occur during all facility operating days and provides a refined analysis and more realistic surface water concentrations for estimating drinking water exposure, and oral and dermal exposure while swimming estimates. The latter scenario provides a more conservative facility release pattern based on the best available information that could lead to risk from chronic exposure for aquatic species. For generic scenarios, annual releases were converted to daily releases based on an estimated central tendency and high-end number of operating days as described in Section 4.2.

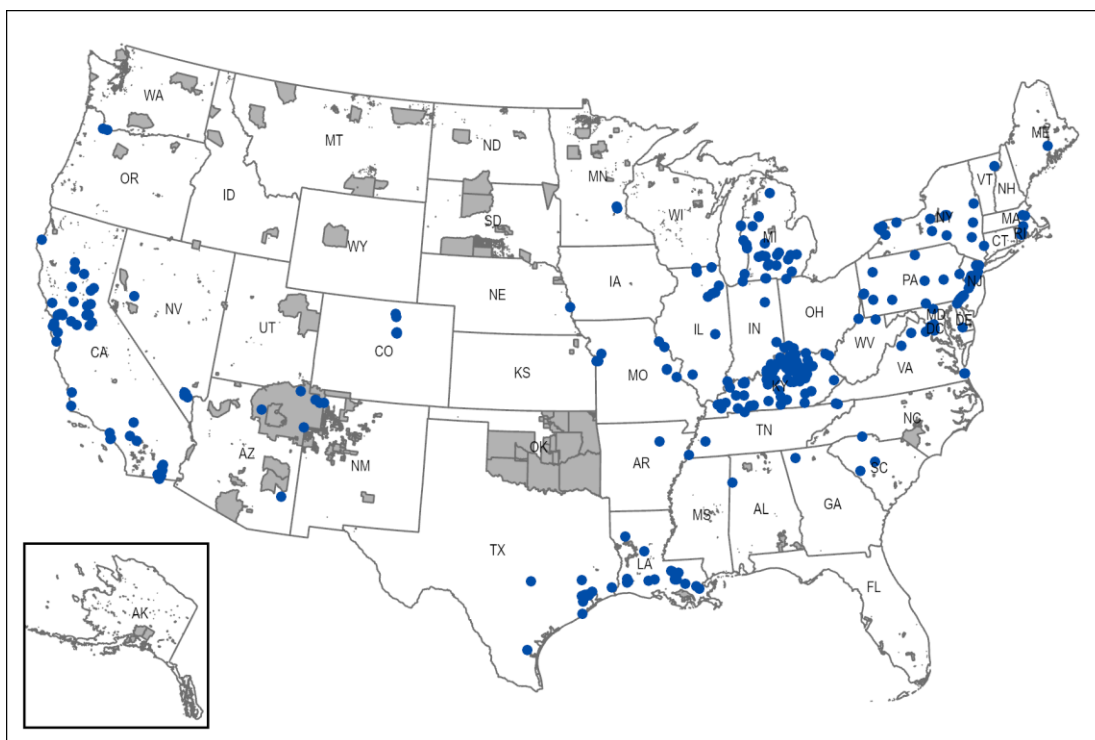


Figure 6-3. Reported 2019–2023 TRI and DMR Facility Releases for *trans*-1,2-Dichloroethylene

To the extent possible, modeled hydrologic flow data (*i.e.*, stream flow) associated with a facility's receiving water body via NPDES permit information was retrieved from the NHDPlus V2.1 dataset ([U.S. EPA and U.S. Geological Survey, 2016](#)). In instances where a representative receiving water body was either not identified in the NPDES permit, not found in the NHDPlus dataset, or unable to be

identified through professional judgement, use of available facility effluent rate or effluent monitoring information was used from the EPA Enforcement and Compliance History Online (ECHO) database.

The ECHO database was accessed and queried for the facilities reporting releases of *trans*-1,2-dichloroethylene.⁷ For all retrieved facilities reporting releases, available NPDES permit IDs and facility-specific receiving water body information was identified. Modeled flow metrics were then extracted for the retrieved reach codes for each facility from the NHDPlus V2.1 Flowline Network Enhanced Unit Runoff Method (EROM) Flow database. EROM is used to estimate mean annual flow and incremental flow for NHDFlowline Features in the NHDPlus V2.1 network. The EROM Flow database provides modeled monthly average flows for each month of the year and mean annual flows. While the EROM Flow database represents averages across a 30-year period, the lowest of the monthly average flows for a receiving water body was selected as a substitute for the 30Q5 flow used in modeling, as both approximate the lowest observed monthly flow at a given location. The substitute 30Q5 flow was then plugged into the regression equation used by E-FAST General Population and Ecological Exposure From Industrial Releases Module to convert between these flow metrics and solved for the 7Q10 flow using Equation 6-1 (U.S. EPA, 2007). As in previous EPA TSCA assessments, EPA has selected the 7Q10 flow as a representative low flow scenario for biological impacts due to effluent in streams, while the harmonic mean (HM) flow represents a more average flow for assessing chronic drinking water exposure and fish ingestion exposure.

Equation 6-1. Calculation of 7Q10 Flow

$$7Q10 = \frac{(0.409 \frac{cfs}{MLD} \times \frac{30Q5}{1.782})^{1.0352}}{0.409 \frac{cfs}{MLD}}$$

Where:

7Q10 = Modeled 7Q10 flow, in MLD (million liters per day)
 30Q5 = Lowest monthly average flow from NHD, in MLD
 cfs = cubic feet per second

Furthermore, the HM flow was calculated using Equation 6-2, derived from the relevant E-FAST regression.

Equation 6-2. Calculation of Harmonic Mean Flow

$$HM = \frac{(0.409 \frac{cfs}{MLD} \times AM)^{0.473} \times (0.409 \frac{cfs}{MLD} \times 7Q10)^{0.552}}{0.409 \frac{cfs}{MLD}}$$

Where:

HM = Modeled harmonic mean flow, in MLD (million liters per day)
 AM = Annual average flow from NHD, in MLD
 7Q10 = Modeled 7Q10 flow from the previous equation, in MLD
 cfs = cubic feet per second

In addition to the hydrologic flow data retrieved from the NHDPlus database, information about the facility effluent rate was collected, as available, from the ECHO API. Where the facility effluent rate

⁷ The EPA Enforcement and Compliance History Online (ECHO) Database is available at: <https://echo.epa.gov/> (accessed July 7, 2026)

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exceeded the hydrologic flow, the facility plant effluent flow rate was applied as the flow in the receiving water body. If neither the NHDPlus nor plant effluent flow were available, the measured *trans*-1,2-Dichloroethylene effluent concentration was substituted for the modeled concentration.

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 6-3. Calculation of Surface Water Concentrations

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

Where:

<i>SWC</i>	=	Surface water concentration (parts per billion (ppb) or µg/L)
<i>WWR</i>	=	Chemical release to wastewater (kg/day)
<i>WWT</i>	=	Removal from wastewater treatment (%)
<i>SF</i>	=	Estimated flow of the receiving stream (million liters/day (MLD))
<i>CF1</i>	=	Conversion factor (10 ⁹ µg/kg)
<i>CF2</i>	=	Conversion factor (10 ⁶ L/day/MLD)

Reported facility releases to DMR represent facilities that directly discharge to surface water (i.e. “direct releasers”) that have already undergone potential wastewater treatment and therefore a WWT value of 0 was applied when estimating surface water concentrations for these releases. TRI reported releases may represent either indirect (i.e., undergo WWT prior to discharge to surface water) or direct releases. Direct releases reported in TRI similarly have already undergone potential WWT and a value of zero was applied. *trans*-1,2-Dichloroethylene had one reported indirect release and this release was assumed to undergo wastewater treatment prior to discharge to surface waters with a removal rate of 73% based on information presented in Section 3.5.2.

Surface water concentrations were modeled for each facility for all years of available data between 2019 to 2023 for both release day scenarios (operating days vs. 21 days) and for all relevant flow metrics for evaluation of exposure pathways (7Q10, 30Q5, and HM). Individual facilities were grouped into their respective OESs (Section 4.1). To characterize the surface water impacts of facility-specific discharges, EPA selected each facility’s highest release across the 2019-2023 five-year time period and compiled those releases according to OES as an initial evaluation step. Table_Apx F-1 presents the highest 7Q10, 30Q5, and HM flow surface water concentration across all facilities and reporting years for each OES. The 7Q10 flow surface water concentration is used to evaluate environmental exposures while the 30Q5 and HM flow concentrations are used to evaluate general population exposures. Complete modeling of all facility release data across all years are available in *Draft Surface Water Concentration Modeling and Environmental Exposure for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026w](#)) and *Draft General Population Surface Water Exposure Estimates for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026k](#)).

Using these initial E-FAST modeled surface water concentrations, exposures and risk estimates for environmental and general populations were calculated as described in Section 6.4 for the general population and in Section 6.5 for environmental populations. For the environmental populations, OESs with calculated acute and/or chronic RQ greater than 1 were flagged for additional tiers of analysis. For the general population, oral and dermal while swimming exposures and chronic non-cancer drinking

water scenarios resulting in risk estimates (MOEs) less than the relative benchmark were identified for additional tiers of analysis. The estimation of these doses and potential risks are shown as follows:

- Environmental Aquatic Species Exposure to Surface Water: Surface Water Concentrations (Table_Apx F-1), EPA screened for preliminary risk to aquatic species including invertebrates, vertebrates and algae. Table_Apx F-2 summarizes the calculated acute and chronic risk quotients and highlights where chronic preliminary risk is identified for aquatic vertebrates with a calculated risk quotient greater than 1.
- Dermal Exposure via Swimming in Surface Water to the General Population: Doses in Table_Apx F-3 and potential preliminary risks in Table_Apx F-4
- Oral Exposure via Swimming in Surface Water to the General Population: Doses in Table_Apx F-5 and potential preliminary risks in Table_Apx F-6
- Drinking Water Exposure to the General Population: Doses in Table_Apx F-7 and potential preliminary risks in Table_Apx F-8

Table 6-3 gives the results for each of the evaluated OES and potential identification of preliminary risk for *trans*-1,2-dichloroethylene Tier 1 analysis. Full description and quantification of these exposures and risk estimates is available in Appendix F, *Draft Surface Water Concentration Modeling and Environmental Exposure for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026w](#)), *Draft General Population Surface Water Exposure Estimates for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026k](#)), and the *Draft Risk Evaluation for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)).

Table 6-3. Identified Preliminary Risk for Tier 1 Environmental and General Population Exposure Scenarios by Occupational Exposure Scenario (OES)

OES	Environmental Exposure				General Population Exposure			
	Acute Aquatic	Chronic Aquatic	Algae	Further Refinement Needed?	Intermediate Dermal	Intermediate Oral	Drinking Water Chronic Non-Cancer	Further Refinement Needed?
Manufacturing	No	Yes	No	Yes	No	No	No	No
Manufacturing as a Byproduct	No	No	No	No	No	No	No	No
Processing – Incorporation into Formulation, Mixture or Reaction Product	No	No	No	No	No	No	No	No
Waste Handling, Disposal and Treatment (Landfill)	No	No	No	No	No	No	No	No
Waste Handling, Disposal and Treatment (Non-POTW WWT)	No	No	No	No	No	No	No	No
Waste Handling, Disposal and Treatment (POTW)	No	No	No	No	No	No	No	No
Waste Handling, Disposal and Treatment (Remediation or Monitoring)	Yes	Yes	No	Yes	No	No	No	No
POTW = publicly owned treatment works; WWT = wastewater treatment								

6.2.1.1.2 Tier 2 Approach and Estimates of Surface Water Concentration

Tier 1 exposure estimates for environmental populations identified scenarios where preliminary risk was observed and additional tiers of refinement of initial modeled surface water concentration were warranted. Based on the Tier 1 facility-specific surface water concentration estimates, three facilities across two OES identified preliminary risk for environmental pathways and were reviewed for refinement. Facilities were reviewed for availability of effluent monitoring information of *trans*-1,2-dichloroethylene as reported within the ECHO database or alternate receiving water body information based on reported TRI Form Rs. Where appropriate, these reported effluent concentrations were used as more representative maximum estimates of potential concentrations entering surface waterbodies. These monitored concentrations were used across all evaluated flow metrics. All three facilities indicating Tier 1 provisional risk were able to be refined with two facilities refined based on available effluent monitoring data and one facility based on Form R information. Refined Tier 2 concentrations are given in Table 6-4. Facilities identified for possible Tier 2 refinement are identified in Table_Apx F-9 based on Tier 1 surface water concentrations and evaluation of preliminary risk for environmental and general populations. Refinements are based off available effluent monitoring data of *trans*-1,2-dichloroethylene as reported in the ECHO database for the specific facility and review of available TRI Form Rs.

The refinement of these facilities resulted in a revised highest representative facility 7Q10 flow surface water concentration and 30Q5/HM flow surface water concentration as compared to those shown in Tier 1 analyses for the Manufacturing OES and the Waste Handling, Treatment, and Disposal – Remediation or Monitoring OES (Tier 1: Table_Apx F-1). Refined Tier 2 surface water concentrations for all evaluated flow metrics (7Q10, 30Q5, and HM) are shown in Table 6-4 and used for evaluation of environmental and general population exposures. Other identified OESs remained the same between Tier 1 and Tier 2 modeled concentration estimates. Overall, after Tier 2 evaluation, modeled surface water concentrations were highest for the Waste Handling, Treatment, and Disposal – POTW OES with a maximum estimated 7Q10 flow concentration of 509 and 29 µg/L for the 21 operating day and maximum operating day release scenarios, respectively (Table 6-4). Waste Handling, Treatment, and Disposal – POTW also had the highest 30Q5 and HM concentrations at 28 and 19 µg/L, respectively, across all modeled OESs (Table 6-4).

Following generation of Tier 2 surface water concentration estimates, preliminary risk was re-evaluated for environmental populations for assessing need for potential further tiers of analysis and refinement. It was determined that no additional refinement was necessary for the evaluation of environmental population exposures. Although Tier 1 surface water concentrations showed no preliminary risk for the general population pathway, Tier 2 surface water concentrations are used for calculation of both environmental and general population exposures moving forward to be consistent in application across both pathways and use the most refined values possible. These exposures are further described for dermal and oral exposures while swimming to the general population in Section 6.4 and for environmental populations in Section 6.5.

Table 6-4. Facilities with Highest Modeled 7Q10, 30Q5, and HM Flow Surface Water Concentrations per OES for TRI and DMR Releases 2019–2023 Following Tier 2 Surface Water Evaluation

OES (NPDES) ^a	Annual Release (kg/yr)	Operating Days	Daily Release Estimate (kg/d)	7Q10 Flow (MLD)	30Q5 Flow (MLD)	HM Flow (MLD)	7Q10 Conc. (µg/L)	30Q5 Conc. (µg/L)	HM Conc. (µg/L)
Manufacturing (LA0000761) ^b	791	21	38	876	876	876	43	43	43
		350	2.3				2.6	2.6	2.6
Manufacturing as a Byproduct (NA) ^c	9.9	21	0.47	79	125	249	6	3.8	1.9
		350	2.8E−02				0.36	0.23	0.11
Processing – Incorporation into Formulation, Mixture or Reaction Product (NA) ^c	227	21	11	351	528	675	31	20	16
		250	0.91				2.6	1.7	1.3
Waste Handling, Treatment, and Disposal – Landfill (PA0043818) ^d	0.14	21	6.9E−03	5.3E−02	0.11	8.1E−02	130	64	85
		365	4.0E−04				7.5	3.7	4.9
Waste Handling, Treatment, and Disposal – non-POTW WWT (CA7000004) ^b	7.3E−02	21	3.5E−03	0.13	0.13	0.13	27	27	27
		365	2.0E−04				1.6	1.6	1.6
Waste Handling, Treatment, and Disposal – POTW (TX0023418) ^{b d}	121	21	5.8	11	12	17	509	479	337
		365	0.33				29	28	19
Waste Handling, Treatment, and Disposal – Remediation or Monitoring (MO0111686) ^d	3.7	21	0.18	0.56	1	1.8	317	169	98
		365	1.0E−02				18	9.7	5.7
7Q10 = the modeled 7Q10 flow, in MLD (million liters per day); 30Q5 = the lowest monthly average flow from NHD, in MLD; NPDES = National Pollutant Discharge Elimination System facility permit number									
^a See Table 4-1 for crosswalk between occupational exposures scenarios (OESs) and conditions of use (COUs)									
^b Concentrations based on plant flow for representative facility extracted from Enforcement and Compliance History Online Dataset (ECHO)									
^c Concentrations based on flows from surrogate water body identified in NHDPlus EROM dataset									
^d Concentrations based on flows from NHDPlus EROM dataset									

6.2.1.2 Generic Scenario Releases

In addition to facility-reported releases to DMR or TRI, when releases are expected from OES activities but do not have specific facility-reported release data in DMR or TRI or when collected release day may underrepresent the release potential, EPA will model potential generic scenario releases to environmental media for various OES (Section 4.1.3). Two of the OES with generated generic scenarios for *trans*-1,2-dichloroethylene had identified potential releases to surface water with details on the development and estimation of those scenarios given above:

- Blowing Agent in Spray Foam (Section 4.2.11; Table 4-18); and
- Vapor Degreasing (Section 4.2.6; Table 4-9).

For each of the generic scenarios, a central tendency and high-end scenario was developed with varying daily release volumes developed based on Monte Carlo modeling of annual releases and days of release. These release volumes are modeled to incorporate an assumption of treatment before release (73% for *trans*-1,2-dichloroethylene). Additionally, the Vapor Degreasing OES had both certain releases to water

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and uncertain media releases to wastewater treatment, hazardous landfills, or incineration (Section 4.2.6). For modeling of surface water concentrations for this OES, the releases to water and the uncertain releases to wastewater treatment were combined to provide an aggregate of both potential releases. Summary information for the two generic scenarios is given in Table 6-5.

Table 6-5. Modeled Generic Scenario Releases with Potential Releases to Surface Water.

OES	Scenario	Annual Release Before Treatment (kg/site-yr)	Annual Release After Treatment ^{a b} (kg/site-yr)	Release Days ^a (days/yr)	Daily Release After Treatment (kg/site-day)
Blowing Agent in Spray Foam (if to wastewater treatment) ^c	CT	0.91	0.25	260	8.2E-02
	HE	1.4	0.37		0.12
Vapor Degreasing (if to wastewater treatment) ^d	CT	428	115	296	0.39
	HE	603	163		0.55
Vapor Degreasing (to water) ^d	CT	65	18	296	6.0E-02
	HE	113	31		0.10
CT = central tendency; HE = high-end					
^a Details on operating days and daily releases provided in Section 4.1.3.					
^b Treatment efficiency applied: 73%					
^c See Table 4-18					
^d See Table 4-9					

Because these estimated releases for a given OES are not site-specific, EPA is unable to identify the receiving water bodies, nor the corresponding location-specific hydrological flow data as described for facility-specific releases in Section 6.2.1.1. For these OES generic scenarios, the Agency generated a distribution of flow metrics by collecting flow data for facilities across North American Industry Classification System (NAICS) codes relevant to *trans*-1,2-dichloroethylene releases to surface water (Table 6-6). The same databases described in Section 6.2.1.1 were queried for facility-specific data including permit and receiving water body information within the NAICS code to develop a modeled distribution of hydrological flow data. This process develops a distribution specific to an industry sector rather than individual facilities and provides a reasonable estimate of the distribution of location-specific values. Processing and generation of relevant flow metrics then followed the same process as described in Section 6.2.1.1 for calculation of 7Q10 and harmonic mean flows respectively. The 10th, 50th, 75th, and 95th percentile (P10, P50, P75, and P90, respectively) of each flow metric were extracted and used for hydrological modeling. A minimum effluent flow rate was applied that was derived from the average reported effluent flow rate across facilities representing an OES.

For *trans*-1,2-dichloroethylene, the supporting NAICS codes for the three modeled generic scenarios with potential releases to surface water are given in Table 6-6 and the resulting 7Q10, 30Q5, and harmonic mean flow values generated from the distribution of flows for each OES is given in Table 6-7.

Table 6-6. Generic Scenario Supporting NAICS Used for Development of Water Body Flow Distributions

OES	Supporting NAICS Codes
Blowing Agent in Spray Foam (n = 4)	238310, 238160, 238390, 238290
Vapor Degreasing (n = 25)	336110, 336120, 336211, 36212, 336213, 336214, 336310, 336320, 336330, 336340, 336350, 336360, 336370, 336390, 336411, 336412, 336413, 336414, 336415, 336419, 336611, 336612, 336991, 336992, 336999

Table 6-7. Distribution of Hydrologic 7Q10, 30Q5, and Harmonic Mean (HM) Flows for OES Generic Scenarios

Generic Scenarios					
OES	Unique Facilities	Flow Percentile ^a	7Q10 Flow (MLD)	30Q5 Flow (MLD)	HM Flow (MLD)
Blowing Agent in Spray Foam	11	P10	26	32	31
		P50	970	1,768	2,174
		P75	2,310	4,108	5,479
		P90	5,930	10,240	16,680
Vapor Degreasing	886	P10	54,862	54,901	54,937
		P50	56,257	57,423	58,740
		P75	72,179	83,756	100,218
		P90	368,868	529,268	942,655
7Q10 = modeled 7Q10 flow in MLD (million liters per day); 30Q5 = the lowest monthly average flow from NHD, in MLD; HM = modeled harmonic mean flow in MLD					
^a The P10, P50, P75, and P90 flows refer to the 10th, 50th, 75th, and 90th percentiles of the distribution of water body flow rates in generic release scenarios.					

Surface water concentrations were modeled for each OES central tendency and high-end generic scenario across all relevant flow metrics (7Q10, 30Q5, and HM) for evaluation of environmental exposure (Table 6-8; See Section 6.5) and general population exposure pathways (Table 6-9; See Section 6.4). Modeled 7Q10 flow concentrations ranged from 1.2×10^{-3} to $4.6 \mu\text{g/L}$, with the highest estimated concentrations modeled for the high-end 7Q10 flow P10 Blowing Agent in Spray Foam OES (Table 6-8). Blowing Agent in Spray Foam OES also had the highest modeled concentrations for the 30Q5 and HM flow metrics. Modeled concentrations across all evaluated scenarios ranged from 8.5×10^{-4} to $3.8 \mu\text{g/L}$ for 30Q5 flow scenarios and 4.8×10^{-4} to $3.9 \mu\text{g/L}$ for harmonic mean flow scenarios (Table 6-9).

Table 6-8. OES Generic Scenario Modeled 7Q10 Flow Surface Water Concentrations

OES	Scenario	Annual Release after Treatment (kg/site-yr)	Release Days (days/yr)	Daily Release After Treatment (kg/site-day) ^{a b}	Flow Percentile ^c	7Q10 Flow (MLD)	7Q10 Water Column Concentration (µg/L)
Blowing Agent in Spray Foam	CT	0.25	260	8.20E-02	P10	26	3.2
					P50	970	8.50E-02
					P75	2,310	3.50E-02
					P90	5,930	1.40E-02
	HE	0.37		0.12	P10	26	4.6
					P50	970	0.12
					P75	2,310	5.20E-02
					P90	5,930	2.00E-02
Vapor Degreasing (Combined) ^d	CT	133	296	0.45	P10	5.5E04	8.20E-03
					P50	5.6E04	8.00E-03
					P75	7.2E04	6.20E-03
					P90	3.7E05	1.20E-03
	HE	194		0.65	P10	5.5E04	1.20E-02
					P50	5.6E04	1.20E-02
					P75	7.2E04	9.00E-03
					P90	3.7E05	1.80E-03

7Q10 = modeled 7Q10 flow in MLD (million liters per day); CT = central tendency; HE = high-end

^a Details on operating days and daily releases are provided in Section 4.1.3

^b Treatment Efficiency Applied: 73%

^c The P10, P50, P75, and P90 flows refer to the 10th, 50th, 75th, and 90th percentiles of the distribution of water body flow rates in generic release scenarios

^d Vapor Degreasing OES represents the combined releases for certain and uncertain releases to water for central tendency and high-end scenarios (e.g., CT + CT and HE + HE)

Table 6-9. OES Generic Scenario-Modeled 30Q5 and Harmonic Mean (HM) Flow Surface Water Concentrations

OES	Scenario	Annual Release After Treatment (kg/site-yr)	Release Days (days/yr)	Daily Release after Treatment (kg/site-day) ^{a b}	Flow Percentile ^c	30Q5 Flow (MLD)	HM Flow (MLD)	30Q5 Water Column Conc. (µg/L)	HM Water Column Conc. (µg/L)
Blowing Agent in Spray Foam	CT	0.25	260	8.20E-02	P10	32	31	2.6	2.6
					P50	1,768	2,174	4.6E-02	3.8E-02
					P75	4,108	5,479	2.0E-02	1.5E-02
					P90	1.0e04	1.7e04	8.0E-03	4.9E-03
	HE	0.37		0.12	P10	32	31	3.8	3.9
					P50	1,768	2,174	6.8E-02	5.5E-02
					P75	4,108	5,479	2.9E-02	2.2E-02
					P90	1.0E04	1.7E04	1.2E-02	7.2E-03

OES	Scenario	Annual Release After Treatment (kg/site-yr)	Release Days (days/yr)	Daily Release after Treatment (kg/site-day) ^{a b}	Flow Percentile ^c	30Q5 Flow (MLD)	HM Flow (MLD)	30Q5 Water Column Conc. (µg/L)	HM Water Column Conc. (µg/L)
Vapor Degreasing (combined) ^d	CT	133	296	0.45	P10	5.5E04	5.5E04	8.2E-03	8.2E-03
					P50	5.7E04	5.9E04	7.8E-03	7.7E-03
					P75	8.4E04	1.0E05	5.4E-03	4.5E-03
					P90	5.3E05	9.4E05	8.5E-04	4.8E-04
	HE	194		0.65	P10	5.5E04	5.5E04	1.2E-02	1.2E-02
					P50	5.7E04	5.9E04	1.1E-02	1.1E-02
					P75	8.4E04	1.0E05	7.8E-03	6.5E-03
					P90	5.3E05	9.4E05	1.2E-03	6.9E-04

30Q5 = lowest monthly average from NHD in MLD (million liters per day); CT = central tendency; HE = high-end; HM = modeled harmonic mean flow in MLD

^a Details on operating days and daily releases are provided in Section 4.1.3

^b Treatment Efficiency Applied: 73%

^c The P10, P50, P75, and P90 flows refer to the 10th, 50th, 75th, and 90th percentiles of the distribution of water body flow rates in generic release scenarios

^d Vapor Degreasing OES represents the combined releases for certain and uncertain releases to water for central tendency and high-end scenarios (e.g., CT + CT and HE + HE)

6.2.2 Drinking Water Concentrations

For the evaluation of drinking water, EPA considers the modeling of facility-specific and generic scenario releases to surface water and review of available monitoring data. As discussed previously in Section 6.1.3, EPA searched peer-review literature, gray literature and databases of monitoring data to obtain concentrations of *trans*-1,2-dichloroethylene in drinking water. These measured monitoring data are used to provide, where possible, contextual and supporting information to the modeled releases. The Agency modeled *trans*-1,2-dichloroethylene concentrations in surface water as described for Tier 1 and Tier 2 analysis in Section 6.2.1. In this section, EPA describes the derivation of those surface water concentrations to drinking water concentration estimates and drinking water exposures.

6.2.2.1 Drinking Water Concentration Estimates via Modeled Surface Water Concentrations

Estimates of drinking water concentrations via surface water were estimated for both facility-specific releases and generic release scenarios and are based off those concentrations estimated using the E-FAST modeling equations described in Section 6.2.1. For both modeling scenarios, the estimated 30Q5 surface water concentrations are used for calculating drinking water doses and initial identification of preliminary acute risk, while the harmonic mean flow surface water concentrations are used for identifying preliminary chronic non-cancer risk. Initial tiering of these drinking water concentration estimates do not incorporate further removal from drinking water treatment, fate or physical-chemical considerations, or additional dilution beyond the point of discharge, and it is assumed that a presumptive drinking water intake is located at the same location or in close proximity to the surface water outfall for the releasing facility. These assumptions result in higher-end estimates of potential drinking water exposures. Drinking water concentrations, resulting doses, and identification of preliminary risk for facility-specific releases were estimated following both Tier 1 and Tier 2 evaluation as follows:

- Tier 1 Drinking Water Exposures to the General Population: Concentrations in Table_Apx F-1 shows concentrations based on 7Q10, 30Q5, and harmonic mean flow metrics; Doses in Table_Apx F-7; and potential preliminary risks in Table_Apx F-8
- Tier 2 Drinking Water Exposures to the General Population: Concentrations in Table 6-4 with

doses and risk discussed further in Section 6.4.3.2.

- Generic Scenario Drinking Water Exposures to the General Population: Concentrations in Table 6-9 with doses and risk discussed further in Section 6.4.3.3.

6.3 Evaluation of Aquatic Sediment

Aquatic sediment concentrations were not quantitatively evaluated as a potential pathway for environmental exposure due to a combination of *trans*-1,2-dichloroethylene physical-chemical properties and supporting evidence from available monitored data that indicate exposures are not expected to occur at levels of concern. Physical and chemical properties of *trans*-1,2-dichloroethylene indicate that this chemical is not expected to bind strongly to sediments and is expected to be mobile in the aquatic environment (Section 3.4.2.2; soil organic log K_{OC} = 1.23). Furthermore, as discussed in Section 6.1.2, all 351 retrieved sediment samples of measured *trans*-1,2-dichloroethylene concentrations in the environment were at or below the reported detection limit (DL ranged from 0.96–110,000 µg/kg), indicating that these monitored concentrations are uniformly low. Described fully in the *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026m](#)) document, initial review identified no sediment-dwelling invertebrate hazard studies for *trans*-1,2-dichloroethylene. Due to this lack of information, environmental hazard toxicity tests were originally ordered, but initial feasibility trials for these tests indicated that due to the volatile and non-adsorptive nature of *trans*-1,2-dichloroethylene, relevant exposures in the test could not be determined. Additionally, alternative approaches to fill the data need to estimate sediment concentrations and potential exposures are unavailable. Therefore, due to physical-chemical properties (Section 3.4.2.2), low observed concentrations of *trans*-1,2-dichloroethylene from available monitoring, and an inability to feasibly determine hazard through testing data, EPA is not further evaluating risks to sediment-dwelling invertebrates as exposures are not expected to occur. Full description of these initial studies and rationale for not evaluating potential exposures within sediment are fully described in *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026m](#)).

6.4 Approach and Estimates of General Population Exposure

6.4.1 Dermal Exposure via Swimming in Surface Water

EPA considers modeling information in its assessment of dermal exposures to the general population while swimming in surface waters containing *trans*-1,2-dichloroethylene resulting from COU releases. The modeling approach is described in Section 6.4.1.1 with estimated concentrations in surface water and doses to the general population shown in Section 6.4.1.2 for both facility-specific and generic scenario releases. Description of available measured data in surface water was described in Section 6.1.1. This section estimates the dermal exposure to the general population through the conversion of previously described surface water concentrations to age-group specific doses as described below. The estimation of these exposures were used to identify potential risks to the general population and aid in determining which evaluation tiers are warranted. For initial identification of potential risks, EPA did not derive an acute oral/dermal benchmark value and the intermediate oral/dermal benchmark (21.4 mg/kg-day with uncertainty factor [UF] = 30; Section 2.6 of *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026m](#))) was utilized to evaluate general population dermal exposures while swimming. This approach represents a high-end screen for identifying potential risks from dermal exposure to *trans*-1,2-dichloroethylene while swimming in surface water.

6.4.1.1 Approach

The general population may swim in surface waters (streams and lakes) that are affected by *trans*-1,2-dichloroethylene releases. Modeled 30Q5 flow surface water concentrations estimated in Section 6.2.1.1

and presented in Table 6-4 for facility-specific releases and Section 6.2.1.2 and presented in Table 6-9 for generic scenario releases were used to estimate intermediate doses (IDR) from dermal exposure while swimming.

Equation 6-4 was used to calculate intermediate dermal doses for adults, youths, and children while swimming.

Equation 6-4. Intermediate Dermal While Swimming Calculation

$$IDR = \frac{SWC \times K_p \times SA \times ET \times CF1 \times CF2}{BW}$$

Where:

<i>IDR</i>	=	Intermediate dose rate (mg/kg/day)
<i>SWC</i>	=	Surface water concentration in receiving water body (ppb or µg/L; 30Q5 concentration for IDR)
<i>K_p</i>	=	Permeability coefficient (cm/h)
<i>SA</i>	=	Skin surface area exposed (cm ²)
<i>ET</i>	=	Exposure time (h/day)
<i>CF1</i>	=	Conversion factor (1.0×10 ⁻³ mg/µg)
<i>CF2</i>	=	Conversion factor (1.0×10 ⁻³ L/cm ³)
<i>BW</i>	=	Body weight (kg)

A summary of inputs used for these exposure estimates are provided in Appendix F.3 and the *Draft General Population Surface Water Exposure Estimates for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026k](#)). A permeability value (*K_p*) of 9.16×10⁻³ cm/h was used for evaluation of dermal exposure while swimming ([TDCE Consortium, 2023](#)).

6.4.1.2 Results

Facility-Specific Releases

Table 6-10 shows a summary of estimated IDRs due to dermal exposure while swimming for adult (21+ years); youth (11–15 years); and children (6–10 years) for the facility in each OES resulting in the highest modeled surface water concentration. Intermediate doses associated with facility-specific releases ranged from 7.1×10⁻⁷ to 1.8×10⁻⁴ mg/kg-day across age groups with the highest doses modeled for Waste Handling, Treatment, and Disposal – POTW OES from a 30Q5 surface water concentration of 28 µg/L.

Generic Scenario Releases

Table 6-11 shows a summary of estimates of IDRs due to dermal exposure while swimming for adult (21+ years); youth (11–15 years); and children (6–10 years) for the high-end release scenario combined with the lowest flow scenario (P10 flow), which results in the highest potential modeled surface water concentrations per OES. Across the two modeled generic scenario OESs, acute doses ranged from 8.0×10⁻⁹ to 5.5×10⁻⁶ mg/kg-day with highest doses modeled for the Blowing Agent in Spray Foam OES from a 30Q5 flow surface water concentration of 3.8 µg/L.

Summary

EPA presents these high-end scenarios for evaluation of possible dermal exposures from both facility-specific and generic scenario releases as no evaluated scenarios resulted in preliminary risks to the general population (*i.e.*, estimated MOEs > benchmark MOE of 30) and all other scenarios for other facility releases or generic scenario releases would result in lower expected doses. Full results of dermal

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exposure while swimming are available in *Draft General Population Surface Water Exposure Estimates for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026k](#)) and these results for non-cancer effects are carried into the *Draft Risk Evaluation for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)) to derive preliminary risk estimates.

Table 6-10. Facility-Specific Intermediate Dermal Doses While Swimming for Adult, Youth, and Child Lifestages by Occupational Exposure Scenario (OES) (Tier 2)

OES ^a	Surface Water Concentrations		Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)
	30Q5 Conc. (µg/L)	HM Conc. (µg/L)	IDR (mg/kg-day)	IDR (mg/kg-day)	IDR (mg/kg-day)
Manufacturing	2.6	2.6	1.7E–05	1.3E–05	8.0E–06
Manufacturing as a Byproduct	0.23	0.11	1.5E–06	1.2E–06	7.10E–07
Processing – Incorporation into Formulation, Mixture or Reaction Product	1.7	1.3	1.1E–05	8.8E–06	5.3E–06
Waste Handling, Treatment, and Disposal – Landfill	3.7	4.9	2.5E–05	1.9E–05	1.1E–05
Waste handling, treatment, and disposal – Non-POTW WWT	1.6	1.6	1.0E–05	8.0E–06	4.8E–06
Waste Handling, Treatment, and Disposal – POTW	28	19	1.8E–04	1.4E–04	8.6E–05
Waste Handling, Treatment, and Disposal – Remediation or Monitoring	20	20	1.3E–04	1.0E–04	6.2E–05
30Q5 = 30 consecutive days of lowest flow over a 5-year period; IDR = intermediate dose rate; HM = harmonic mean					
^a Each OES represented by the facility within each OES with the highest estimated surface water concentration as described in Section 6.2.1.1.					

Table 6-11. Generic Scenario Intermediate Dermal Doses While Swimming for Adult, Youth, and Child Lifestages by Occupational Exposure Scenario (OES) (Tier 2)

OES ^a	Flow Percentile	Modeled Surface Water Concentrations		Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)
		30Q5 Conc. (µg/L)	HM Conc. (µg/L)	IDR (mg/kg-day)	IDR (mg/kg-day)	IDR (mg/kg-day)
Blowing Agent in Spray Foam	P10	3.8	3.9	5.5E-06	4.2E-06	2.5E-06
Vapor Degreasing (Combined)	P10	1.2E-02	1.2E-02	1.7E-08	1.3E-08	8.0E-09
30Q5 = 30 consecutive days of lowest flow over a 5-year period; HM = harmonic mean; IDR = intermediate dose rate						
^a Each OES represented in table by the high-end release scenario for that OES as described in Section 6.2.1.2.						

6.4.2 Oral Exposure via Swimming in Surface Water

EPA considers modeling in its assessment of oral exposure while swimming in surface waters containing *trans*-1,2-dichloroethylene resulting from COU activities. The modeling approach is described in Section 6.4.2.1 with estimated concentrations and doses shown in Section 6.4.2.2 for both facility-specific and generic scenario releases. This section estimates oral exposure to the general population through the conversion of previously described modeled surface water concentrations to age-group specific doses as described below. These estimated exposures were used to identify potential risks to the general population and aid in determining which evaluation tiers are warranted. For initial identification of potential risks, EPA did not derive an acute oral/dermal benchmark value and the intermediate oral/dermal benchmark (21.4 mg/kg-day with UF=30; Section 2.6 of *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* (U.S. EPA, 2026m)) was utilized to evaluate general population oral exposures while swimming. This approach represents a high-end screen for identifying potential risks from oral exposure to *trans*-1,2-dichloroethylene while swimming in surface water.

6.4.2.1 Approach

The general population may swim in surface waters (streams and lakes) that are affected by *trans*-1,2-dichloroethylene releases. Modeled surface water concentrations estimated in Section 6.2.1.1 and presented in Table 6-4 for facility-specific releases and Section 6.2.1.2 and presented in Table 6-9 for generic scenario releases were used to estimate intermediate doses (IDR) due to ingestion while swimming.

Equation 6-5 was used to calculate intermediate oral doses for adults, youth and children while swimming:

Equation 6-5. Intermediate Oral Ingestion while Swimming Calculation

$$IDR = \frac{SWC \times IR \times CF1}{BW}$$

Where:

IDR = Intermediate dose rate (mg/kg/day)
SWC = Surface water concentration in receiving water body (ppb or µg/L; 30Q5)

			concentration for ADR)
<i>IR</i>	=		Daily ingestion rate (L/day)
<i>CF1</i>	=		Conversion factor (1.0×10^{-3} mg/ μ g)
<i>BW</i>	=		Body weight (kg)

6.4.2.2 Results

Facility-Specific Releases

Table 6-12 shows a summary of estimates of IDRs due to oral exposure while swimming for adult (21+ years); youth (11–15 years); and children (6–10 years) for the facility in each OES resulting in the highest modeled surface water concentration. Intermediate doses associated with facility-specific releases ranged from 6.9×10^{-7} to 1.5×10^{-4} mg/kg-day across age groups with the highest doses modeled for Waste Handling, Treatment, and Disposal – POTW OES from a 30Q5 flow surface water concentration of 28 μ g/L.

Generic Scenario Releases

Table 6-13 shows a summary of estimates of IDRs due to oral exposure while swimming for adult (21+ years); youth (11–15 years); and children (6–10 years) for the high-end release scenario combined with the lowest flow scenario (P10 flow), which results in the highest potential modeled surface water concentrations per OES. Across the two modeled generic scenario OESs, intermediate doses ranged from 3.6×10^{-8} to 2.0×10^{-5} mg/kg-day across age groups with highest doses modeled for the Blowing Agent in Spray Foam OES from a 30Q5 flow surface water concentration of 3.8 μ g/L.

Summary

EPA presents these higher-end scenarios for evaluation of possible oral exposures from both facility-specific and generic scenario releases as no evaluated scenarios resulted in preliminary risks to the general population (*i.e.*, estimated MOEs > benchmark MOE of 30) and all other scenarios for other facilities or generic scenario releases would result in lower expected doses. Full results of oral exposure due to swimming are available in *Draft General Population Surface Water Exposure Estimates for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026k](#)), and these results for acute non-cancer effects are carried into the *Draft Risk Evaluation for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)) to derive preliminary risk estimates.

Table 6-12. Facility-Specific Intermediate Oral Doses While Swimming for Adult, Youth, and Child Lifestages by Occupational Exposure Scenario (OES) (Tier 2)

OES ^a	Modeled Surface Water Concentrations		Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)
	30Q5 Conc. (μ g/L)	HM Conc. (μ g/L)	IDR (mg/kg-day)	IDR (mg/kg-day)	IDR (mg/kg-day)
Manufacturing	2.6	2.6	8.9E–06	1.4E–05	7.8E–06
Manufacturing as a Byproduct	0.23	0.11	7.8E–07	1.2E–06	6.9E–07
Processing – Incorporation into Formulation, Mixture or Reaction Product	1.7	1.3	5.9E–06	9.2E–06	5.2E–06
Waste Handling, Treatment, and Disposal – Landfill	3.7	4.9	1.3E–05	2.0E–05	1.1E–05

OES ^a	Modeled Surface Water Concentrations		Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)
	30Q5 Conc. (µg/L)	HM Conc. (µg/L)	IDR (mg/kg-day)	IDR (mg/kg-day)	IDR (mg/kg-day)
Waste Handling, Treatment, and Disposal – Non-POTW WWT	1.6	1.6	5.4E–06	8.3E–06	4.7E–06
Waste Handling, Treatment, and Disposal – POTW	28	19	9.5E–05	1.5E–04	8.3E–05
Waste Handling, Treatment, and Disposal – Remediation or Monitoring	20	20	6.9E–05	1.1E–04	6.0E–05
30Q5 = 30 consecutive days of lowest flow over a 5-year period; HM = harmonic mean; IDR = intermediate dose rate					
^a Each OES is represented by the facility within each OES with the highest estimated surface water concentration as described in Section 6.2.1.1.					

Table 6-13. Generic Scenario Intermediate Oral Doses While Swimming for Adult, Youth, and Child Lifestages by Occupational Exposure Scenario (OES) (Tier 2)

OES ^a	Flow Percentile	Modeled Surface Water Concentrations		Adult (21+ years)	Youth (11–15 Years)	Child (6–10 years)
		30Q5 Conc. (µg/L)	HM Conc. (µg/L)	IDR (mg/kg-day)	IDR (mg/kg-day)	IDR (mg/kg-day)
Blowing Agent in Spray Foam	P10	3.8	3.9	1.3E–05	2.0E–05	1.1E–05
Vapor Degreasing (combined)	P10	1.2E–02	1.2E–02	4.1E–08	6.3E–08	3.6E–08
30Q5 = 30 consecutive days of lowest flow over a 5-year period; HM = harmonic mean; IDR = intermediate dose rate						
^a Each OES represented in table by the high-end release scenario for that OES as described in Section 6.2.1.2.						

6.4.3 Drinking Water Exposure

EPA considers both modeling and measured monitoring in its assessment of drinking water exposure from *trans*-1,2-dichloroethylene to the general population. The modeling approach is described in Section 6.4.3.1 with estimated doses to the general population shown in Section 6.4.3.2 for facility-specific releases and Section 6.4.3.3 for generic scenario releases. Description of available measured data in drinking water was explained in Section 6.1.3. This section estimates the drinking water exposure to the general population through the conversion of previously described surface water concentrations to age-group specific doses as described below. Evaluation of these drinking water exposures follows a tiered approach where potential risks to the general population are identified to aid in determining whether additional analysis or refinement is warranted.

6.4.3.1 Approach

Drinking water exposures were calculated for a variety of lifestages ranging from infants to adults for both facility-specific and generic scenario releases. Drinking water exposures for bottle-fed infants (<1 year), toddlers (1-5 years) and adults (21+ years) are presented below but full explanation of all age groups is available in *Draft General Population Surface Water Exposure Estimates for trans-1,2-Dichloroethylene* (U.S. EPA, 2026k). By including infant exposure estimates, EPA is considering PESS and protecting this sensitive subpopulation. The potential average daily dose (ADD; Equation 6-6) is used for evaluating chronic non-cancer drinking water exposures. Acute exposures to drinking water were not evaluated since an acute oral/dermal benchmark value was not derived as described in Section 2.6 of *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* (U.S. EPA, 2026m). Cancer exposures from drinking water were also not evaluated since carcinogenic effects from trans-1,2-dichloroethylene are not expected (U.S. EPA, 2026t).

Equation 6-6. Drinking Water Average Daily Dose Calculation

$$ADD = \frac{(SWC \times (1 - \frac{DWT}{100}) \times IR_{dw} \times ED \times RD \times CF1}{(BW \times AT \times CF2)}$$

Where:

ADD	=	Average daily dose (mg/kg/day)
SWC	=	Surface water concentration in receiving water body (ppb or µg/L; harmonic mean concentration for average daily dose [ADD])
DWT	=	Removal during drinking water treatment (%) (not applied for this analysis)
IR _{dw}	=	Drinking water intake rate (L/day)
ED	=	Exposure duration (years for ADD)
RD	=	Release days (days/yr for ADD)
BW	=	Body weight (kg)
AT	=	Averaging time (years for ADD)
CF1	=	Conversion factor (1.0×10 ⁻³ mg/µg)
CF2	=	Conversion factor (365 days/year)

A summary of inputs used for these exposure estimates is provided in *Draft General Population Surface Water Exposure Estimates for trans-1,2-Dichloroethylene* (U.S. EPA, 2026k). Drinking water doses were calculated for both facility-specific and generic scenario releases to identify potential exposures and preliminary risks relative to their non-cancer benchmarks. Calculated doses were used to inform whether additional tiers of analysis were necessary as explained in Sections 6.2.1 and 6.2.2 and Appendix F.1.5. A complete description and explanation of results is given for facility-specific releases in Section 6.4.3.2 and for generic scenario releases in Section 6.4.3.3

6.4.3.2 Results for Facility-Specific Releases

As described in Section 6.2.1.1 and Section 6.2.2, the evaluation of drinking water exposures and doses for facility-specific releases followed a tiered analysis where if preliminary risks relative to the non-cancer benchmarks are identified, higher tiers of analysis or refinement are investigated. Tier 1 estimation of surface water concentrations identified no preliminary risks for drinking water below chronic non-cancer benchmarks (Table Apx F-8), but Tier 2 surface water concentrations were used for final characterization to harmonize evaluated concentrations across the general population and environmental population pathways since Tier 1 surface water concentrations resulted in preliminary risk for the environmental population pathway (Table 6-3). Table 6-14 shows the calculated doses to

adults, infants and toddlers following the Tier 2 modeling evaluation of harmonic mean flow surface water concentrations shown in Table 6-4. As mentioned in Section 6.2.2, both Tier 1 and Tier 2 analyses assume that the estimated surface water concentrations represents the drinking water concentration; do not incorporate chemical removal from drinking water treatment or additional dilution beyond the point of discharge; and assume that the surface water outfall for the releasing facility is located near the drinking water intake location. Therefore, estimated drinking water concentrations would be expected to be higher-end estimates of potential exposure.

Average daily doses ranged from 1.2×10^{-6} to 5.6×10^{-4} mg/kg-day across age groups with the highest doses modeled for the Waste Handling, Treatment and Disposal (Remediation and Monitoring) OES with a harmonic mean flow concentration of 20 µg/L. Preliminary risks were not identified (*i.e.*, estimated MOEs > benchmark MOE of 300) chronic non-cancer drinking water exposures for any OES following Tier 2 refinement. Therefore, releases from other facilities would be expected to have lower estimated doses and risk. Full results for drinking water exposure are available in *Draft General Population Surface Water Exposure Estimates for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026k](#)) and these results for acute and chronic non-cancer effects are carried into the *Draft Risk Evaluation for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)) to derive risk estimates.

6.4.3.3 Results for Generic Scenario Releases

Drinking water exposures from estimated generic scenario releases described in Section 6.2.1.2 and Section 6.2.2 were evaluated from estimated harmonic mean flow surface water concentrations as shown in Table 6-9. Table 6-15 shows the calculated chronic non-cancer drinking water doses to adults, infants and toddlers based on estimated surface water concentrations.

Average daily doses associated with high-end release scenarios modeled using the P10 harmonic mean flow percentile ranged from 1.1×10^{-7} to 7.7×10^{-5} mg/kg-day across age groups with the highest doses modeled for Blowing Agent in Spray Foam OES from a harmonic mean flow concentration of 3.9 µg/L. Preliminary risks were not identified (*i.e.*, estimated MOEs were greater than the benchmark MOEs of 30 or 300) for chronic non-cancer drinking water exposures for either of the generic scenario OESs. These results for chronic non-cancer drinking water effects are carried into the *Draft Risk Evaluation for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)) to derive risk estimates.

Table 6-14. Facility-Specific Chronic Drinking Water Doses for Adult, Infant, and Toddler Lifestages by Occupational Exposure Scenario (OES) Based on Tier 2 Modeled Surface Water Concentrations

OES ^a	Modeled Surface Water Concentrations		Adult (21+ years)	Infant (Birth to <1 year)	Toddler (1–5 years)
	30Q5 Conc. (µg/L)	HM Conc. (µg/L)	ADD (mg/kg-day)		
Manufacturing	2.6	2.6	2.7E-05	6.9E-05	3.0E-05
Manufacturing as a Byproduct	0.23	0.11	1.2E-06	3.1E-06	1.3E-06
Processing – Incorporation into Formulation, Mixture or Reaction Product	1.7	1.3	1.0E-05	2.6E-05	1.1E-05
Waste Handling, Treatment, and Disposal – Landfill	3.7	4.9	5.4E-05	1.4E-04	5.9E-05
Waste Handling, Treatment, and Disposal – Non-POTW WWT	1.6	1.6	1.7E-05	4.4E-05	1.9E-05

OES ^a	Modeled Surface Water Concentrations		Adult (21+ years)	Infant (Birth to <1 year)	Toddler (1–5 years)
	30Q5 Conc. (µg/L)	HM Conc. (µg/L)	ADD (mg/kg-day)		
Waste Handling, Treatment, and Disposal – POTW	28	19	2.1E–04	5.4E–04	2.3E–04
Waste Handling, Treatment, and Disposal – Remediation or Monitoring	20	20	2.2E–04	5.6E–04	2.4E–04
30Q5 = 30 consecutive days of lowest flow over a 5-year period; ADD = average daily dose; HM = harmonic mean ^a Each OES is represented by the facility within that OES with the highest estimated surface water concentration for that OES as described in 6.2.1.1.					

Table 6-15. Generic Scenario Chronic Drinking Water Doses for Adult, Infant, and Toddler Lifestages by Occupational Exposure Scenario (OES)

OES ^a	Flow Percentile	Modeled Surface Water Concentrations		Adult (21+ years)	Infant (Birth to < 1 year)	Toddler (1–5 years)
		30Q5 Conc. (µg/L)	HM Conc. (µg/L)	ADD (mg/kg-day)		
Blowing Agent in Spray Foam	P10	3.8	3.9	3.0E–05	7.7E–05	3.3E–05
Vapor Degreasing (combined)	P10	1.2E–02	1.2E–02	1.1E–07	2.7E–07	1.2E–07
30Q5 = 30 consecutive days of lowest flow over a 5-year period; HM = harmonic mean; ADD = average daily dose ^a Each OES represented in table by the high-end release scenario for that OES as described in Section 6.2.1.2.						

6.4.4 Fish Ingestion Exposure

As described in Section 8, exposure to *trans*-1,2-dichloroethylene via fish ingestion is not expected to be a pathway of concern for either human or piscivorous receptors. Bioaccumulation estimates indicate a modeled low bioconcentration factor of 8.7 L/kg and an upper-trophic fish BAF value of 9.3 L/kg wet-weight (Section 3.5.4), that are consistent with its physical and chemical properties (log K_{OW} = 1.93; Section 2.2.1.7). Supporting this expectation, EPA did not identify any studies that report evidence of *trans*-1,2-dichloroethylene in tissues of wild-caught fish or other organisms (U.S. EPA, 2026m). Based on the above factors, considerations, and investigations, a quantitative screening-level fish ingestion assessment was not conducted for *trans*-1,2-dichloroethylene.

6.5 Environmental Exposures for Surface Water and Sediment

6.5.1 Surface Water

EPA considered exposures to *trans*-1,2-dichloroethylene via surface water for aquatic vertebrates, aquatic invertebrates, and aquatic plants. As described in Section 6.2, EPA modeled concentrations of *trans*-1,2-dichloroethylene in surface water based on a tiered approach for both facility-specific releases reported to the TRI and DMR databases between 2019 to 2023, as well as estimated generic scenario releases based on relevant OESs. Following Tier 2 analysis of surface water concentrations, the highest modeled 7Q10 surface water concentrations using TRI and DMR facility release data was represented by the Waste Handling, Treatment, and Disposal (POTW) OES with concentrations of 29 µg/L for the maximum days of release scenario and 509 µg/L for the 21-day release scenario (Table 6-4). These surface water concentrations represent high-end exposure concentrations used in screening environmental risk to aquatic organisms in the *Draft Risk Evaluation for trans-1,2-Dichloroethylene* (U.S. EPA, 2026t).

6.5.2 Sediment

As mentioned in Section 6.3, aquatic sediments were not further evaluated as a pathway for environmental exposure for *trans*-1,2-dichloroethylene due to (1) the combination of physical and chemical properties (Section 3.4.2.2) indicating that *trans*-1,2-dichloroethylene will not partition to sediment, (2) supporting evidence from available monitored data indicating low measured concentrations, and (3) an inability to feasibly determine hazard through testing data. Together these lines of evidence indicate exposures are not expected to occur at levels of concern to environmental populations.

6.6 Strengths, Limitations, Assumptions and Key Sources of Uncertainty for Surface Water and Sediment

Surface Water Concentrations

EPA primarily relied on modeling for estimation of surface water and drinking water concentrations of *trans*-1,2-dichloroethylene as well as associated default and user-selected inputs for these models which can affect the overall strength in evaluating surface water concentrations. EPA used E-FAST as part of a tiered approach to estimate concentrations of *trans*-1,2-dichloroethylene within surface water which does not consider fate or hydrologic transport characteristics and is intended to give a representative estimate of surface water concentrations at the point of discharge, but more conservative compared to potential downstream concentrations. For facility releases, EPA relied on the use of TRI and DMR data which can either underestimate or overestimate potential releases. For example, reporting to TRI is based on annual reported loadings and does not include facilities with fewer than 10 full-time employees, nor does it consider certain sectors that may lead to underestimates in total *trans*-1,2-dichloroethylene releases to the environment. Additionally, the EPA Pollutant Loading Tool compiles and makes public discharges as reported to DMRs and required in NPDES permits and provides data on the amount and monitored concentration of *trans*-1,2-dichloroethylene in discharged effluent to the receiving water body. In compilation of this information, DMR monitoring data is often over shorter time periods of months to quarters, which are then extrapolated to estimate annual total releases that may under or overestimate releases.

In instances where EPA identified preliminary risks relative to the benchmark for the evaluated routes, the use of the higher tier evaluation scenarios to refine releases and release monitoring information at individual facilities in this assessment act as a check on estimated releases and increases the validity of estimated surface water concentrations. Adding additional strength to this evaluation, EPA incorporated an updated hydrologic flow network and flow data into this assessment that allowed a more site-specific consideration of release location and associated receiving water body flows.

As mentioned previously, the evaluation of generic scenarios is unable to identify a specific known release or evaluate those releases at a specific location or associated receiving water body. This leads to uncertainty about release volumes or potential receiving water body flows. However, the generation of distributions of both release volumes and days of release through Monte Carlo modeling as well as the potential distributions of flows derived based on generic facility data for these OESs are intended to give the range of possible exposures encountered at these facilities.

Drinking Water Concentrations

Drinking water concentrations relied on the same modeling approach as used to evaluate surface water concentrations with similar strengths, weaknesses, and assumptions described above. Initial tiers of drinking water exposure evaluation consider concentrations near the point of discharge without the consideration of drinking water treatment. Although higher tier refinements and estimation of drinking

water concentrations are available, they were not deemed necessary for the evaluation of *trans*-1,2-dichloroethylene due to no identified preliminary risk at lower tiers. Given the incorporation of more conservative inputs at these lower tiers, estimated values would be expected to represent higher-end estimations of drinking water exposure giving EPA robust confidence that this evaluation effectively evaluates potential exposure to the general public. While generic scenario releases do not allow for the same degree of refinement as facility-specific releases, there is strong confidence that the evaluated scenarios and inputs to those scenarios are effective in estimating the range of drinking water concentrations across the range of release and flow inputs for an OES. Lending support to the drinking water modeling evaluation for both facility-specific and generic scenarios is that modeling scenarios are generally in agreement with measured information with low concentrations for both modeled and measured concentrations.

6.7 Evidence Integration and Weight of Scientific Evidence

6.7.1 Evidence Integration and Weight of Scientific Evidence for Surface Water

6.7.1.1 Measured and Modeled Information

EPA quantitatively modeled estimated concentrations of *trans*-1,2-dichloroethylene in surface water from known facility releases as reported to DMR and TRI as well as developed generic release scenarios using the E-FAST modeling tool. With the use of updated hydrologic flow information there is increased confidence in the accuracy of the estimated surface water concentrations, and for facility-specific modeling, better linkages between the facility releases and their reported receiving water body. Additionally, the use of tiering by identifying preliminary risk to both environmental and human populations provided greater confidence and better characterization of the facility releases and representation of surface water concentrations. Comparing between modeled surface water concentrations using the maximum operating days scenario for the highest facility-reported releases per OES and the modeled generic scenarios show that modeled concentrations are broadly similar (*e.g.*, within the same order of magnitude) offering increased confidence of estimated surface water concentrations.

Although there are limited available measured concentrations of *trans*-1,2-dichloroethylene in surface waters, these monitored values provide a point of reference and comparison with the modeled releases estimates. While it is difficult to directly compare monitored values to potential modeled releases due to measured concentrations oftentimes not being temporally or geographically close to known releases of *trans*-1,2-dichloroethylene, measured concentrations are low and similar in magnitude to modeled facility and generic scenario estimates. The high-end modeled concentrations, based on industrial releases data released over a limited number of days exceeded the highest monitoring values by 1 to 2 orders of magnitude, therefore support that the evaluated scenarios captured the range of potential concentrations and scenarios for environmental and general population exposure. Additionally, in instances where these concentrations indicated preliminary risk, the tiering approaches and targeted refinement of releases increased confidence in resulting environmental and general population exposures.

6.7.1.2 General Population Dermal and Oral Exposure while Swimming

There is high confidence that the modeled surface water concentrations presented for both the facility-specific releases and generic scenario releases represent higher-end estimated concentrations, and that these concentrations are reasonably applied for estimation of potential dermal and oral exposure while swimming in surface water across the evaluated age groups and OESs. EPA's Swimmer Exposure Assessment Model provided detailed information on the skin surface areas for dermal exposure and

potential swimming exposure times for the evaluated age groups given as high-end default durations for the evaluated age groups ([U.S. EPA, 2015b](#)). For estimation of oral exposures, age group specific ingestion rates are selected from EPA's *Exposure Factors Handbook* as upper percentile values while swimming ([U.S. EPA, 2019b](#)).

Additionally, EPA did not derive an acute oral/dermal benchmark value. The intermediate oral/dermal benchmark (see Section 2.6 of *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026l](#))) was utilized to evaluate general population oral and dermal exposures while swimming in surface water. This approach represents a high-end screen for identifying potential risks from exposure to *trans*-1,2-dichloroethylene while swimming in surface water. Furthermore, estimated concentrations are representative of those expected near the point of discharge to receiving waterbodies and a more conservative estimate of expected exposures. Concentrations would be expected to dilute and/or degrade with time and movement downstream. Therefore, EPA has robust confidence that estimates of exposure are representative of higher-end exposure estimates for oral and dermal exposure per OES while swimming in surface water.

6.7.1.3 Environmental Exposure to Surface Water

Environmental exposures to surface water were effectively modeled using the E-FAST modeling tool. Exposures to aquatic biota followed a tiered structure whereby if preliminary risk was identified at a lower tier using more conservative inputs and higher-end release information, those scenarios were evaluated for potential refinement. The refinement process resulted in revised estimations of potential environmental exposure where appropriate that resulted in RQs less than 1 across the range of evaluated OESs.

6.7.1 Evidence Integration and Weight of Scientific Evidence for Drinking Water

6.7.1.1 Measured and Modeled Information

EPA quantitatively modeled estimated concentrations of *trans*-1,2-dichloroethylene in surface water from known facility releases as reported to DMR and TRI as well as developed generic release scenarios using the E-FAST modeling tool for evaluation of the drinking water pathway. Additionally, the use of tiering for identifying preliminary risk and areas of potential refinement for the drinking water pathway provided greater confidence and better characterization of the facility releases and representation of surface water concentrations and drinking water exposures.

There was ample monitoring data of *trans*-1,2-dichloroethylene in drinking water across multiple reporting cycles due to it being a regulated water contaminant. EPA has robust confidence based on the available data that *trans*-1,2-dichloroethylene is infrequently detected, and when detected is below the MCL of 100 µg/L. While it is difficult to directly compare monitored values to potential modeled releases due to measured concentrations oftentimes not being temporally or geographically close to known releases of *trans*-1,2-dichloroethylene, most measured concentrations are low and similar in magnitude to modeled facility and generic scenario estimates.

6.7.1.2 General Population Drinking Water Exposure

As mentioned above, there is high confidence that the modeled surface water concentrations presented for both the facility-specific releases and generic scenario releases represent higher-end concentrations, and that these concentrations are reasonably applied for initial identification of drinking water exposure across the evaluated age groups. The use of a tiering structure to evaluate and where possible, refine these, offered increasing confidence and robustness in predicted drinking water exposures. Although it is difficult to directly compare monitored values to modeled releases due to measured concentrations

4513 oftentimes not being temporally or geographically close to known releases of
4514 *trans*-1,2-dichloroethylene, the ample monitoring data of *trans*-1,2-dichloroethylene in drinking water
4515 across multiple reporting cycles due to it being a regulated drinking water contaminant broadly
4516 confirmed modeled results. That is, available data showed that *trans*-1,2-dichloroethylene is infrequently
4517 detected in drinking water and when measured, most measured concentrations are low and similar in
4518 magnitude to the modeled facility and generic scenario estimates.

7 LAND AND GROUNDWATER PATHWAY ASSESSMENT

Land contamination from *trans*-1,2-dichloroethylene is not expected to be significant. Although potential pathways include waste disposal to hazardous waste landfills, land application of biosolids containing trace amounts, and atmospheric deposition, these contribute little in practice (Section 3.4.1 and 3.4.3). TRI reported releases to land ranged from 4 to 10,910 lb between 2019 to 2023—a small fraction (<12%) of total releases. The compound's volatility and limited sorption favor off-gassing rather than accumulation in soil; and engineered controls (e.g., lined landfills) further limit migration of *trans*-1,2-dichloroethylene to soil and persistence.

7.1 Concentrations of *trans*-1,2-Dichloroethylene in Biosolids

The term “biosolids” refers to treated sludge that meets the EPA pollutant and pathogen requirements for land application and surface disposal and can be beneficially recycled (40 CFR Part 503) ([U.S. EPA, 1993](#)). Biosolids generated during the treatment of industrial and municipal wastewater may be applied to agricultural fields or pastures as fertilizer in either its dewatered form or as a water-biosolid slurry.

Sludge from POTWs is not expected to contain significant amounts of *trans*-1,2-dichloroethylene due to its volatility (Henry's Law constant of 7.51×10^{-3} atm·m³/mol at 20 °C), low affinity for organic matter (log K_{OC} 1.23–1.77), as well as low releases to water (<1%) reported by TRI. EPI Suite™ predicts less than 1% of *trans*-1,2-dichloroethylene in a wastewater will sorb to sludge during wastewater treatment.

7.1.1 Measured Concentrations in Biosolids

Sludge from POTWs is not expected to contain significant amounts of *trans*-1,2-dichloroethylene due to its volatility and low affinity for organic matter (Section 3.5.2) as well as low releases to water (<1%) reported by TRI. However *trans*-1,2-dichloroethylene was measured in wastewater treatment sludge (sewage sludge generated during secondary or more advanced treatment) at a maximum concentration of 10.7 mg/kg by the 1988 NSSS, with a detection frequency of 1% from a sample size of 178 across 176 U.S. POTWs. Detection limits ranged from 3 to 41 µg/kg, depending on whether samples were wet or dry ([U.S. EPA, 1996, 1990](#)). No more recent national occurrence data for *trans*-1,2-dichloroethylene in sewage sludge are available. Subsequent EPA sewage sludge surveys did not analyze chlorinated volatile organic compounds but focused on other contaminants. *trans*-1,2-Dichloroethylene was also measured in a study of 40 POTWs and was measured in sludge at concentrations between 1 and 96,000 µg/L with a detection frequency of 60% in 436 samples and detection limits between 5 and 10 µg/L.

The 40 POTW study was an EPA-sponsored investigation of 40 full-scale POTWs located across the United States and selected to represent a range of geographic regions, plant sizes, treatment processes, and wastewater characteristics. The study was conducted to characterize the fate and removal of priority pollutants during municipal wastewater treatment ([U.S. EPA, 1982a](#)). Note that the reported concentration from the 40 POTW studies are not considered representative of land applied biosolids because the raw sludge values reflects the primary sludge as it was removed from the primary clarifiers before further treatment rather than treated biosolids intended for land application. In addition, the concentration was reported in µg/L rather than on a dry-weight basis, creating uncertainty regarding the solids content and comparability to biosolids data. Given the volatile nature of *trans*-1,2-dichloroethylene and expected losses during treatment, digestion, dewatering, storage, and land application, concentrations in finished biosolids would be expected to be substantially lower.

7.1.2 Modeled Concentrations in Biosolids

In the absence of recent measured data, EPA estimated the maximum amount of *trans*-1,2-dichloroethylene entering wastewater treatment from the maximum releases reported for any facility in

its Discharge Monitoring Report. The releases were converted to daily loading rates and used as input to the SimpleTreat 4.0 wastewater treatment plant model ([RIVM, 2015](#)). It was assumed that the modeled site used activated sludge wastewater treatment and that SimpleTreat 4.0 defaults were a reasonable representation of the activated sludge treatment at the site. Using this loading data, the model predicted *trans*-1,2-dichloroethylene concentration in combined sludge of 24.14 mg/kg.

7.2 Concentrations of *trans*-1,2-Dichloroethylene Deposited from Air to Soil

Given its Henry's Law constant (7.51×10^{-3} atm·m³/mol) and low sorption indicated by a log K_{OC} of 1.23, the flux of *trans*-1,2-dichloroethylene from air to soil is expected to be low based on fugacity and LRTP screening. Partitioning analyses and fugacity modeling show that when releases are at steady state and primarily to air, *trans*-1,2-dichloroethylene is expected to partition primarily to air (Section 3.2.2). Additional fugacity modeling done using the OECD LRTP Screening Tool shows that *trans*-1,2-dichloroethylene has an estimated transport efficiency of 0.035% (Section 3.4.1). The transport efficiency is the percentage of emission flux that is deposited to the soil and water of a hypothetical region adjacent to the region receiving emissions. With the low transport efficiency estimated for *trans*-1,2-dichloroethylene, air deposition to soil is not expected to be an exposure pathway for *trans*-1,2-dichloroethylene that will contribute significantly to dermal or ingestion risks for the general population or terrestrial organisms. Consequently, EPA did not estimate soil concentrations due to deposition.

7.3 Concentrations and Exposure of *trans*-1,2-Dichloroethylene in Landfills

Although landfills are a potential source of chemicals in the environment, according to the EPA's TRI database, less than 6 metric tons of *trans*-1,2-dichloroethylene were disposed of in landfills between 2019 and 2023. *trans*-1,2-Dichloroethylene can also potentially be present in landfills due to the degradation product of other chlorinated ethenes, such as trichloroethylene or perchloroethylene ([Freedman et al., 2001](#); [Lorah and Olsen, 1998](#); [Lesage et al., 1990](#); [Lage and Parsons, 1985](#)).

Limited data directly applicable to the fate of *trans*-1,2-dichloroethylene in landfills and landfill leachate plumes were found in the literature search conducted as part of the systematic review process. Available data suggest that *trans*-1,2-dichloroethylene can be found in groundwater near landfills ([Freedman et al., 2001](#); [Lesage et al., 1990](#)); however, its presence was attributed to the biodegradation of other chlorinated ethenes, such as perchloroethylene or trichloroethylene. Given the limited amounts reported to landfills by EPA's TRI, *trans*-1,2-dichloroethylene is not expected to be present at significant levels in landfill leachate as a result of COUs.

7.3.1 Modeled Concentrations in Landfill Leachate Impacted Groundwater

This section presents a scenario-based estimate of groundwater concentrations in the near-field of a landfill receiving *trans*-1,2-dichloroethylene (*i.e.*, potential landfill leachate influence). These modeled results are provided to contextualize and bound possible near-field conditions. The assessment was completed using the Hazardous Waste Delisting Risk Assessment Software (DRAS). DRAS was specifically designed to address the Criteria for Listing Hazardous Waste identified in Title 40 CFR 261.11(a)(3), a requirement for evaluating proposed hazardous waste delisting. In this assessment, DRAS was used to determine potential groundwater concentrations of *trans*-1,2-dichloroethylene after disposal into a non-hazardous waste landfill. The results of this assessment are provided in Table 7-1. This assessment relied on the default waste loading rates for RCRA Subtitle C landfills available in DRAS. Similarly, the assessment relied on the default values for *trans*-1,2-dichloroethylene as the chemical of concern. Leachate concentrations were estimated over a range that encompasses

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literature-reported measurements, with the maximum set at roughly an order of magnitude above the highest reported leachate concentration (Schrab et al., 1993; Forst et al., 1989; Sabel and Clark, 1984). Because DRAS calculates a weight-adjusted dilution attenuation factor (DAF) rather than a groundwater concentration, a back calculation was used to convert the DAF to a potential concentration that receptors located within 1 mile of a landfill might be exposed if the release was not controlled. Based on 2019 to 2023 TRI data, the largest annual land release of *trans*-1,2-dichloroethylene to landfills reported by TRI reporting facilities was 10,910 lb (4,949 kg) in 2023. However, due to uncertainties in the disposal rates to landfills, EPA performed DRAS runs across loading rates that span five orders of magnitude, including one run at 10,000 kg/year, which is approximately one order of magnitude higher than the highest reported land release rate. The resulting possible groundwater concentrations were predicted to be less than 0.01 mg/L when assuming a max leachate concentration of 100 mg/L and a loading rate of 10,000 kg/year Table 7-1.

Table 7-1. Estimated Groundwater Concentrations (mg/L) of *trans*-1,2-Dichloroethylene Found in Wells Within 1 Mile of a Disposal Facility Determined by the DRAS Model^a

Leachate Concentration	Loading Rate				
	1 (kg/year)	10 (kg/year)	100 (kg/year)	1,000 (kg/year)	10,000 (kg/year)
0.1 mg/L	1.22E-09	1.16E-08	1.11E-07	1.06E-06	1.01E-05
1 mg/L	1.22E-08	1.16E-07	1.11E-06	1.06E-05	1.01E-04
10 mg/L	1.22E-07	1.16E-06	1.11E-05	1.06E-04	1.01E-03
100 mg/L	1.22E-06	1.16E-05	1.11E-04	1.06E-03	1.01E-02
DRAS = Hazardous Waste Delisting Risk Assessment Software					
^a Concentrations organized by potential loading rates (kg/year) and potential leachate concentrations (mg/L).					

7.3.2 Drinking Water Exposure via Landfill Leachate Impacted Groundwater

Drinking water exposures for bottle-fed infants (<1 year) and adults (21+ years) are presented below for landfill leachate impacted groundwater, assuming consumption of untreated private well water (e.g., farm owners), which differs from Section 6.4.3 above that addresses drinking water sourced from surface water. By including infant exposure estimates, EPA is considering PESS and protecting this sensitive subpopulation. The average daily doses (ADD ; Equation) are used for evaluating chronic non-cancer drinking water exposures. A summary of inputs used for these exposure estimates is provided in the *Draft Predicted Groundwater Concentrations, Exposure and Risks from Releases to Landfills for trans-1,2-Dichloroethylene* (U.S. EPA, 2026r). Drinking water doses were calculated to identify exposures and preliminary risks relative to their non-cancer benchmark. At the highest assessed loading rate and leachate concentration, estimated chronic doses across age groups were 1.11×10^{-4} to 2.83×10^{-4} mg/kg-day (See Table 7-2 and Table 7-3), based on a groundwater concentration of 0.01 mg/L. Preliminary risks were not identified (i.e., estimated MOEs were greater than the benchmark MOEs of 300) for chronic non-cancer drinking water exposures.

Equation 7-1. Drinking Water Average Daily Dose Calculation

$$ADD = \frac{(GWC \times IR_{dw} \times ED \times F)}{(BW \times AT \times CF)}$$

Where:

ADD = Average daily dose (mg/kg/day)
 GWC = Groundwater concentration (mg/L; DRAS model output)

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IR_{dw}	=	Drinking water intake rate (L/day)
F	=	Frequency (days/yr)
ED	=	Exposure duration (years for ADD)
BW	=	Body weight (kg)
AT	=	Averaging time (years for ADD)
CF	=	Conversion factor (365 days/year)

Table 7-2. Drinking Water Average Daily Doses (mg/kg/day) for Adults Based on Estimated Concentrations in Leachate Impacted Groundwater

Leachate Concentration (mg/L)	Loading Rate (kg/yr)				
	1	10	100	1,000	10,000
0.10	1.34E-11	1.28E-10	1.22E-09	1.16E-08	1.11E-07
1	1.34E-10	1.28E-09	1.22E-08	1.16E-07	1.11E-06
10	1.34E-09	1.28E-08	1.22E-07	1.16E-06	1.11E-05
100	1.34E-08	1.28E-07	1.22E-06	1.16E-05	1.11E-04

Table 7-3. Drinking Average Daily Doses (mg/kg/day) for Infants Based on Estimated Concentrations in Leachate Impacted Groundwater

Leachate Concentration (mg/L)	Loading Rate (kg/yr)				
	1	10	100	1,000	10,000
0.10	3.41E-11	3.26E-10	3.11E-09	2.97E-08	2.83E-07
1	3.41E-10	3.26E-09	3.11E-08	2.97E-07	2.83E-06
10	3.41E-09	3.26E-08	3.11E-07	2.97E-06	2.83E-05
100	3.41E-08	3.26E-07	3.11E-06	2.97E-05	2.83E-04

7.4 Concentrations of *trans*-1,2-Dichloroethylene in Soil

7.4.1 Measured Concentrations in Soil

There were no recent peer reviewed studies conducted in the United States with data on concentrations of *trans*-1,2-dichloroethylene in soil identified during systematic review.

The complete set of *trans*-1,2-dichloroethylene monitoring results from the WQP (NWQMC, 2022) were retrieved in May 2026. The database contained only 33 soil samples collected between 2015 and 2025 with concentrations reported at the detection limits and detection limits ranged from 4.5×10^{-4} to 1.3×10^{-3} mg/kg. It is unclear whether these are true detections or non-detect concentrations reported at the limit of detection (LOD).

7.4.2 Modeled Concentrations in Soil and Soil Pore Water

To assess soil concentrations resulting from biosolid applications, EPA relied upon modeling work conducted in Canada (EC/HC, 2011), which used Equation 60 of the European Commission Technical Guidance Document (TGD) (ECB, 2003). The equation in the TGD is as follows:

Equation 7-2. Predicted Environmental Concentration in Soil (mg/kg)

$$PEC_{soil} = \frac{C_{sludge} \times AR_{sludge}}{D_{soil} \times BD_{soil}}$$

Where:

PEC_{soil}	=	predicted environmental concentration (PEC) for soil (mg/kg)
C_{sludge}	=	concentration in sludge (mg/kg) = 24.14 (Section 7.1.2)
AR_{sludge}	=	application rate to sludge amended soils (kg/m ² /yr); default = 0.5 from Table A-11 of (ECB, 2003)
D_{soil}	=	depth of soil tillage (m); default = 0.2 m in agricultural soil and 0.1 m in pastureland from Table A-11 of (ECB, 2003)
BD_{soil}	=	bulk density of soil (kg/m ³); default = 1,700 kg/m ³ from Section 2.3.4 of (ECB, 2003)

Using this equation, the modeled concentration of *trans*-1,2-dichloroethylene in receiving an annual application of biosolids was estimated to be 7.1×10^{-2} mg/kg for pastureland and 3.55×10^{-2} mg/kg for agricultural soils.

To estimate soil pore water concentrations for *trans*-1,2-dichloroethylene in soil receiving biosolids for exposures to ecological species, EPA used a modified version of the equilibrium partitioning (EqP) equation developed for weakly adsorbing chemicals such as 1,1-dichloroethane and other volatile organic carbons. The modified equation accounts for the contribution of dissolved chemical to the total chemical concentration in soil or sediment (Fuchsman, 2003). The equation assumes that the adsorption of chemical to the mineral components of sediment particles is negligible:

Equation 7-3. Predicted Environmental Concentration in Soil Pore Water

$$C_{total} = C_{dissolved} \times \left[(f_{OC} \times K_{OC}) + \frac{1 - f_{solids}}{f_{solids}} \right]$$

Where:

C_{total}	=	Total chemical concentration in soil (µg/kg)
$C_{dissolved}$	=	Chemical concentration dissolved in pore water (µg/L)
f_{OC}	=	Fraction of soil present as organic carbon
K_{OC}	=	Organic carbon-water partition coefficient
f_{solids}	=	Fraction of soil solids

Using Equation 7-3 and estimating $C_{dissolved}$ from the K_{OC} of 1.23 L/kg for *trans*-1,2-dichloroethylene assuming a soil organic carbon fraction (f_{OC}) of 0.02, and a soil solids fraction of 0.5, the estimated pore water concentrations are 34.6 µg/L in tilled agricultural soil and 68.3 µg/L in pastureland.

7.5 Environmental Exposure Concentrations in Soils

EPA considered exposure to *trans*-1,2-dichloroethylene via soil for terrestrial plants and soil dwelling invertebrates. The Agency modeled concentrations of *trans*-1,2-dichloroethylene in surface soil as a result of biosolids application to agricultural lands, as described in Section 7.4.2. The modeled concentration of *trans*-1,2-dichloroethylene in soils of 0.071 mg/kg-soil will be compared to hazard thresholds for terrestrial plants and soil-dwelling invertebrates in the *Draft Risk Evaluation for trans-1,2-Dichloroethylene* (U.S. EPA, 2026t).

7.6 Concentrations of *trans*-1,2-Dichloroethylene in Groundwater

The complete set of *trans*-1,2-dichloroethylene monitoring results from the WQP (NWQMC, 2022) were retrieved in April 2026 (U.S. EPA, 2026u). The WQP dataset included 24,143 groundwater samples collected in the United States between 2015 and 2025 (Figure 7-1), with concentrations ranging from 0.01 to 6,700 µg/L. The detection limits for the samples ranged from 1.49×10^{-4} to 149 µg/L. The data show that while about 16% of the samples report measured concentrations of *trans*-1,2-dichloroethylene in groundwater, concentrations were generally low, with only a small fraction occurring at the upper end of the observed range. This means that the samples are dominated by non-detects and low concentrations of *trans*-1,2-dichloroethylene. Further examination of some of the higher concentrations show that they are from remediation programs at contaminated facilities with a documented history of chlorinated-solvent releases—primarily tetrachloroethylene and trichloroethylene—from legacy dry-cleaning and related commercial/industrial uses. In anaerobic groundwater, those parent solvents dechlorinate to 1,2-dichloroethylene isomers and then to vinyl chloride. Legacy tetrachloroethylene/trichloroethylene trapped in low-permeability zones can slowly diffuse back into groundwater, sustaining 1,2-dichloroethylene (including *trans*-1,2-dichloroethylene) for long periods. Under moderately reducing conditions, and during remedial actions that stimulate biodegradation, dechlorination can cause a temporary build-up of 1,2-dichloroethylene isomers as the parent solvents break down.

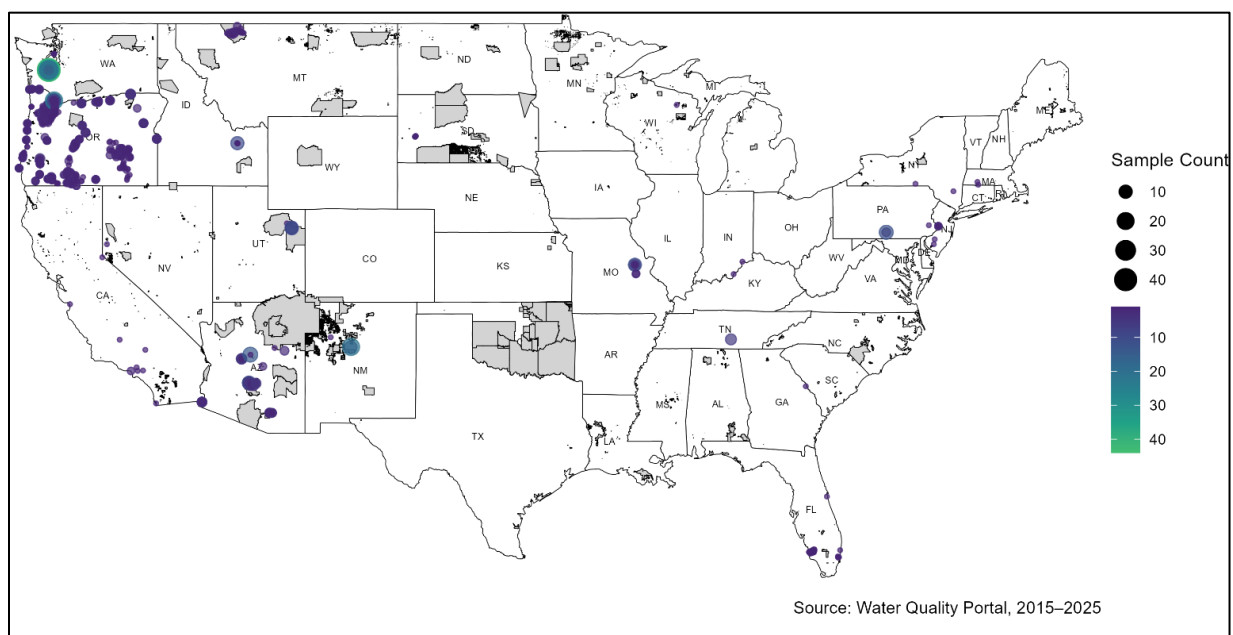


Figure 7-1. Groundwater Sampling Locations of *trans*-1,2-Dichloroethylene Retrieved from the Water Quality Portal

Each cluster (bubble) represents the number of samples at that location based on longitude and latitude coordinates rounded to five decimal places. AIANNH tribal boundaries are shaded in gray. Note: Alaska, American Samoa, Guam, Hawaii, N. Mariana Islands, Puerto Rico, and the U.S. Virgin Islands are not shown because the WQP did not contain *trans*-1,2-dichloroethylene groundwater monitoring for these locations.

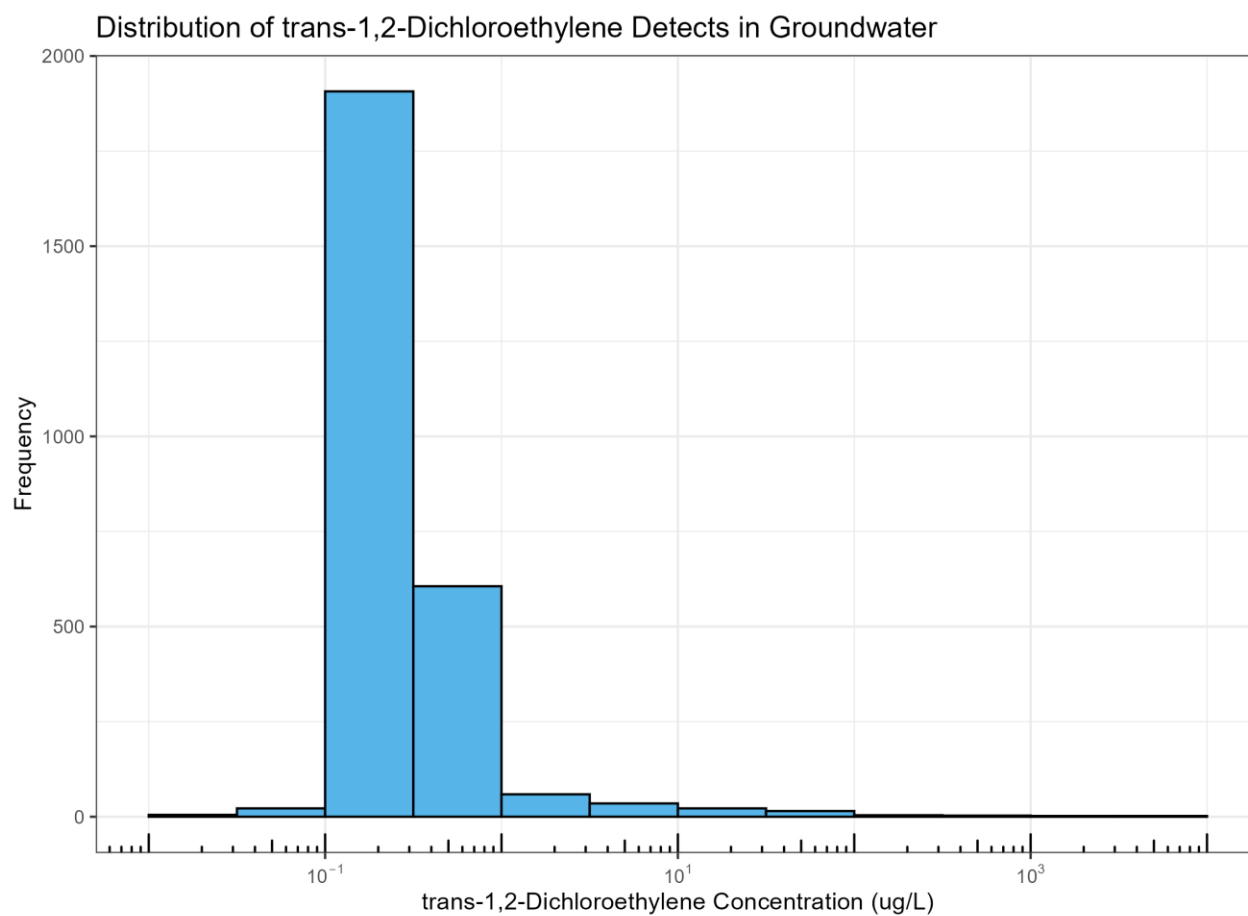


Figure 7-2. Distribution of *trans*-1,2-Dichloroethylene Groundwater Monitoring Samples with Concentrations at or Above the Detection Limit as Reported in the Water Quality Portal

The State of Washington’s Environmental Information Management System (EIMS) was also queried for groundwater samples in April 2026. There were 46,809 groundwater samples reported between 2015 and 2025 with *trans*-1,2-dichloroethylene concentrations ranging from 1.25×10^{-2} to 1×10^4 $\mu\text{g/L}$ and MDLs ranging from 5×10^{-5} to 1.6×10^4 $\mu\text{g/L}$. However, when that data is filtered to remove samples associated with contamination clean up and underground tank monitoring programs, only 9,921 samples remained, of which 9,426 were below the detection limit (<5% detection frequency). The remaining concentrations range from 0.1 to 42 $\mu\text{g/L}$ and are more likely to be representative of ambient groundwater concentrations ([WA DOE, 2026](#)).

There were no other recent peer-reviewed studies conducted in the United States with data on concentrations of *trans*-1,2-dichloroethylene in groundwater identified during systematic review.

Although there are samples with higher concentrations of *trans*-1,2-dichloroethylene from the EIMS, these are typically samples targeted at legacy contamination rather than COUs and are not expected to be representative of current ambient groundwater concentrations of *trans*-1,2-dichloroethylene. Note that there is poor spatial correlation between WQP groundwater concentration data and TRI land release locations indicating that detections may stem from other sources such as legacy sources or cleanup sites or the degradation product of other chlorinated ethenes, such as trichloroethylene or tetrachloroethylene ([Freedman et al., 2001](#); [Lorah and Olsen, 1998](#); [Lesage et al., 1990](#); [Lage and Parsons, 1985](#)) rather than current TRI facilities.

7.7 Evidence Integration and Weight of Scientific Evidence for Land Pathway

Available lines of evidence indicate that *trans*-1,2-dichloroethylene is not expected to be present in significant concentrations in landfill leachate, biosolids groundwater, or soils.

Based on TRI reported releases between 2019 and 2023, releases to landfills are relatively low ($\leq 12\%$). Available peer-reviewed studies have attributed its presence in landfill impacted groundwater to the biodegradation of compounds such as tetrachloroethylene or trichloroethylene rather than direct disposal of *trans*-1,2-dichloroethylene.

Although *trans*-1,2-dichloroethylene is commonly detected in groundwater, there is uncertainty about the source since it is a well-established intermediate in the biodegradation of tetrachloroethylene or trichloroethylene and known releases of *trans*-1,2-dichloroethylene to land are low. Given the low risk of failure of the predominant land release scenario (landfills), the low volume of releases reported to landfills by EPA's TRI, the fugacity analysis of *trans*-1,2-dichloroethylene (indicating that it is more likely to partition to air from soil rather than water), as well as WQP data indicating low detection frequencies and low concentrations of *trans*-1,2-dichloroethylene in groundwater, there is uncertainty around the source of *trans*-1,2-dichloroethylene in groundwater.

Furthermore, the spatial distribution of groundwater concentration data from WQP does not align with release locations reported by TRI. This introduces uncertainty in interpreting the source of detected concentrations. This lack of co-location also supports the conclusion that groundwater contamination is not entirely attributable to TSCA uses. The observed occurrences are more likely due to a combination of direct releases and in situ formation via transformation of higher chlorinated solvents in groundwater ([Freedman et al., 2001](#); [Lesage et al., 1990](#)) (see Section 3.4.3.3 for more details).

Screening level estimates for landfill impacted groundwater were predicted to be less than 0.01 mg/L (Section 7.3.1). Uncertainties and limitations are inherent in the modeling of groundwater concentrations from disposing chemical substances into poorly managed RCRA Subtitle D landfills as well as those that are not regulated as closely. These uncertainties include, but are not limited to, (1) determining the total and leachable concentrations of waste constituents, (2) estimating the release of pollutants from the waste management units to the environment, and (3) estimating and transport of pollutants in a range of variable environments by process that often are not completely understood or are too complex to quantify accurately. To address some of these uncertainties and add strength to the assessment, EPA ran the DRAS Model under multiple scenarios, varying waste loading rates and assumed leachate concentrations. These considerations add value to estimate exposure that falls at an unknown percentile of the full distribution of exposures. The DRAS Model is based on a survey of drinking water wells located downgradient from a waste management unit ([U.S. EPA, 1988](#)). Due to the age of the survey, it is unclear how the survey represents current conditions and proximity of drinking water wells to disposal units. Similarly, it is not clear if the surveyed waste management units are representative of current waste management practices. EPA therefore has moderate confidence in the accuracy of modeled estimates of *trans*-1,2-dichloroethylene in groundwater from TSCA releases and that the modeled estimates are protective of human health.

Biosolids monitoring data indicate that *trans*-1,2-dichloroethylene is rarely detected (detection frequency $< 1\%$) and it is not a target analyte in most regulatory biosolids programs. In addition, TRI reported releases to water are very low ($< 1\%$). Based on physical-chemical properties, *trans*-1,2-dichloroethylene present in wastewater influent will tend to volatilize during treatment. This suggests

that biosolids are unlikely to represent a meaningful source to soils. Screening level estimates for soil concentrations resulting from biosolid application were estimated to be a maximum of 0.071 mg/kg.

In soil, *trans*-1,2-dichloroethylene is characterized by high volatility and relatively low sorption potential, limiting its persistence in the vadose zone. And monitoring data confirm that *trans*-1,2-dichloroethylene is not frequently detected in soil (detection frequency <5%).

Overall, EPA has moderate confidence that *trans*-1,2-dichloroethylene will be present at low concentrations in groundwater and soils based on the monitoring data, physical and chemical properties, and release data.

8 ENVIRONMENTAL TROPHIC TRANSFER AND BIOACCUMULATION

8.1 Approach and Methodology and Exposure Scenarios

EPA evaluated the reasonably available information for environmental exposure of *trans*-1,2-dichloroethylene to aquatic and terrestrial species. There are three primary exposure pathways for ecological receptors to environmental releases:

- exposures for aquatic species from releases to water;
- exposures for terrestrial species from fugitive releases to ambient air; and
- exposures for terrestrial species from releases to land from biosolids application to soils.

Environmental exposures for aquatic species are described in Section 6 and for terrestrial species in Section 7.

8.2 Trophic Transfer Exposure Analysis

Trophic transfer is the process by which chemical contaminants can be taken up by organisms through dietary and media exposures and transferred from one trophic level to another. The ecological organization of species, populations and communities in the environment can be described in terms of “trophic levels,” which is essentially what foods are consumed. Organisms may be exposed to chemicals through media and diet. Chemicals can be transferred from contaminated media and diet to biological tissue and accumulate throughout an organism’s lifespan (bioaccumulation) if they are not readily excreted or metabolized. Through dietary consumption of prey, a chemical can subsequently be transferred from one trophic level to another. This process has been termed trophic transfer. Trophic transfer can occur within aquatic and terrestrial ecosystems as upper trophic level species consume lower trophic level species. It can also take place between aquatic and terrestrial compartments with aquatic-dependent predators, such as mink and osprey, primarily consuming aquatic organisms. If biomagnification occurs, higher trophic level predators will contain greater body burdens of bioaccumulative contaminants compared to lower trophic level organisms.

Trophic transfer is important to consider in risk evaluations conducted under TSCA to ensure that exposure is not underestimated and risk estimates are protective of the environment. A tiered approach is typically implemented to evaluate a chemical’s potential risk via trophic transfer.

The risk evaluations for 1,1-dichloroethane ([U.S. EPA, 2025c](#)) and 1,2-dichloroethane ([U.S. EPA, 2026ab](#)) quantitatively evaluated the trophic transfer of these chlorinated solvents with subsequent dietary exposures for terrestrial mammals and birds as the result of oral exposures. As the results of these analyses did not show risk for terrestrial wildlife, food chain (oral) exposures and risk are not quantitatively evaluated for *trans*-1,2-dichloroethylene based on its similar physical-chemical properties and reported and estimated bioconcentration and bioaccumulation factors.

8.3 Environmental Aggregate Exposure

The environmental exposure assessment for *trans*-1,2-dichloroethylene did not assess aggregate exposures for either aquatic or terrestrial exposure scenarios. Given the volatile nature of the chemical, its low affinity for soil organic matter and its bioaccumulation factor less than 1,000, aggregate exposure scenarios were not considered likely for *trans*-1,2-dichloroethylene. More on the physical-chemical properties can be found in Section 2 and the fate and transport of the chemical can be found in Section 3.

8.4 Evidence Integration and Weight of Scientific Evidence for Trophic Transfer

For the *trans*-1,2-dichloroethylene environmental exposure assessment, EPA did not include a quantitative analysis of trophic transfer as described in Section 3.5.4.

8.5 Environmental Exposure Summary

EPA assessed the reasonably available information for environmental exposure of *trans*-1,2-dichloroethylene to aquatic and terrestrial species. The key points of the environmental exposure assessments are summarized below:

- EPA expects the main environmental exposure pathways to be surface water, soil, and air. The air pathway was assessed for its contribution via fugitive emissions to ambient air with subsequent exposures via inhalation by mammalian wildlife and direct exposure to terrestrial plants. The land pathway was assessed for its contribution via application of biosolids to soil.
- *trans*-1,2-Dichloroethylene exposure to aquatic species through surface water were modeled to estimate concentrations at the point of release.
 - Modeled data based on the highest modeled 7Q10 surface water concentrations using TRI and DMR facility release data was represented by the Waste Handling, Treatment, and Disposal (POTW) OES with concentrations of 29 µg/L for the maximum days of release scenario and 509 µg/L for the 21-day release scenario
- *trans*-1,2-Dichloroethylene exposure to terrestrial species through soil, and air were also assessed using modeled data.
 - Modeled data based on releases to air estimated a maximum upper bound (95th percentile) concentration from fugitive release to be 146 ug/m³.
 - Modeled data based on biosolid application, soil concentration calculated to be 0.71 mg/kg-soil.

Exposure through diet was not assessed quantitatively through a trophic transfer analysis. A qualitative assessment based on physical-chemical properties of *trans*-1,2-dichloroethylene, and results from quantitative analysis of other chlorinated solvents show that trophic transfer is not expected to be a viable pathway for *trans*-1,2-dichloroethylene exposure.

9 OCCUPATIONAL EXPOSURE ASSESSMENT

9.1 Industrial and Commercial Conditions of Use

For workplace exposures, EPA considered exposures to both workers who directly handle *trans*-1,2-dichloroethylene and ONUs who do not directly handle *trans*-1,2-dichloroethylene but may be exposed to vapors, particulates, or mists that enter their breathing zone while working in locations in close proximity to where *trans*-1,2-dichloroethylene is being used. EPA evaluated inhalation exposures to both workers and ONUs and dermal exposures to workers. An occupational exposure assessment was conducted for each OES, where possible, as specified in Table 4-1 of Section 4.

For occupational exposure assessment, EPA used measured (personal or area) and modeled air concentrations to assess inhalation exposure. Dermal monitoring data were not available; therefore, the Agency estimated dermal exposure levels using a modeling approach. EPA applied the following hierarchy (Table 9-1) in selecting data and approaches for assessing occupational exposures ([CEB, 1991](#)):

Table 9-1. Hierarchy of Data and Approaches for Assessing Occupational Exposures to *trans*-1,2-Dichloroethylene

Type of Approach	Description
1. Monitoring data	a. Personal and directly applicable
	b. Area and directly applicable
	c. Personal and potentially applicable or similar
	d. Area and potentially applicable or similar
2. Modeling approaches	a. Surrogate monitoring data

EPA utilized the estimated central tendency and high-end full-shift TWA inhalation exposure concentrations and estimated dermal concentrations to calculate exposure metrics required for risk evaluation. Additionally, the Agency estimated the number of workers potentially exposed for each OES. The amount and the strength of the evidence available for inhalation and dermal exposure estimates vary widely among the OESs, and as such EPA evaluated the evidence including strengths, limitations, uncertainties and assumptions made to arrive at an overall confidence rating for the assessment of each OES. See individual subsections in Section 9.2 for details on specific data utilized for each OES. Additionally, the *Draft Occupational Risk Calculator for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026q](#)) includes the data and calculations used to determine occupational risk for workers and occupational non-users to *trans*-1,2-dichloroethylene. The Agency's estimates of occupational exposure presented in this document do not assume the use of PPE; however, the effect of respiratory and dermal protection factors on EPA's occupational exposure estimates can be explored in the "Risk Reduction" tab in the *Draft Occupational Risk Calculator for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026q](#)) supplemental file. For more discussion on respiratory protection and glove protection, refer to Section 9.1.5 below.

9.1.1 Identifying Exposure Groups and Worker Activities

EPA recognizes that exposure potential can vary in an OES facility where *trans*-1,2-dichloroethylene is manufactured, processed or used. Exposure group refers to a group of potentially exposed persons with a similar exposure profile to a chemical substance or mixture based on the substantial similarity of tasks performed, the manner in which the tasks are performed, and the materials and processes with which they work (40 CFR 751.5). For each OES assessed, EPA identified exposure groups (also referred to as

similar exposure groups [SEGs]) and worker activities. EPA then estimated exposures by exposure group and utilized these to calculate risk estimates.

EPA performed a literature search and reviewed data from systematic review to identify worker activities that could potentially result in occupational exposures. Where worker activities were unclear or not available, the Agency referenced relevant GSs and ESDs. Additionally, for manufacturing and processing, EPA utilized information from industry submitted test orders to identify and describe exposure groups. In this scenario, the Agency received detailed information on the exposure groups (also referred to as similar exposure groups or SEGs), including worker activities and exposure levels, through the submission of the test order summary report. Where sufficient information to define specific worker exposure groups was not available, EPA assessed exposures to the general categories of workers and ONUs. The Agency distinguished workers as those who worked in close proximity to *trans*-1,2-dichloroethylene, having direct contact and/or handling of the chemical. ONUs do not directly handle *trans*-1,2-dichloroethylene but may be indirectly exposed to it as part of their employment.

9.1.2 Estimating Inhalation Exposures for Exposure Groups – Monitoring Data

EPA reviewed workplace inhalation monitoring data collected by government agencies such as Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH), monitoring data found in published literature (*i.e.*, personal exposure monitoring data and area monitoring data), and monitoring data submitted as part of test orders. Studies were evaluated using the evaluation strategies described in the 2021 Draft Systematic Review Protocol ([U.S. EPA, 2021c](#)). Data and studies considered in this assessment can be found in the *Draft Systematic Review Protocol for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026x](#)) and in the “Inhalation Exposure” tab of the *Draft Occupational Risk Calculator for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026q](#)).

As previously described, EPA utilized the hierarchy of data and approaches for assessing occupational exposure as described in Table 9-1. In the absence of chemical- and OES-specific personal breathing zone (PBZ) data, EPA considers area monitoring data, which is collected at a stationary location as opposed to on a person. Generally, there is more uncertainty in use of this data, and more information is needed on the worker activity pattern to estimate the amount of time the worker is at the monitored location. Where directly applicable data was not available, EPA then considered analogous exposure monitoring data, which is monitoring data for the same chemical but for a different (but similar) OES.

In some cases, monitoring sample durations were shorter or longer than 8 hours. Eight-hour TWAs were estimated by normalizing the measured inhalation concentration to an 8-hour period based on the actual sample duration. EPA estimated occupational exposures representative of the central tendency and high-end exposure conditions. Central tendency exposures are assumed to represent occupational exposures in the center of the distribution for a given COU. The high-end exposure is assumed to be representative of occupational exposures that occur at probabilities greater than or equal to the 90th percentile, but below the exposure of the individual with the highest exposure ([U.S. EPA, 1992a](#)). Exposures are calculated from the monitoring datasets provided in the sources depending on the size of the dataset. For datasets with six or more data points, central tendency and high-end exposures were estimated using the 50th and 95th percentiles. For datasets with three data points, central tendency exposure was calculated using the median and the maximum was presented as the high-end exposure estimate. For datasets with two data points, the midpoint was presented as a midpoint value and the higher of the two values was presented as a higher value. Finally, datasets with only one data point presented the single exposure value.

For datasets including exposure data that were reported as below the limit of detection (LOD), EPA estimated the exposure concentrations for these data, following EPA's *Guidelines for Statistical Analysis of Occupational Exposure Data* ([U.S. EPA, 1994](#)), which recommends using the $\frac{LOD}{\sqrt{2}}$ if the geometric standard deviation of the data is less than 3.0 and $\frac{LOD}{2}$ if the geometric standard deviation is 3.0 or greater.

9.1.3 Estimating Inhalation Exposure – Modeling

Use of Surrogate Monitoring Data

As specified in the data hierarchy (Table 9-1), in some cases where inhalation exposures were expected for an OES but monitoring data specific to *trans*-1,2-dichloroethylene was not available, monitoring data of the same OES but from a different chemical were utilized in the inhalation exposure assessment. In these cases, EPA compared the physical properties of possible surrogate chemicals to find the most appropriate surrogate and correction factors were applied to adjust for differences in chemical properties such as vapor pressure. For the assessment of *trans*-1,2-dichloroethylene, the Agency utilized surrogate monitoring data for other chlorinated solvents from previous published risk evaluations.

When using this approach, EPA corrected for differences in physical-chemical properties between *trans*-1,2-dichloroethylene and the surrogate chemical. EPA utilized Equation 9-1 to correct vapor monitoring data from a surrogate chemical to the chemical of interest:

Equation 9-1.

$$C_{v2} = C_{v1} \times \frac{VP_2 \times X_2}{VP_1 \times X_1}$$

Where:

C_{v2}	=	Estimated volumetric concentration of the chemical of interest (ppm)
C_{v1}	=	Measured volumetric concentration of surrogate chemical in air (ppm)
VP_1	=	Vapor pressure of surrogate chemical (torr)
X_1	=	Mole fraction of surrogate chemical in mixture (unitless)
VP_2	=	Vapor pressure of chemical of interest (torr)
X_2	=	Mole fraction of chemical of interest in mixture (unitless)

9.1.4 Estimating Dermal Exposure for Exposure Groups – Modeling

EPA did not identify any dermal exposure monitoring data for any OES through systematic review or through other reasonably available sources (*e.g.*, public comments). Therefore, to assess dermal exposure, the Agency used the EPA Dermal Exposure to Volatile Liquids Model (DEVL) to calculate the acute absorbed dose rate (AADR) for each OES. The acute dermal exposures were calculated to determine intermediate and chronic dermal exposures (which will be defined in Section 9.1.6) and were not assessed in the risk evaluation due to the lack of evidence of acute dermal toxicity (see *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026m](#)) for more details).

In TSCA risk evaluations, EPA has used both flux-based and fraction absorbed-based approaches to estimate dermal exposure. The distinction between the flux-based and fraction absorbed-based dermal approaches is based on whether the applied dose of the chemical on the skin is expected to deplete during the exposure period. If it does deplete, then the fraction absorbed approach is used. For volatile chemicals in occupational settings, EPA utilizes a fraction absorbed approach. This approach assumes that the chemical is both absorbed into the skin and lost to evaporation, and the dose is likely to deplete before the end of the workday ([Frasch et al., 2014](#)). This differs from non-volatile chemicals where the

depletion of the applied dose is entirely dependent on the rate of absorption into the skin.

The exposure concentration is determined based on EPA's review of currently available products and formulations containing *trans*-1,2-Dichloroethylene. The dose estimates assume one dermal exposure event (applied dose) per workday and approximately 0.7 to 1.7% of the applied dose is absorbed through the skin, based on fractional absorption data that was developed from a TSCA section 4 test order TDCE Consortium Final Study Report ([TDCE Consortium, 2023](#)). At each concentration, the majority of radioactivity was unabsorbed, indicating that under finite conditions, *trans*-1,2-dichloroethylene was most likely to quickly volatilize from the skin surface. All occupational COUs involve handling *trans*-1,2-dichloroethylene in a concentration greater than 10%. Therefore, the highest concentration of 10% test preparation in IPM was used. When statistically adjusted, (see ([U.S. EPA, 2026i](#))) mean absorption was 1.2%. Absorption was variable across all test formulations without a consistent concentration-response, so EPA applied the European Food Safety Authority (EFSA) upper and lower confidence adjustment, resulting in a percent absorption ranging from 0.7 to 1.7% ([Authority et al., 2017](#)). Therefore, EPA employed a Monte Carlo model of occupational dermal exposure with a uniform distribution for percent absorbed ranging from 0.7 to 1.7%. A complete analysis of the results is contained in Section 2.2.1 of the *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026m](#)).

In the dermal exposure modeling equation, the frequency of events (FT) is shown as a linear relationship with the acute absorbed dose; however, this fails to account for time between contact events. Since the chemical simultaneously evaporates from and absorbs into the skin, dermal exposure is a function of both the number of contact events per day and the time between contact events. EPA did not identify information on how many contact events may occur and the time between contact events. Therefore, EPA assumes a single contact event per day for estimating dermal exposures.

The values of the dermal load (Q_u) were based on experimental studies of non-aqueous liquids to measure the quantity remaining on the skin after contact. The liquids utilized in the studies included mineral oil, cooking oil, and bath oil. The oils were selected for their suitability for human use (non-toxic) and their varying viscosities (160.2 centistokes [cSt], 59.2 cSt, and 33.3 cSt respectively). In the study, an initial wipe test was performed that consisted of the subjects wiping their hands with a cloth saturated with the test substance. The amount of liquid retained on the hands was measured immediately after the application. The values from the study ranged from 0.7 to 2.1 mg/cm² with a midpoint of 1.4 mg/cm² ([U.S. EPA, 1992b](#)). The study utilized oils as these had better retention and ease of measuring the amount of chemical retained on skin. Given *trans*-1,2-dichloroethylene is a less viscous and more volatile liquid than the oils used in the study, these dermal loadings values are likely an overestimate. The fraction absorbed as provided by the test order multiplied by the loading is the portion that is actually absorbed with the majority of the amount on the skin volatilized. In summary, for volatile liquids, EPA does not estimate a dermal dose without accounting for fraction absorbed vs. the fraction volatilized.

EPA used a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method using the Dermal Exposure to Volatile Liquids Model. Specific details of the dermal exposure assessment for each OES can be found in Section 9.2 and equations for estimating dermal exposures can be found in Appendix A.9.

EPA did not assess dermal exposures to ONUs because EPA does not expect ONUs to directly handle *trans*-1,2-dichloroethylene as part of their duties. Therefore, ONUs are not expected to have dermal exposures during the course of their work.

9.1.5 Consideration of Exposure Controls and Personal Protective Equipment (PPE)

The Agency's estimates of occupational exposure presented in this draft TSD do not assume the use of PPE; however, the effect of PPE on EPA's occupational exposure estimates is presented in the "Risk Reduction" tab of the *Draft Occupational Risk Calculator for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026q](#)) supplemental file, and is discussed in the *Draft Risk Evaluation for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026t](#)).

OSHA and NIOSH recommend employers utilize the hierarchy of controls⁸ to address hazardous exposures in the workplace. The hierarchy of controls strategy outlines, in descending order of priority, elimination, substitution, engineering controls, administrative controls, and lastly PPE. The hierarchy of controls prioritizes the most effective measures, which eliminate or substitute the harmful chemical (e.g., use a different process, substitute with a less hazardous material), thereby preventing or reducing exposure potential. Following elimination and substitution, the hierarchy recommends engineering controls to isolate employees from the hazard, followed by administrative controls or changes in work practices to reduce exposure potential (e.g., source enclosure, local exhaust ventilation systems). Administrative controls are policies and procedures instituted and overseen by the employer to protect worker exposures. OSHA and NIOSH recommend the use of PPE (e.g., respirators, gloves) as the last means of control, when the other control measures cannot reduce workplace exposure to an acceptable level.

The remainder of this section discusses respiratory protection and glove protection, including protection factors for various respirators and dermal protection strategies:

Respiratory Protection

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, providing 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 be selected based on the respiratory hazard(s) to which the worker will be exposed, in addition to workplace and user factors that affect respirator performance and reliability. Assigned protection factors (APFs) are provided in Table 1 under CFR 1910.134(d)(3)(i)(A) (see below in Table 9-2) 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 respiratory protection program according to the requirements of OSHA's Respiratory Protection Standard. Workers are required to use respirators that meet or exceed the required level of protection listed in Table 9-2. Based on the APF, inhalation exposures may be reduced by a factor of 5 to 10,000 if respirators are properly fitted and worn.

EPA does not quantitatively apply respirator protection factors to inhalation exposure estimates but does include information, such as from test orders, that it has gathered on respirators used at the facilities monitored and from industries within an OES. In the risk assessment (not part of this draft TSD), if the estimated risks are below benchmark values, EPA does estimate the protection factor needed for an acceptable risk. A qualitative review can then be done as to whether the respirators described can provide the protection level needed.

⁸ https://www.osha.gov/sites/default/files/Hierarchy_of_Controls_02.01.23_form_508_2.pdf (accessed July 28, 2026)

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Table 9-2. Assigned Protection Factors for Respirators in OSHA Standard 29 CFR 1910.134

Type of Respirator	Quarter Mask	Half Mask	Full Facepiece	Helmet/Hood	Loose-Fitting Facepiece
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)					

Dermal Protection

OSHA's hand protection standard (29 CFR 1910.138) requires employers select and use appropriate hand protection when expected to be exposed to hazards such as those from skin absorption of harmful substances; severe cuts or lacerations; severe abrasions; punctures; chemical burns; thermal burns; and harmful temperature extremes. Dermal protection selection provisions are provided in CFR 1910.138(b) and require that appropriate hand protection is selected based on the performance characteristics of the hand protection relative to the task(s) to be performed, conditions present, duration of use, and the hazards to which employees will be exposed.

Unlike respiratory protection, OSHA standards do not provide quantitative protection factors associated with various hand protection PPE, such as gloves, and data about the frequency of effective glove use—that is, the proper use of effective gloves—is very limited in industrial settings. Initial literature review suggests that there is unlikely to be sufficient data to justify a specific probability distribution for effective glove use for a chemical or industry. Instead, the impact of effective glove use is explored by considering different percentages of effectiveness.

Where available, EPA includes information, such as from test order submissions, on gloves worn at the monitored facilities, or for facilities within an OES. EPA does not quantitatively apply dermal protection factors to dermal exposure estimates from the modeling approaches. Where dermal risks are identified EPA performs a qualitative review comparing the level of dermal risk exceedance with the information on dermal protection that is available.

9.1.6 Estimating Acute, Intermediate, and Chronic (Non-Cancer) Inhalation and Dermal Exposures

The estimated full-shift TWA inhalation exposures were used to calculate acute exposure concentrations (AC), intermediate average daily concentrations (ADC_{intermediate}), and average daily concentrations (ADC) for chronic, non-cancer risks. This report also assesses *trans*-1,2-dichloroethylene dermal exposures to workers in occupational settings, presented as a dermal acute absorbed dose rate (AADR),

as described in Section 9.2 and in Appendix A.9. For each COU, the estimated acute dermal exposures (AADR) were calculated to determine intermediate and chronic (non-cancer) dermal exposures and were not assessed in the risk evaluation due to the lack of evidence of acute dermal toxicity (see *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026m](#)) for more details).

These calculations require additional parameter inputs, such as years of exposure, exposure duration and frequency, and lifetime years. Equations, parameter inputs, and sample calculations for these exposures can be found in Appendix A.2.

For the final exposure result metrics, each of the input parameters (*e.g.*, air concentrations or dermal doses, working years, exposure frequency, lifetime years) may be a point estimate (*i.e.*, a single descriptor or statistic such as central tendency or high-end) or a full distribution. EPA considered three general approaches for estimating the final exposure result metrics:

- **Deterministic calculations:** EPA used combinations of point estimates of each parameter to estimate a central tendency and high-end for each final exposure metric result. The Agency documented the method and rationale for selecting parametric combinations to be representative of central tendency and high-end.
- **Probabilistic (stochastic) calculations:** EPA used Monte Carlo simulations using the full distribution of each parameter to calculate a full distribution of the final exposure metric results and selecting the 50th and 95th percentiles of this resulting distribution as the central tendency and high-end, respectively.
- **Combination of deterministic and probabilistic calculations:** EPA had full distributions for some parameters but point estimates of the remaining parameters. For example, the Agency used Monte Carlo modeling to estimate exposure concentrations but only had point estimates of exposure duration and frequency as well as lifetime years. In such cases, EPA documented the approach and rationale for combining point estimates with distribution results for estimating central tendency and high-end results.

9.1.7 Assess Weight of Scientific Evidence and Assign Confidence Ratings

Evidence integration for the occupational exposure assessment includes analysis, synthesis, and integration of information and data to produce estimates of occupational exposures. During evidence integration, EPA considered the likely location, duration, intensity, frequency, and quantity of exposures while also considering factors that increase or decrease the strength of evidence when analyzing and integrating the data. Data sources are rated with one of four possibilities: *high*, *medium*, *low*, and *unacceptable*. Key factors EPA considered when integrating evidence includes the following:

1. **Data Quality:** EPA only integrated data or information rated as high, medium, or low obtained during the data evaluation phase. Data and information rated as uninformative are not used for quantitative exposure estimates. In general, higher rankings are given preference over lower ratings; however, lower ranked data may be used over higher ranked data when specific aspects of the data are carefully examined and compared. For example, a lower ranked dataset that precisely matches the OES of interest may be used over a higher ranked study that does not as closely match the OES of interest.
2. **Data Hierarchy:** EPA used both measured and modeled data to obtain accurate and representative estimates (*e.g.*, central tendency, high-end) of the occupational exposures resulting directly from a specific source, medium, or product. If available, measured exposure data are given preference over modeled data, with the highest preference given to data that are both

chemical-specific and directly representative of the OES/exposure source.

EPA considered both data quality and data hierarchy when determining evidence integration strategies. The final integration of the occupational exposure evidence combined decisions regarding the strength of the available information, including information on plausibility and coherence across each evidence stream.

After the occupational exposure assessment for an OES is completed, EPA assesses the weight of scientific evidence for the OES and assigns a confidence rating. The Agency evaluated the weight of scientific evidence supporting the occupational exposure assessment based on the strengths, limitations, and uncertainties associated with the occupational exposure estimates. The conclusion is summarized using confidence descriptors: *robust*, *moderate*, *slight*, or *indeterminate*. EPA considers factors including the quantity and quality of the data/information, applicability of the exposure data to the OES (including considerations of temporal relevance, locational relevance), and the representativeness of the estimate for the whole industry. The weight of scientific evidence conclusions and overall confidence for each OES are described in Section 9.3.

9.1.8 Estimating the Number of Workers and Occupational Non-Users Potentially Exposed

When available, EPA first utilized CDR data to estimate the number of workers potentially exposed to *trans*-1,2-dichloroethylene.

EPA supplemented available CDR data with a method that involves estimating the number of sites for *trans*-1,2-dichloroethylene for an OES with an estimate of the average number of workers for sites with an OES. The remainder of this section describes the specific steps that were done in this assessment for estimating the number of workers and ONUs per OES for *trans*-1,2-dichloroethylene.

Estimating Number of Sites for trans-1,2-Dichloroethylene for an OES

This is the result of mapping of sites from data for *trans*-1,2-dichloroethylene collected from data sources including TRI, DMR, and CDR. For several OES, the number of sites was estimated from environmental release modeling.

Estimating the Average Number of Workers per Site for the OES

EPA estimated the average number of workers per site following the steps described below:

1. Identified the NAICS codes for the industry sectors associated with the OES.
2. Estimated total employment by industry/occupation combination using the U.S. Bureau of Labor Statistics' Occupational Employment Statistics data (BLS Data).
3. Refined the Occupational Employment Statistics estimates where they are not sufficiently granular by using the U.S. Census' Statistics of U.S. Businesses (SUSB) (SUSB Data) data on total employment by 6-digit NAICS.
4. Used the estimated workers/ONUs per site in the 6-digit NAICS code and multiply by the number of sites estimated from CDR, TRI, Discharge Monitoring Report (DMR) and/or National Emissions Inventory (NEI). In DMR data, sites report SIC codes rather than NAICS codes; therefore, the Agency mapped each reported SIC code to a NAICS code for use in this analysis.
5. Combined the data generated in Steps 1 through 4 above to produce an estimate of the number of employees using *trans*-1,2-dichloroethylene in each industry/occupation combination and sum these to arrive at a total estimate of the number of employees with exposure within the OES.

There are uncertainties surrounding the estimated number of workers potentially exposed to *trans*-1,2-dichloroethylene. First, BLS employment data for each industry/occupation combination are only

available at the 3-, 4-, or 5-digit NAICS level—rather than at the full 6-digit NAICS level. This lack of specificity could result in an overestimate of the number of exposed workers if some 6-digit NAICS are included in the less granular BLS estimates but are not likely to use *trans*-1,2-dichloroethylene for the assessed applications. EPA addressed this issue by refining the Occupational Employment Statistics data using total employment data from the U.S. Census' SUBS. The effects of this uncertainty on the number of worker estimates are unknown, as the uncertainties may result in either over or underestimation of the estimates depending on the actual distribution.

Second, EPA's determinations of industries (represented by NAICS codes) and occupations (represented by Standard Occupational Classification [SOC] codes) that are associated with the OESs assessed in this report are based on EPA's understanding of how *trans*-1,2-dichloroethylene is used in each industry. The designations of which industries and occupations have potential exposures is a matter of professional judgment; therefore, the possibility exists for the erroneous inclusion or exclusion of some industries or occupations. This may result in inaccuracy but would be unlikely to systematically either overestimate or underestimate the count of exposed workers.

For additional details on how the number of workers and ONUs were determined for *trans*-1,2-dichloroethylene, including how worker and ONU designations were made, refer to Appendix E.

9.2 Occupational Exposure Assessment by OES

9.2.1 Manufacturing as a Primary Product – OES #1

9.2.1.1 Exposure Groups and Worker Activities

As described in Section 4.2.1, EPA received information on the production of *trans*-1,2-dichloroethylene as a primary product from the TDCE Consortium in response to a test order issued under section 4(a) of TSCA.

The Final Study Report submitted to EPA by the TDCE Consortium ([Exponent, 2023](#)) detailed worker activities per similar exposure group (SEG) that occurred during inhalation monitoring at a site where *trans*-1,2-dichloroethene was manufactured. The Study Report also identified task-level SEGs to represent tasks that regularly occurred during full-shift SEG sampling.

Outside Lead Operator/B-Operator – Batch Manufacturing

The work activities of the two job titles are the same, with lead operators managing the process and assisting as needed, and B-operators performing most of the physical tasks. The operators work a 12-hour shift. The operators' responsibilities include sample collection, locking out equipment for maintenance, and performing inspection rounds.

Operator – Distillation Operation

The operators manage the distillation process. The operators work a 12-hour shift. The operators' responsibilities include sample collection, locking out equipment for maintenance, and performing inspection rounds.

Shipping/Warehouse Worker – Batch Manufacturing

Shipping/warehouse workers are responsible for drumming and truck loading of the final product. Shipping/warehouse workers work a 12-hour shift.

Laboratory Technician – Batch Manufacturing

Laboratory technicians analyze samples of the product for quality control. Laboratory technicians work a 12-hour shift.

Occupational Non-User

ONUs in the inhalation sampling study included shift supervisors, inside lead operators/ board operators, in-house maintenance workers/instrument technicians, and contract maintenance workers.

9.2.1.2 Occupational Exposure Inhalation Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was primary data. Occupational inhalation data for *trans*-1,2-dichloroethylene during manufacturing as a primary product were provided via a test order submission from the TDCE Consortium ([Exponent, 2023](#)). EPA identified 29 worker and 37 ONU full-shift PBZ samples at 1 facility from the test order data to estimate inhalation exposure. The total number of non-detects was 26 (LOD <0.02 to <0.04 ppm). For all datasets, the geometric standard deviation of the measured data was greater than three; therefore, the Agency assessed non-detects at the limit of detection divided by two (LOD/2) .

The worker samples collected were from operators/process technicians, logistics/distribution technicians, maintenance technicians, and laboratory technicians at the site. From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in Table 9-3.

Table 9-3. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Manufacturing as a Primary Product in Chemical Manufacturing

Worker Description	No. of Samples	No. of Detected Samples ^a	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Outside Lead Operator/B-Operator –Batch Manufacturing	5	4	461	680	0.11	0.57
Operator – Distillation Operation	13	6	652	699	1.3E–02	0.79
Shipping/Warehouse Worker – Batch Manufacturing	5	5	675	720	8.3	30
Laboratory Technician – Batch Manufacturing	6	0	645	671	1.3E–02	1.3-2
ONU	37	10	443	670	1.7E–02	0.15
^a Limit of detection (LOD) ranged from <0.02 to <0.04 ppm, depending on sample duration. All datasets are from the TDCE Consortium Test Order (Exponent, 2023).						

Using the 8-hour TWA inhalation concentrations presented in Table 9-3, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-4 below.

Table 9-4. Full-Shift Inhalation Exposure Metrics for Manufacturing as a Primary Product

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Outside Lead Operator/B-Operator – Batch Manufacturing	7.4E-02	0.39	5.4E-02	0.29	5.1E-02	0.27
Operator – Distillation Operation	1.3E-02	0.79	8.5E-03	0.54	6.2E-03	0.40
Shipping/Warehouse Worker – Batch Manufacturing	5.7	20	4.2	15	3.9	14
Laboratory Technician – Batch Manufacturing	8.5E-03	8.8E-03	6.3E-03	6.4E-03	5.8E-03	6.0E-03
ONU	1.2E-02	0.10	8.7E-03	7.4E-02	8.1E-03	7.0E-02

9.2.1.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. The concentration evaluated for this dermal exposure ranges from 90 to 100% based on information reported to the 2024 CDR ([U.S. EPA, 2026a](#)). Table 9-5 summarizes the acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during manufacturing as a primary product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-5. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Manufacturing as a Primary Product

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	7.4	21
	Acute Absorbed Dose (mg/kg-day)	9.2E-02	0.26
	Intermediate Absorbed Dose (mg/kg-day)	6.8E-02	0.19
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	6.3E-02	0.18

9.2.1.4 Information on Exposure Controls and Personal Protective Equipment

According to the *trans*-1,2-dichloroethylene test study report for the TDCE Consortium, workers and ONUs were sampled at one manufacturing facility. Distillation and batch operators generally worked outdoors with no respiratory protection, except for the use of a half-face respirator during a 15-minute task of isolating equipment, handling drums of catalyst, and adding stabilizer. Any samples were handled inside fume hoods. Shipping/warehouse workers work outdoors with local exhaust ventilation during loading activities. Some of these workers also wore half face respirators with organic vapor cartridges, but some did not. Laboratory technicians conducted activities inside fume hoods with no respiratory protection, inside a room under general ventilation (6 air changes per hour [ACH]). ONUs generally worked outdoors with no respiratory protection. All workers and ONUs wore nitrile or

leather/cut resistant gloves, flame resistant clothing, and goggles or safety glasses ([Exponent, 2023](#)).

9.2.1.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during manufacturing ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 325199 – All Other Basic Organic Chemical Manufacturing
- 325110 – Petrochemical Manufacturing
- 325180 – Other Basic Inorganic Chemical Manufacturing.

Table 9-6 summarizes the per site estimates for this OES based on the methodology described.

Table 9-6. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-Dichloroethylene During Manufacturing as a Primary Product

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
325199 – All Other Basic Organic Chemical Manufacturing	33	16
3251100 – Petrochemical Manufacturing		
325180 – Other Basic Inorganic Chemical Manufacturing		
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.2 Manufacturing as a Byproduct OES #2

9.2.2.1 Exposure Groups and Worker Activities

Based on manufacturing operations for similar chlorinated solvents, workers are potentially exposed to *trans*-1,2-dichloroethylene during its manufacture from the cleaning of reaction equipment and storage containers. Additionally, workers are potentially exposed during the handling and transport of the reaction mixture.

Inhalation and dermal exposures are expected for manual loading and transfer activities. Workers may experience inhalation and dermal exposure to *trans*-1,2-dichloroethylene during the cleaning of reaction vessels and other equipment, as well as the rinsing of storage containers.

ONUs include employees that work at the sites where *trans*-1,2-dichloroethylene is manufactured, but they 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. ONUs for this scenario include supervisors, managers, and other employees that may be in the production area but do not perform tasks that result in the same level of exposure as those workers that engage in tasks related to the manufacture of *trans*-1,2-dichloroethylene.

9.2.2.2 Occupational Exposure Inhalation Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was surrogate data from the manufacturing of *trans*-1,2-dichloroethylene as a primary product. EPA did not identify inhalation monitoring data for the manufacturing of *trans*-1,2-dichloroethylene as a byproduct. The surrogate data has a high-quality rating from the systematic review process.

Occupational inhalation data for *trans*-1,2-dichloroethylene during manufacturing as a primary product were provided via a test order submission from the TDCE Consortium ([Exponent, 2023](#)). EPA identified 29 worker and 37 ONU full-shift PBZ samples at 1 facility from the test order data to estimate inhalation exposures.

The worker samples collected were from operators, logistics/distribution technicians, and laboratory technicians at the site. From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in Table 9-7.

Table 9-7. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Manufacturing as a Byproduct in Chemical Manufacturing

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Outside Lead Operator/B-Operator – Batch Manufacturing	5	4	461	680	0.11	0.57
Operator – Distillation Operation	13	6	652	699	1.3E-02	0.79
Laboratory Technician – Batch Manufacturing	6	0	645	671	1.3E-02	1.3E-02
ONU	37	10	443	670	1.7E-02	0.15
^a Limit of detection ranged from <0.02 to <0.04 ppm, depending on sample duration. All datasets are from the TDCE Consortium Test Order (Exponent, 2023).						

Using the 8-hour TWA inhalation concentrations presented in Table 9-7, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-8.

Table 9-8. Full-Shift Inhalation Exposure Metrics for Manufacturing as a Byproduct

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Outside Lead Operator/B-Operator –Batch Manufacturing	7.4E-02	0.39	5.4E-02	0.29	5.1E-02	0.27
Operator – Distillation Operation	1.3E-02	0.79	8.5E-03	0.54	6.2E-03	0.40
Laboratory Technician – Batch Manufacturing	8.5E-03	8.8E-03	6.3E-03	6.4E-03	5.8E-03	6.0E-03
ONU	1.2E-02	0.10	8.7E-03	7.4E-02	8.1E-03	7.0E-02

9.2.2.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. The concentration evaluated for this dermal exposure was 1.25% as 1.25 lb of mixed chlorinated organic liquids are unintentionally produced per 100 lb of ethylene dichloride manufactured (VI, 2020). Table 9-9 summarizes the acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during manufacturing as a primary product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-9. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Manufacturing as a Byproduct

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	9.7E-02	0.27
	Acute Absorbed Dose (mg/kg-day)	1.2E-03	3.4E-03
	Intermediate Absorbed Dose (mg/kg-day)	8.9E-04	2.5E-03
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	8.3E-04	2.5E-03

9.2.2.4 Information on Exposure Controls and Personal Protective Equipment

No specific information on exposure controls and PPE was found for manufacturing as a byproduct. Exposure controls and PPE are expected to be similar to those used during manufacturing as a primary product, as discussed in Section

9.2.2.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during manufacturing (U.S. BLS, 2023; U.S. Census Bureau, 2017). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 325199 – All Other Basic Organic Chemical Manufacturing
- 325110 – Petrochemical Manufacturing
- 325180 – Other Basic Inorganic Chemical Manufacturing.

Table 9-10 summarizes the per site estimates for this OES based on the methodology described.

Table 9-10. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-Dichloroethylene During Manufacturing as a Byproduct

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
325199 – All Other Basic Organic Chemical Manufacturing	33	16
3251100 – Petrochemical Manufacturing		
325180 – Other Basic Inorganic Chemical Manufacturing		
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.3 Repackaging – OES #3

9.2.3.1 Exposure Groups and Worker Activities

During repackaging, worker exposures via inhalation of *trans*-1,2-dichloroethylene vapors may occur when transferring *trans*-1,2-dichloroethylene from the import drums into smaller containers. Workers may also be exposed via inhalation of vapor or dermal contact with liquid *trans*-1,2-dichloroethylene when cleaning import drums following emptying. Workers may also be exposed via inhalation of vapor or dermal contact with liquid *trans*-1,2-dichloroethylene at repackaging sites during loading and offloading from ships, trucks, totes, barges, and railcars. In these cases, activities may include connecting and disconnecting hoses during chemical transfers, purging hoses, filling storage tanks ([U.S. EPA, 2022a](#)).

ONUs include supervisors, managers, and other employees who work at the import site, where repackaging occurs, but do not directly handle *trans*-1,2-dichloroethylene. Therefore, EPA expects the ONUs to have lower inhalation exposures, lower vapor-through-skin uptake (vapor absorption through skin), and no dermal exposures compared to workers who handle the chemicals directly.

9.2.3.2 Occupational Inhalation Exposure Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was analogous data from the manufacturing of *trans*-1,2-dichloroethylene as a primary product. EPA did not identify inhalation monitoring data for the manufacturing of *trans*-1,2-dichloroethylene as a byproduct. The surrogate data has a high-quality rating from the systematic review process.

Occupational inhalation data for *trans*-1,2-dichloroethylene during processing into a formulation, mixture, or reaction product were provided via a test order submission from the TDCE Consortium ([Exponent, 2023](#)) contained data from repackaging job tasks. EPA identified 15 worker and 15 ONU full-shift PBZ samples at 2 facilities from the test order data to estimate inhalation exposures.

The worker samples collected were from drum fillers and packaging operators at the sites. From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in Table 9-11.

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Table 9-11. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Repackaging

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Drum filler	6	6	492	498	1.0	1.5
Packaging Operator – container packaging	6	6	448	457	28	130
ONU ^b	12	12	448	498	1.4	1.4

^a Limit of detection ranged from <0.02 to <0.04 ppm, depending on sample duration.
^b Assumed ONU exposure was central tendency of worker exposure of combined SEGs.
 All datasets are from the TDCE Consortium Test Order ([Exponent, 2023](#)).

As only full-shift data is provided in the test order report, EPA also identified four short-term monitoring samples collected during the repackaging of dichloromethane ([Unocal Corporation, 1987](#)). EPA adjusted the monitoring data using the ratio of the vapor pressures of the two chemicals. From this monitoring data, the Agency calculated the 50th and 95th percentile short-term exposure concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in the following table.

Table 9-12. Short-Term Inhalation Exposures to *trans*-1,2-Dichloroethylene During Repackaging

Worker Description	Number of Samples	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	Short-Term Concentration (ppm) ^a	
				Central Tendency	High-End
Drum filler	4	30	50	9.3	81

^a Surrogate data was dichloromethane with vapor pressure correction
 Dataset is from the Unocal ([1987](#))

Using the 8-hour TWA inhalation concentrations presented in Table 9-11, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-13 below.

Table 9-13. Full-Shift Inhalation Exposure Metrics for Repackaging

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Drum filler	0.68	1.0	0.50	0.75	0.46	0.70
Packaging Operator – container packaging	46	83	33	61	31	57
ONU	0.98	0.98	0.72	0.72	0.45	0.67

9.2.3.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4

above and Appendix A.9. The Agency assumed that the facilities repackaged neat *trans*-1,2-dichloroethylene for this dermal exposure. Table 9-14 summarizes the acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during manufacturing as a primary product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-14. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Repackaging

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose rate (mg/day)	7.8	22
	Acute Absorbed Dose (mg/kg-day)	9.7E-02	0.27
	Intermediate Absorbed Dose (mg/kg-day)	7.1E-02	0.20
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	5.4E-02	0.16

9.2.3.4 Information on Exposure Controls and Personal Protective Equipment

Repackaging facilities were not sampled during the TDCE Consortium Test Order ([Exponent, 2023](#)) and EPA identified limited information on control technologies utilized at repackaging sites. According to the 2009 Emission Scenario Document for Transport and Storage of Chemicals, the controls applied to the transfer process will be different depending on the container being filled or emptied, and the type of chemical being transferred (such as solids, volatile liquids, viscous liquids) ([OECD, 2009b](#)). The Repackaging Generic Scenario lists two repackaging sites from a 2013 Health and Safety Laboratory Study in which local exhaust ventilation was the primary air quality control utilized ([U.S. EPA, 2022a](#)).

When filling containers, emissions can potentially occur from overfill and spills. However, the use of automated filling equipment, along with secondary containment systems, should minimize the emission to the environment for overfill and spills. Containment methods include bunds, kerbs, drip trays, or any other systems that will prevent a spilled product escaping are recommended ([OECD, 2009b](#)).

Limited information was found regarding typical PPE workers use during repackaging operations. The Repackaging Generic Scenario notes one chemical wholesaler website that indicates commonly used PPE includes safety glasses, face shields, aprons, and gloves ([U.S. EPA, 2022a](#)).

9.2.3.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during repackaging ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 424610 – Plastics Materials and Basic Forms and Shapes Merchant Wholesalers
- 424690 – Other Chemical and Allied Products Merchant Wholesalers
- 424710 – Petroleum Bulk Stations and Terminals
- 424720 – Petroleum and Petroleum Products Merchant Wholesalers (except Bulk Stations and Terminals).

Table 9-15 summarizes the per site estimates for this OES based on the methodology described.

Table 9-15. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-Dichloroethylene During Repackaging

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
424610 – Plastics Materials and Basic Forms and Shapes Merchant Wholesalers	1	1
424690 – Other Chemical and Allied Products Merchant Wholesalers		
424710 – Petroleum Bulk Stations and Terminals		
424720 – Petroleum and Petroleum Products Merchant Wholesalers (except Bulk Stations and Terminals)		
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.4 Processing as a Reactant – OES #4

9.2.4.1 Exposure Groups and Worker Activities

During processing *trans*-1,2-dichloroethylene as a reactive intermediate, workers are potentially exposed to *trans*-1,2-dichloroethylene when unloading transport containers, cleaning transport containers, and cleaning reaction vessels or other equipment. These activities are all potential sources of worker exposure via inhalation of vapor or dermal contact with liquids.

ONUs include employees (*e.g.*, supervisors, managers) at the processing site that do not directly handle *trans*-1,2-dichloroethylene. Therefore, the ONUs are expected to have lower inhalation exposures, lower vapor through-skin uptake, and no expected dermal exposure.

9.2.4.2 Occupational Inhalation Exposure Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was analogous data from the manufacturing of *trans*-1,2-dichloroethylene as a primary product. EPA did not identify inhalation monitoring data for the processing of *trans*-1,2-dichloroethylene as a reactant. The surrogate data has a high-quality rating from the systematic review process.

Occupational inhalation data for *trans*-1,2-dichloroethylene during manufacturing as a primary product were provided via a test order submission from the TDCE Consortium ([Exponent, 2023](#)). EPA identified 29 worker and 37 ONU full-shift PBZ samples at 1 facility from the test order data to estimate inhalation exposures.

The worker samples collected were from operators, logistics/distribution technicians, and laboratory technicians at the site. From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in the following table.

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Table 9-16. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Processing as a Reactant

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Outside Lead Operator/B-Operator –Batch Manufacturing	5	4	461	680	0.11	0.57
Operator – Distillation Operation	13	6	652	699	1.3E-02	0.79
Laboratory Technician – Batch Manufacturing	6	0	645	671	1.3E-02	1.3E-02
ONU	37	10	443	670	1.7E-02	0.15

^a Limit of detection ranged from <0.02 to <0.04 ppm, depending on sample duration. All datasets are from the TDCE Consortium Test Order ([Exponent, 2023](#)).

As only full-shift data is provided in the test order report, EPA also found two short-term monitoring samples collected during the use of dichloromethane as a reactive intermediate ([TNO \(CIVO\), 1999](#); [Olin, 1979](#)). The Agency acknowledges that this data is older and may not reflect current practices. EPA adjusted the monitoring data using the ratio of the vapor pressures of the two chemicals. From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in the following table.

Table 9-17. Short-Term Inhalation Exposures to *trans*-1,2-Dichloroethylene During Processing as a Reactant

Worker Description	Number of Samples	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	Short-Term TWA (ppm) ^a	
				Central Tendency	High-End
Worker	2	10	25	300	470

^a Surrogate data was dichloromethane with vapor pressure correction
Data is from TNO ([1999](#)) and Olin ([1979](#))

Using the 8-hour TWA inhalation concentrations presented in Table 9-16, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-18 below.

Table 9-18. Full-Shift Inhalation Exposure Metrics for Processing as a Reactant

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Outside Lead Operator/B-Operator –Batch Manufacturing	7.4E-02	0.39	5.4E-02	0.29	5.1E-02	0.27
Operator – Distillation Operation	1.3E-02	0.79	8.5E-03	0.54	6.2E-03	0.40
Laboratory Technician – Batch Manufacturing	8.5E-03	8.8E-03	6.3E-03	6.4E-03	5.8E-03	6.0E-03
ONUs	1.2E-02	0.10	8.7E-03	7.4E-02	8.1E-03	7.0E-02

9.2.4.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. EPA assumed that facilities processed neat *trans*-1,2-dichloroethylene for this dermal exposure. Table 9-19 summarizes the acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during processing as a reactant. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-19. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Processing as a Reactant

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	7.8	22
	Acute Absorbed Dose (mg/kg-day)	9.7E-02	0.27
	Intermediate Absorbed Dose (mg/kg-day)	7.1E-02	0.20
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	6.6E-02	0.19

9.2.4.4 Information on Exposure Controls and Personal Protective Equipment

No specific information was found concerning exposure controls and PPE for worker and ONUs during processing as a reactant. However, for large-scale industrial processes, controls, and PPE are expected to be similar to the manufacturing facilities as described in Section 9.2.1.4.

9.2.4.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during processing as a reactant ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 325211 – Plastics Material and Resin Manufacturing
- 325199 – All Other Basic Organic Chemical Manufacturing
- 325110 – Petrochemical Manufacturing
- 325180 – Other Basic Inorganic Chemical Manufacturing.

Table 9-20 summarizes the per site estimates for this OES based on the methodology described.

Table 9-20. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-Dichloroethylene During Processing as a Reactant

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
325211 – Plastics Material and Resin Manufacturing	27	15
325199 – All Other Basic Organic Chemical Manufacturing		
3251100 – Petrochemical Manufacturing		
325180 – Other Basic Inorganic Chemical Manufacturing		
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.5 Incorporation into Formulation, Mixture, or Reaction Product – OES #5

9.2.5.1 Exposure Groups and Worker Activities

As described in Section 4.2.1, EPA received information about the manufacturing, processing, and use of *trans*-1,2-dichloroethylene from the TDCE Consortium in response to a test order issued under section 4(a) of TSCA.

The Final Study Report submitted to EPA by the TDCE Consortium ([Exponent, 2023](#)) detailed worker activities per SEG that occurred during inhalation monitoring at sites where *trans*-1,2-dichloroethene was processed into a formulation, mixture, or reaction product. The Study Report also identified task-level SEGs to represent tasks that regularly occurred during full-shift SEG sampling.

Process Operator (3M)

Process operators work a 12-hour shift. Their work activities include transferring raw materials into the steel tote and blending the material.

Packaging Operator (3M)

Packaging operators work an 8-hour shift. Their work activities include transferring the blended material from the steel tote into final product containers.

Production Technician (BASF)

Production technicians work an 8-hour shift. They perform the blending and packaging tasks at their facility.

Batch Maker (Huntsman)

Batch makers work an 8-hour shift. Their primary job responsibilities are to transfer raw materials received in 55-gallon drums into closed blenders

Drum Filler (Huntsman)

Drum fillers work an 8-hour shift. They fill drums with the mixed product at one of five filling stations (two have an automated filling system while the remaining three are semi-automatic filling system). They also pack the containers for shipment.

Technician – Blending (Microcare)

Blending technicians work 10-hour shifts. They are involved in the overall blending operation (including transferring raw materials from drum to tote; transferring blended products from tote into final packaging; moving and preparing packaging for filling; labeling packaging; loading filled packages onto pallets; and general cleanup). Technicians involved in the blending operation transfer raw materials to totes where the mixing occurs. The raw materials are received in 55-gallon drums and are pumped through a pneumatic pump/hose assembly into a closed blend tote where the blending is conducted by weight. The technicians' work activities include transferring the pump/hose assembly from an empty drum to a full drum during the raw material transfer process; during this procedure, the technicians may manually connect and disconnect the hose assembly. Mixing of a tote is completed in a close-loop process; there is no open mixing performed. The transfer from drum to tote takes approximately 30 minutes and mixing of the tote may take up to 120 minutes. Once mixed, the final product is then pumped directly into various containers for distribution. The technicians involved in blending operations package one-gallon products directly from the bulk blending operation; for this process, the technicians use a pneumatic pump and hose with a diving nozzle placed directly into the container being filled.

Technician – Aerosol Packaging (Microcare)

Aerosol packaging technicians work 10-hour shifts. They are involved in the packaging of the final product in aerosol foam. These technicians set up the containers, ranging in size from 8 oz to 24 oz in volume, and oversee the filling of the containers with product, which is an automated process. The transfer of the final product from the totes to the aerosol packaging line is performed using same type of pneumatic pump/hose assemblies as used for blending, and the technicians may make/break connections during set-up or breakdown of a production run. The technicians then pack the containers for shipment.

Technician – Liquid Packaging (Microcare)

Liquid packaging technicians work 10-hour shifts. They set up containers, ranging in size from pint to 55 gallons, and oversee the filling of the containers with product, which is an automated process. The transfer of the final product from the totes to the liquid packaging line is performed using same type of pneumatic pump/hose assemblies as used for blending, and the technicians may make/break connections during set-up or breakdown of a production run. The technicians then pack the containers for shipment.

Return Goods Authorization (RGA) Operations Tech (Versum)

RGA Operations Technicians job responsibilities include receiving returned containers (ranging in size from less than 1 liter to 1,000 liters, with the majority of the containers being 20 liters or less), decontamination of the containers, and waste consolidation.

Distillation Operation Tech (Versum)

Distillation Operations Technicians work an 8-hour shift. The technicians' primary job responsibilities involve operating the purification systems for all chemistries, which includes loading the drums of material into the purification system, monitoring the purification process, and collecting quality control samples of the raw materials and finished products.

Coat and Wash Operations Tech (Versum)

Coat and Wash Operations Technicians work an 8-hour shift. The technicians' primary job responsibilities include coating, washing, and inspecting quartz vessels and refurbishing Teflon valves.

QC Technician (Versum)

QC Technicians work an 8-hour shift. The technician's primary job responsibilities involve logging in samples, preparing samples for testing, and cleaning the testing equipment.

Packaging Operator (Versum)

Packaging operators work an 8-hour shift and are responsible for filling and packaging the final products into their shipping containers.

9.2.5.2 Occupational Inhalation Exposure Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was primary data. Occupational inhalation data for *trans*-1,2-dichloroethylene during incorporation into formulation, mixture, or reaction product were provided via a test order submission from the TDCE consortium ([Exponent, 2023](#)). EPA identified 70 worker and 60 ONU samples at 5 facilities from the test order data to estimate inhalation exposures

The worker samples collected were from batch makers, coat and wash operations technicians, distillation operation technicians, drum fillers, packaging operators, production technicians, QC technicians, RGA operations technicians, aerosol packaging technicians, and blending technicians at the five sites. From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in Table 9-21.

Table 9-21. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Incorporation into Formulation, Mixture, or Reaction Product

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Packaging Operator – container packaging (3M 1)	6	6	448	457	67	120
Process Operator (3M 1)	8	8	578	745	1.5	3.0
Technician – Aerosol Packaging (Microcare)	6	6	630	630	13	58
Technician – Blending (Microcare)	8	8	630	630	5.9	45
Production Technician (BASF)	9	9	488	514	0.76	5.2
Batch Maker (Huntsman)	9	9	409	499	0.38	1.6
Drum Filler (Huntsman)	6	3	492	498	1.0	1.5
ONU (3M 1, BASF, Microcare, Huntsman)	44	42	451	699	0.32	6.0
Coat & Wash Operations Tech (Versum)	3	0	477	496	1.7E-02	1.7E-02
Distillation Operation Tech (Versum)	3	3	500	511	0.43	0.63
Packaging Operator – bubbler	3	0	480	497	1.7E-02	1.7E-02

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
packaging (Versum)						
QC Technician (Versum)	3	1	480	502	1.7E-02	9.7E-02
RGA Operations Tech (Versum)	6	5	494	536	2.4	6.4
ONU (Versum)	16	1	475	543	1.7E-02	3.9E-02
^a Limit of detection ranged from <0.02 to <0.04 ppm, depending on sample duration. All datasets are from the TDCE Consortium Test Order (Exponent, 2023).						

Using the 8-hour TWA inhalation concentrations presented in Table 9-21, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-22 below.

Table 9-22. Full-Shift Inhalation Exposure Metrics for Incorporation into Formulation, Mixture, or Reaction Product

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Packaging Operator – container packaging (3M 1)	46	83	33	61	31	57
Process Operator (3M 1)	1.0	2.0	0.75	1.5	0.71	1.4
Technician - Aerosol Packaging (Microcare)	8.7	39	6.4	29	5.9	27
Technician - Blending (Microcare)	4.0	31	3.0	23	2.8	21
Production Technician (BASF)	0.51	3.5	0.38	2.6	0.35	2.4
Batch maker (Huntsman)	0.26	1.1	0.19	0.82	0.18	0.77
Drum filler (Huntsman)	0.68	1.0	0.50	0.75	0.46	0.70
ONU (3M 1, BASF, Microcare, Huntsman)	0.21	4.1	0.16	3.0	0.15	2.8
Coat & Wash Operations Tech (Versum)	1.2E-2	1.2E-2	8.7E-3	8.7E-3	8.1E-3	8.1E-3
Distillation Operation Tech (Versum)	0.29	0.43	0.21	0.32	0.20	0.29
Packaging Operator – bubbler packaging (Versum)	1.2E-2	1.2E-2	8.6E-3	8.6E-3	8.1E-3	8.1E-3
QC Technician (Versum)	1.2E-2	6.6E-2	8.6E-3	4.8E-2	8.1E-3	4.5E-2
RGA Operations Tech (Versum)	1.6	4.4	1.2	3.2	1.1	3.0
ONU (Versum)	1.2E-2	2.7E-2	8.6E-3	2.0E-2	8.3E-3	1.8E-2

9.2.5.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. The concentration evaluated for this dermal exposure ranges from 1 to

100% based on product information detailed in Appendix A.9 and that facilities may use neat *trans*-1,2-dichloroethylene to create their formulations. Table 9-23 summarizes the acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during incorporation into formulation, mixture, or reaction product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-23. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Incorporation into Formulation, Mixture, or Reaction Product

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	3.1	14
	Acute Absorbed Dose (mg/kg-day)	3.8E-02	0.17
	Intermediate Absorbed Dose (mg/kg-day)	2.8E-02	0.13
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	2.6E-02	0.12

9.2.5.4 Information on Exposure Controls and Personal Protective Equipment

The *trans*-1,2-dichloroethylene test study report sampled workers and ONUs at four formulation facilities, which are discussed below ([Exponent, 2023](#)).

At a foam blowing additive formulation site, batch makers worked indoors and wore full-face negative pressure respirators when transferring 55-gallon drums of *trans*-1,2-dichloroethylene to a blender. Additional PPE for transferring included Tyvek suit or chemical-resistant apron. During open sampling, no respiratory protection was worn. During all batch making activities, workers wore nitrile gloves, and goggles or safety glasses. Drum fillers transferred blended products into final drum packaging and did not wear respiratory protection but they did use local exhaust ventilation (LEV), which was called a slot hood. These workers also wore nitrile gloves, face shields, goggles or safety glasses, and chemical-resistant aprons. ONUs wore nitrile gloves, goggles or safety glasses, and no respiratory protection.

There were two cleaning/degreasing formulation sites. At the first site, process operators wear nitrile gloves, goggles or safety glasses, and long sleeve flame resistant clothing, with no respiratory protection. During transfer of *trans*-1,2-dichloroethylene, operators handle dip pipes with nozzles equipped with LEV. Packaging operators wear nitrile leather/cut-resistant gloves, and goggles or safety glasses, with no respiratory protection. During filling of containers, some workers used nozzles equipped with LEV, but others did not use any ventilation. ONUs at this site wore nitrile gloves and goggles or safety glasses, but no respiratory protection. At the second cleaning/degreasing formulation site, blending technicians worked in a booth with LEV, or used an elephant trunk with LEV. Aerosol packing technicians utilized a fume hood, with additional ventilation of a floor air pull near the chemical filling heads. ONUs typically worked with no LEV, but sometimes worked with chemicals other than *trans*-1,2-dichloroethylene at neighboring fume hoods or in booths with LEV. All workers and ONUs wore nitrile gloves, goggles or safety glasses, and no respiratory protection.

At a formulation site for polyurethane systems additives, production technicians wore nitrile gloves, goggles or safety glasses, with no respiratory protection or LEV. ONUs at this site also wore nitrile gloves, goggles or safety glasses, and no respiratory protection, but sometimes worked inside a fume hood.

The Emission Scenario Document on Adhesive Formulation notes that no specific data were found on pollution control technologies used by the adhesives formulation industry; however, it is likely that some sites may implement pretreatment of their process wastewaters or have controls on their process stacks ([OECD, 2009a](#)).

9.2.5.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during formulation of adhesives and sealants ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 325520 – Adhesive Manufacturing
- 325998 – All Other Miscellaneous Chemical Product and Preparation Manufacturing
- 325510 – Paint and Coating Manufacturing
- 324191 – Petroleum Lubricating Oil and Grease Manufacturing.

Table 9-24 summarizes the per site estimates for this OES based on the methodology described.

Table 9-24. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-Dichloroethylene During Incorporation into Formulation, Mixture, or Reaction Product

Potentially Exposed During Incorporation into Formulation, Mixture, or Reaction Product		
NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
325520 – Adhesive Manufacturing	12	7
325998 – All Other Miscellaneous Chemical Product and Preparation Manufacturing		
325510 – Paint and Coating Manufacturing		
324191 – Petroleum Lubricating Oil and Grease Manufacturing		
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.6 Vapor Degreasing – OES #6

9.2.6.1 Exposure Groups and Worker Activities

As described in Section 4.2.1, EPA received information about the manufacturing, processing, and use of *trans*-1,2-dichloroethylene from the TDCE Consortium in response to a test order issued under section 4(a) of TSCA.

The Final Study Report submitted to EPA by the TDCE Consortium ([Exponent, 2023](#)) detailed worker activities per SEG that occurred during inhalation monitoring at a site where *trans*-1,2-dichloroethylene was used for vapor greasing. The Study Report also identified task-level SEGs to represent tasks that regularly occurred during full-shift SEG sampling.

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Assembler Operating Ultrasonic Machine

Assemblers are responsible for operating the ultrasonic vapor degreaser machines. Assemblers work an 8-hour shift during which they are involved in the ultrasonic vapor degreaser cleaning operation for approximately 2 hours. The cleaning operation is summarized as such: *trans*-1,2-dichloroethylene is pumped into the ultrasonic vapor degreaser from a drum. Parts are placed on a metal tree in a basket on the vapor degreaser; the basket is then placed in the machine, the lid is closed, and the basket is lowered. Once the drying cycle is complete, the basket is removed and the parts (hung on a tree within the basket) are removed. There is no employee contact with the ultrasonic vapor degreaser, as the basket is dry when the technician removes it due to the multiple dry cycles. When the cleaning cycle is complete, the ultrasonic vapor degreaser condenses and recycles the cleaning liquid for reuse. The technicians rarely have to pour solvent solution into the machine, as topping up is conducted by maintenance once a week.

A total of 140 cleaning cycles are completed each day across the 5 ultrasonic vapor degreasers in the facility; each technician rotates positions during their shift and performs at most 5 to 6 cycles per shift, with each cycle lasting 5 to 6 minutes. Assemblers rotate through the adjacent line assembly positions every two hours; only one in five positions on the line interact with the ultrasonic vapor degreasers as described. At most, the assemblers are involved in the cleaning operation for 10 minutes of their 120-minute rotation. When they are not involved in the cleaning task, assemblers work on other adjacent processes, such as deburring, polishing etc. During a cycle, the lid on the ultrasonic vapor degreaser is automatically closed.

Waste Handling/Maintenance Workers

The waste handling/maintenance workers perform weekly maintenance on the ultrasonic vapor degreasers' water separator. During this process, the workers drain the solvent fluid from the machine, collect the dirty fluid in a waste drum, and then refill the machine with clean fluid. The fluid is drained through a valve for "dirty" fluid, then poured into the waste drum. New cleaner is pumped directly into the machine. The workers are also responsible for changing filters. The waste handling/maintenance workers work an 12-hour shift, during which they are involved in ultrasonic vapor degreaser maintenance for approximately one hour per week. Each machine is drained and re-filled on an as-needed basis, with a frequency of about once a week.

Vapor Degreaser – Technician/Process Mechanic Operating Degreaser

Technicians/Process Mechanics are responsible for operating the vapor degreaser unit. At the end of the five-minute cleaning cycle, the process mechanic opens the degreaser lid, grabs the degreaser basket handle and removes the basket, then closes the lid. Additional solvent is poured by the mechanic through a fill port on the machine as needed; the solvent is packaged in five-gallon metal containers. One process mechanic may perform one to seven cleaning cycles per shift. Technicians/Process Mechanics work an 8-hour shift, during which they are involved in *trans*-1,2-dichloroethylene work processes for 1 to 7 minutes total when the vapor degreaser lid is opened (30 seconds to open and add a basket, 30 seconds to open and remove a basket).

ONUs

ONUs include technicians and process mechanics that do not work on the vapor degreaser unit during their shift may potentially enter the area containing the vapor degreaser during their work activities, which may include preparing and welding tubing.

Changeout of the solvent for the vapor degreaser was not monitored, but occurs annually and is performed by maintenance personnel. During the process, which takes approximately 60 minutes, the dirty solvent is pumped directly into a closed-top 55-gallon waste drum; the unit is allowed to dry and

then any dry residue remaining is scraped out, collected in a plastic bag, and placed in a closed-top 55-gallon drum. Both liquid and dry waste drums are then retrieved by a third-party waste contractor and moved off-site.

9.2.6.2 Occupational Inhalation Exposure Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was primary data. Occupational inhalation data for *trans*-1,2-dichloroethylene during its use during vapor degreasing were provided via a test order submission from the TDCE consortium ([Exponent, 2023](#)). EPA identified 20 worker and 11 ONU samples at 2 facilities from the test order data to estimate inhalation exposures

The worker samples collected were from technicians and process mechanics operating degreasers at one site and assemblers and maintenance workers at the other site. From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in Table 9-25.

Table 9-25. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Vapor Degreasing

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Technician/Process Mechanic Operating Degreaser (Boeing 1)	9	9	480	480	3.5	7.2
Assembler Operating Ultrasonic Machine (3M 2)	8	8	451	470	1.3	2.2
Waste Handling/Maintenance Worker (3M 2)	3	3	700	716	11	18
ONU	11	11	437	480	0.73	1.5

^a Limit of detection ranged from <0.02 to <0.04 ppm, depending on sample duration.
All datasets are from the TDCE Consortium Test Order ([Exponent, 2023](#)).

EPA also found four short-term PBZ monitoring samples collected during vapor degreasing using *trans*-1,2-dichloroethylene ([3M, 2010](#)). From this monitoring data, EPA calculated the 50th and 95th percentile short-term TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in Table 9-26.

Table 9-26. Short-Term Inhalation Exposures to *trans*-1,2-Dichloroethylene During Vapor Degreasing

Worker Description	Number of Samples	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	Short-Term TWA (ppm)	
				Central Tendency	High-End
Vapor Degreasing (Operator)	4	60	60	17	20

Dataset is from 3M ([2010](#))

Using the 8-hour TWA inhalation concentrations presented in Table 9-25, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-27 below.

Table 9-27. Full-Shift Inhalation Exposure Metrics for Vapor Degreasing

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Technician/Process Mechanic Operating Degreaser (Boeing 1)	2.4	4.9	1.8	3.6	1.6	3.3
Assembler Operating Ultrasonic Machine (3M 2)	0.9	1.5	0.66	1.1	0.62	1.0
Waste Handling/Maintenance Worker (3M 2)	7.7	13	5.7	9.2	5.3	8.6
ONU	0.50	1.0	0.37	0.75	0.34	0.70

9.2.6.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. The concentration evaluated for this dermal exposure ranges from 1 to 100% based on product information detailed in Appendix A.9. Table 9-28 summarizes the acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during manufacturing as a primary product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-28. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Vapor Degreasing

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	4.7	16
	Acute Absorbed Dose (mg/kg-day)	5.8E-02	0.20
	Intermediate Absorbed Dose (mg/kg-day)	4.3E-02	0.15
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	4.0E-02	0.14

9.2.6.4 Information on Exposure Controls and Personal Protective Equipment

According to the *trans*-1,2-dichloroethylene test study report for the TDCE Consortium, workers and ONUs were sampled at one facility performing vapor degreasing. The technicians/process mechanics operating the degreaser and ONUs all wore nitrile gloves, goggles, or safety glasses, but no respiratory protection nor LEV ([Exponent, 2023](#)).

According to the Emission Scenario Document on the Use of Vapour Degreasers, control equipment may include covers on top of OTVDs, freeboard refrigeration devices, increased freeboard ratio, and carbon adsorption systems. PPE may include respirators and gloves ([OECD, 2021](#)).

9.2.6.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during the use of cleaning/degreasing solvents ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 336110 – Automobile and Light Duty Motor Vehicle Manufacturing
- 336120 – Heavy Duty Truck Manufacturing
- 336211 – Motor Vehicle Body Manufacturing
- 336212 – Truck Trailer Manufacturing
- 336213 – Motor Home Manufacturing
- 336214 – Travel Trailer and Camper Manufacturing
- 336310 – Motor Vehicle Gasoline Engine and Engine Parts Manufacturing
- 336320 – Motor Vehicle Electrical and Electronic Equipment Manufacturing
- 336330 – Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing
- 336340 – Motor Vehicle Brake System Manufacturing
- 336350 – Motor Vehicle Transmission and Power Train Parts Manufacturing
- 336360 – Motor Vehicle Seating and Interior Trim Manufacturing
- 336370 – Motor Vehicle Metal Stamping
- 336390 – Other Motor Vehicle Parts Manufacturing
- 336411 – Aircraft Manufacturing
- 336412 – Aircraft Engine and Engine Parts Manufacturing
- 336413 – Other Aircraft Parts and Auxiliary Equipment Manufacturing
- 336414 – Guided Missile and Space Vehicle Manufacturing
- 336415 – Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
- 336419 – Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing
- 336611 – Ship Building and Repairing
- 336612 – Boat Building
- 336991 – Motorcycle, Bicycle, and Parts Manufacturing
- 336992 – Military Armored Vehicle, Tank, and Tank Component Manufacturing
- 336999 – All Other Transportation Equipment Manufacturing.

Table 9-29 summarizes the per site estimates for this OES based on the methodology described.

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5922
5923**Table 9-29. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-Dichloroethylene During Vapor Degreasing**

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site ^a
336110 – Automobile and Light Duty Motor Vehicle Manufacturing	76	22
336120 – Heavy Duty Truck Manufacturing		
336211 – Motor Vehicle Body Manufacturing		
336212 – Truck Trailer Manufacturing		
336213 – Motor Home Manufacturing		
336214 – Travel Trailer and Camper Manufacturing		
336310 – Motor Vehicle Gasoline Engine and Engine Parts Manufacturing		
336320 – Motor Vehicle Electrical and Electronic Equipment Manufacturing		
336330 – Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing		
336340 – Motor Vehicle Brake System Manufacturing		
336350 – Motor Vehicle Transmission and Power Train Parts Manufacturing		
336360 – Motor Vehicle Seating and Interior Trim Manufacturing		
336370 – Motor Vehicle Metal Stamping		
336390 – Other Motor Vehicle Parts Manufacturing		
336411 – Aircraft Manufacturing		
336412 – Aircraft Engine and Engine Parts Manufacturing		
336413 – Other Aircraft Parts and Auxiliary Equipment Manufacturing		
336414 – Guided Missile and Space Vehicle Manufacturing		
336415 – Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing		
336419 – Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing		
336611 – Ship Building and Repairing		
336612 – Boat Building		
336991 – Motorcycle, Bicycle, and Parts Manufacturing		
336992 – Military Armored Vehicle, Tank, and Tank Component Manufacturing		
336999 – All Other Transportation Equipment Manufacturing		

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NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site ^a
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.7 Misc. Non-Aerosol Industrial and Commercial Uses (Cleaning and Degreasing Agents, Lubricants and Greases, Mold Release) – OES #7

9.2.7.1 Exposure Groups and Worker Activities

As described in Section 4.2.1, EPA received information about the manufacturing, processing, and use of *trans*-1,2-dichloroethylene from the TDCE Consortium in response to a test order issued under section 4(a) of TSCA.

The Final Study Report submitted to EPA by the TDCE Consortium ([Exponent, 2023](#)) detailed worker activities per SEG that occurred during inhalation monitoring at sites where *trans*-1,2-dichloroethene was used during miscellaneous non-aerosol industrial and commercial uses. The Study Report also identified task-level SEGs to represent tasks that regularly occurred during full-shift SEG sampling.

Aircraft Technicians Performing Cleaning Task

Aircraft technicians are responsible for cleaning tools that come in contact with the tubing lines with the *trans*-1,2-dichloroethylene containing liquid cleaner. During this process, the worker applies the cleaner to a cloth and then cleans the tools. An inspection is then conducted to ensure the tools are cleaned. Approximately two ounces of cleaner are used during the cleaning process. The liquid cleaner is not used to clean the tubing lines unless an inspection of the line shows a contaminant to be present, which is a rare occurrence; approximately another two ounces of liquid would then be used to clean the lines. After the cleaning process, the cloth is disposed of in a red hazardous waste can. Technicians work an 8-hour shift, during which they perform the cleaning or flushing activity for less than 30 minutes per shift, for two shifts per month. When not performing this task, the technicians are installing other aerospace parts on the aircraft.

Flush Cleaning – Flight Mechanics Performing Flush Cleaning

Flight mechanics are responsible for performing the flushing activity. During this process, the worker applies the *trans*-1,2-dichloroethylene containing liquid to the hydraulic system part through a spray bottle, bug sprayer, or pours it from the bottle; anywhere from a single spray from a spray bottle up to a gallon of liquid may be used. Smaller amounts of liquid are sprayed and wiped, while larger amounts are poured from the bottle and collected on absorbent mats. Materials are disposed of in closed hazardous waste containers. Flight mechanics work an 8-hour shift, during which they are involved in the flushing activity for less than 30 minutes per shift, for one shift each week. For the remainder of their shift, the flight mechanics' work activities include preparing jets for flight, running engines, and performing repairs.

Technicians – Tube Dipping, Edge Cutting and Buffing (3M #3)

Technicians are responsible for manually dipping the tubes into the containers that hold the 20 ounces of lubricant containing 50% *trans*-1,2-dichloroethylene. The tubes are dipped into the container, where they remain until they are removed using a metal pick and transferred to the processing operation, where they are placed on the molding machines. To remove the tubes, the technicians use a metal pick and load them into the molding machine. The tubes are not dried prior to the technician sliding them on to the molding machine mandrels. When the molding step is complete, the tubes are removed by the operator and put into boxes that are sent to the warehouse where they are stored until they are needed for further

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processing. The technicians refill the container once per shift from a flammable liquid storage container; the technicians manually pump the material into the flammable liquid storage container from a 55-gallon drum, located in the work area, as needed. If the fluid in the container becomes too dirty, it is transferred into a waste container and refilled. One technician can operate two molding machines; each molding machine has a small container of lubricant and tubes.

Technicians work an 8-hour shift, during which they are involved in manually dipping and removing the tubes for 60 minutes total per shift, 30 minutes per machine. For the remainder of their shift, the technicians are performing other tasks, including quality checking parts, buffing the ends, cutting additional tubes, packing parts, and refilling stock material on the molding machines.

Technicians – Slitter Knife Cleaning (3M #5)

Technicians use the solvent cleaner containing 49 to 51% *trans*-1,2-dichloroethylene to clean the knives. The cleaning solvent is packaged in one-gallon containers, from which the product is dispensed into 500-milliliter (mL) squeeze bottles via direct pouring using a small funnel. The liquid is then dispensed directly onto the wipe. The wipe is then applied to the knife and cleaned, which takes less than 5 minutes per knife to complete; once the knife is cleaned, the wipe is disposed of in a 5-gallon labeled hazardous waste bucket with a latching lid. The technicians work a 12-hour shift, during which they use the product on a daily basis, once at the end of each shift, for less than a 5-minute use. For the remainder of their shift, the technicians operate the machine, clear machine jams, and load product inputs for slitting and packing product into boxes.

9.2.7.2 Occupational Inhalation Exposure Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was primary data. Occupational inhalation data for *trans*-1,2-dichloroethylene during miscellaneous non-aerosol industrial and commercial uses were provided via a test order submission from the TDCE Consortium ([Exponent, 2023](#)). EPA identified 22 full-shift worker samples at 3 facilities from the test order data to estimate inhalation exposures. EPA did not identify any full-shift ONU PBZ samples. Therefore, EPA used the central tendency from workers to represent ONU exposures.

The full-shift worker samples collected were from aircraft technicians and technicians at three sites. From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in Table 9-30.

Table 9-30. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Misc. Non-Aerosol Industrial and Commercial Uses

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Aircraft Technician Performing Cleaning Task (Boeing 1)	2	2	435	440	0.90	1.4
Technician – tube dipping, edge cutting and buffing (3M 3)	14	14	458	471	8.1	28
Technician – slitter knife cleaning (3M 5)	6	6	708	714	5.6	17
ONU ^b	22	22	435	714	6.1	6.1

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Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
^a Limit of detection ranged from <0.02 to <0.04 ppm, depending on sample duration.						
^b Assumed ONU exposure was central tendency of worker exposure of combined SEGs.						
All datasets are from the TDCE Consortium Test Order (Exponent, 2023).						

The test order submission from the TDCE Consortium ([Exponent, 2023](#)) contained short-term exposure monitoring data for this OES. From this monitoring data, EPA calculated the 50th and 95th percentile short-term exposure concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in Table 9-31.

Table 9-31. Short-Term Inhalation Exposures to *trans*-1,2-Dichloroethylene During Misc. Non-Aerosol Industrial and Commercial Uses

Worker Description	Number of Samples	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	Short-Term TWA (ppm)	
				Central Tendency	High-End
Aircraft Technician Performing Cleaning Task (Boeing 1)	2	60	127	1.2	2.2
Flight Mechanics Performing Flush Cleaning (Boeing 2)	9	4.0	75	0.96	82
ONU	6	40	75	0.20	1.3
All datasets are from the TDCE Consortium test order(Exponent, 2023).					

Using the 8-hour TWA inhalation concentrations presented in Table 9-30, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-32 below.

Table 9-32. Full-Shift Inhalation Exposure Metrics for Misc. Non-Aerosol Industrial and Commercial Uses

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Aircraft Technician Performing Cleaning Task (Boeing 1)	0.61	0.97	0.45	0.71	0.42	0.67
Technician – tube dipping, edge cutting and buffing (3M 3)	5.5	19	4.0	14	3.8	13
Technician – slitter knife cleaning (3M 5)	3.8	12	2.8	8.5	2.6	8.0
ONU	4.1	4.1	3.0	3.0	2.8	2.8

9.2.7.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. The concentration evaluated for this dermal exposure ranges from 1 to 100% based on product information detailed in Appendix A.9. Table 9-33 summarizes the acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during manufacturing as a primary product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-33. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Misc. Non-Aerosol Industrial and Commercial Uses

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	2.7	12
	Acute Absorbed Dose (mg/kg-day)	3.3E-02	0.15
	Intermediate Absorbed Dose (mg/kg-day)	2.4E-02	0.11
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	2.3E-02	0.10

9.2.7.4 Information on Exposure Controls and Personal Protective Equipment

According to the *trans*-1,2-dichloroethylene test study report for the TDCE Consortium, workers and ONUs were sampled at one facility performing non-aerosol degreasing. Flight mechanics performing flush cleaning and ONUs all wore nitrile gloves, goggles or safety glasses, but the use of respiratory protection or LEV was not indicated ([Exponent, 2023](#)).

9.2.7.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during the use of cleaning/degreasing solvents ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 336110 – Automobile and Light Duty Motor Vehicle Manufacturing
- 336120 – Heavy Duty Truck Manufacturing
- 336211 – Motor Vehicle Body Manufacturing
- 336212 – Truck Trailer Manufacturing
- 336213 – Motor Home Manufacturing
- 336214 – Travel Trailer and Camper Manufacturing
- 336310 – Motor Vehicle Gasoline Engine and Engine Parts Manufacturing
- 336320 – Motor Vehicle Electrical and Electronic Equipment Manufacturing
- 336330 – Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing
- 336340 – Motor Vehicle Brake System Manufacturing
- 336350 – Motor Vehicle Transmission and Power Train Parts Manufacturing
- 336360 – Motor Vehicle Seating and Interior Trim Manufacturing
- 336370 – Motor Vehicle Metal Stamping

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- 6059 • 336390 – Other Motor Vehicle Parts Manufacturing
- 6060 • 336411 – Aircraft Manufacturing
- 6061 • 336412 – Aircraft Engine and Engine Parts Manufacturing
- 6062 • 336413 – Other Aircraft Parts and Auxiliary Equipment Manufacturing
- 6063 • 336414 – Guided Missile and Space Vehicle Manufacturing
- 6064 • 336415 – Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
- 6065 • 336419 – Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing
- 6066 • 336611 – Ship Building and Repairing
- 6067 • 336612 – Boat Building
- 6068 • 336991 – Motorcycle, Bicycle, and Parts Manufacturing
- 6069 • 336992 – Military Armored Vehicle, Tank, and Tank Component Manufacturing
- 6070 • 336999 – All Other Transportation Equipment Manufacturing.

6073 Table 9-34 summarizes the per site estimates for this OES based on the methodology described.

6074

6075 **Table 9-34. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-**

6076 **Dichloroethylene During the Use of Cleaning/Degreasing Solvents**

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site ^a
336110 – Automobile and Light Duty Motor Vehicle Manufacturing	76	22
336120 – Heavy Duty Truck Manufacturing		
336211 – Motor Vehicle Body Manufacturing		
336212 – Truck Trailer Manufacturing		
336213 – Motor Home Manufacturing		
336214 – Travel Trailer and Camper Manufacturing		
336310 – Motor Vehicle Gasoline Engine and Engine Parts Manufacturing		
336320 – Motor Vehicle Electrical and Electronic Equipment Manufacturing		
336330 – Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing		
336340 – Motor Vehicle Brake System Manufacturing		
336350 – Motor Vehicle Transmission and Power Train Parts Manufacturing		
336360 – Motor Vehicle Seating and Interior Trim Manufacturing		
336370 – Motor Vehicle Metal Stamping		
336390 – Other Motor Vehicle Parts Manufacturing		
336411 – Aircraft Manufacturing		
336412 – Aircraft Engine and Engine Parts		

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site ^a
Manufacturing	76	22
336413 – Other Aircraft Parts and Auxiliary Equipment Manufacturing		
336414 – Guided Missile and Space Vehicle Manufacturing		
336415 – Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing		
336419 – Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing		
336611 – Ship Building and Repairing		
336612 – Boat Building		
336991 – Motorcycle, Bicycle, and Parts Manufacturing		
336992 – Military Armored Vehicle, Tank, and Tank Component Manufacturing		
336999 – All Other Transportation Equipment Manufacturing		
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.8 Commercial Aerosol Products (Aerosol Degreasing, Aerosol Lubricants, Mold Release) – OES #8

9.2.8.1 Exposure Groups and Worker Activities

As described in Section 4.2.1, EPA received information about the manufacturing, processing, and use of *trans*-1,2-dichloroethylene from the TDCE Consortium in response to a test order issued under section 4(a) of TSCA.

The Final Study Report submitted to EPA by the TDCE Consortium ([Exponent, 2023](#)) detailed worker activities per SEG that occurred during inhalation monitoring at sites where *trans*-1,2-dichloroethene was used as a commercial aerosol degreasing product. The Study Report also identified task-level SEGs to represent tasks that regularly occurred during full-shift SEG sampling.

Test and Evaluation Technicians (Technicians)

Test and Evaluation Technicians (Technicians) are responsible for using the flux remover to clean the electronic components. During the process, the worker applies the aerosol remover to the electronic component either by holding the component or by setting it in a pan. As the liquid flushes the component, it is collected into a pan that is then poured into a collection bottle and capped. No rags are used. The technicians may spot clean one to nine components at a time, with up to 30 components cleaned in a shift. A total of 6 to 8 ounces (oz) of the liquid are used per day and four 12-ounce bottles are used per week. Technicians work an 8-hour shift during which they are involved in using the TDCE-containing aerosol flux remover for less than 30 minutes per shift. For the remainder of their shift, the technicians are building and testing electronic components.

Mechanics

Mechanics use the TDCE-containing cleaner on a daily basis as part of the inspection process. During the inspection process, the worker sprays the aerosol cleaner onto the part, which is located either on a workbench or within the equipment; no wiping of the product occurs after application. If used daily, mechanics may use between 1.5 and 4 cans per week on parts that vary from 1 and 7 inches. When the aerosol cans are determined by the mechanics to be empty and contain no residual amount of cleaner they are disposed of by the mechanics in a closed metal waste bin. Mechanics work an 8-hour shift, during which they use the TDCE-containing cleaner for less than 2 to 3 minutes per application and for a maximum of four to five applications per day (for a maximum use of 15 minutes per day). For the remainder of their shift, the mechanics are preparing parts and equipment for processing and conducting parts inspections.

Mechanics (Auto)

Mechanics in auto repair shops use aerosol/degreasers on a daily basis to clean various parts of the vehicle including brakes, transmissions, and rotors. If used daily for brake replacement, EPA assumes that 3.75 brake replacements would happen in an auto repair shop on a single day. The mechanics were assumed to use between one and three cans of aerosol/degreaser per day. EPA modeled these assumptions in CEM with one can being the low-end, two cans for a medium scenario, and three cans for a high-end scenario. The mechanics may use general purpose degreasers on other parts in the car, but the guides that were available online focused on brake replacements, and EPA modeled the results on available information.

9.2.8.2 Occupational Inhalation Exposure Results

Technicians and Mechanics

For these scenarios, the highest method from the exposure assessment hierarchy that was available was primary data. Occupational inhalation data for *trans*-1,2-dichloroethylene during commercial aerosol cleaning and greasing uses were provided via a test order submission from the TDCE consortium ([Exponent, 2023](#)). EPA identified 16 worker and 2 ONU samples at 2 facilities from the test order data to estimate inhalation exposures. The ONUs in this data set were scheduled to work with *trans*-1,2-dichloroethylene on the day of monitoring, but circumstances prevented them from using the chemical that day.

The worker samples collected were from technicians and mechanics at two sites. EPA requested via the test order approval process that workers exposed to aerosolized forms of *trans*-1,2-dichloroethylene have their monitoring samples collected using an active pump in combination with the passive badges used for all other samples. The dual sampling was an attempt to understand if aerosol dynamics had a role in exposure and if differences could be measured between the two techniques. From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in Table 9-35.

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Table 9-35. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Commercial Aerosol Uses

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Mechanic (Boeing 3) (Badge)	8	8	444	459	0.19	1.0
Mechanic (Boeing 3) (Active) ^b	4	4	460	467	0.26	0.47
Technician (Boeing 1) (Badge)	8	8	480	481	0.69	6.9
ONU (Badge)	2	2	445	480	0.28	0.43
ONU (Mechanic, Active) ^b	1	0	460	460	5.4E-02	5.4E-02

^a Limit of detection ranged from <0.02 to <0.04 ppm, depending on sample duration.

^b The test order did not explicitly define the active sample pump flow rate that was used and EPA is not able to repeat their calculations to determine a limit of detection.

All datasets are from the TDCE Consortium test order([Exponent, 2023](#)).

EPA also found two short-term PBZ monitoring samples collected during aerosol degreasing using *trans*-1,2-dichloroethylene ([3M, 2019](#)). From this monitoring data, EPA calculated the 50th and 95th percentile short-term TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in Table 9-36.

Table 9-36. Short-Term Inhalation Exposures to *trans*-1,2-Dichloroethylene During Commercial Aerosol Uses

Worker Description	Number of Samples	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	Short-Term TWA (ppm)	
				Central Tendency	High-End
Worker	2	25	25	5.0	9.2

Data is from 3M ([2019](#)).

Using the 8-hour TWA inhalation concentrations presented in Table 9-36, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-37.

Table 9-37. Full-Shift Inhalation Exposure Metrics for Commercial Aerosol Uses

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Mechanic	0.13	0.68	9.3E-02	0.50	8.7E-02	0.47
Technician	0.47	4.7	0.35	3.4	0.32	3.2
ONU	5.4E-02	8.1E-02	3.5E-02	5.9E-02	3.7E-02	5.5E-02

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Mechanics (Auto)

EPA modeled the Aerosol/Degreaser commercial scenario for mechanics using degreasers to clean various auto parts in an auto repair shop. The Consumer Exposure Model was selected to model worker inhalation exposures to *trans*-1,2-dichloroethylene aerosol/degreaser products. For more information and details on the model, see the user guide and model download instructions at <https://www.epa.gov/tsc-screening-tools/cem-consumer-exposure-model-download-and-install-instructions> (accessed July 29, 2026). In addition, see the *Draft Consumer and Commercial Exposure Analysis and Risk Calculator for trans-1,2-Dichloroethylene* (U.S. EPA, 2026f) for all analysis done. EPA assumed that the same types of consumer aerosol/degreaser products would also be in auto repair shops but used by mechanics all day.

EPA identified several online guides to understand the average number of bays, ceiling heights, and square footage of the auto repair shops for automobiles and trucks. [Best Auto Repair Shop Layout Design: Floor Plans That Work \(2026\) | Prestige 360 Design](#), [A Guide to Auto Repair Shop Buildings](#), [The State of General Auto Repair Shops in the United States Parts Tech Report 2025](#), and [Staff Report: Initial Statement of Reasons for the Proposed Airborne Toxic Control Measure for Emissions of Chlorinated Toxic Air Contaminants from Automotive Maintenance and Repair Activities Volume II: Technical Support Document](#) (all hyperlinks accessed July 29, 2026). The values selected are listed in Table 9-38.

Table 9-38. Model Inputs for Consumer Exposure Model (CEM)

Parameters	Units	Building Inputs
Number of Bays	N/A	8.15
Bay Area Square Footage	ft ²	3,200 ^a
Ceiling Height	ft	14
Bay Volume	ft ³	44,800
Bay Volume	m ³	1,269
Ventilation Rate	cubic feet per minute (cfm)/ft ²	0.75
Air Exchange Rate	changes per hour	3.2
^a Building Square Footage = 400 ft ² /bay × 8.15 bays		

Air Exchange Rate and Ventilation

The scenario was modeled using the air exchange flow rates from the outside (Zone 0) to the inside of the auto repair shop bay (Zone 1). The Air Exchange Rate (AER) was calculated based on Equation 9-2.

Equation 9-2.

$$AER = \frac{\text{Ventilation Rate} \left(\frac{\text{cfm}}{\text{ft}^2} \right) \times \text{Bay Area Square Footage Floor Area (ft}^2\text{)} \times 60 \left(\frac{\text{min}}{\text{hour}} \right)}{\text{Bay Volume (ft}^3\text{)}}$$

$$AER = \frac{0.75 \left(\frac{\text{cfm}}{\text{ft}^2} \right) \times 3,200 \text{ (ft}^2\text{)} \times 60 \left(\frac{\text{min}}{\text{hour}} \right)}{44,800 \text{ (ft}^3\text{)}}$$

$$AER = 3.2 \text{ changes per hour}$$

According to the [Staff Report: Initial Statement of Reasons for the Proposed Airborne Toxic Control Measure for Emissions of Chlorinated Toxic Air Contaminants from Automotive Maintenance and Repair](#) (accessed July 28, 2026), the number of brake jobs per year at 137 Brake/Automotive Repair Shops surveyed across California averaged 936 yearly brake jobs. EPA divided 936 yearly jobs by the number of operating 250 days per year which equals 3.75 brake jobs per day at each auto repair shop. The report also notes that 14.4 oz were used per brake job. EPA assumed that for a high-end scenario, the auto mechanic may use three full 18-ounce cans per day or 54 total oz. Two cans were assumed for the medium scenario and 1 can for low end scenario. In grams, 85g equals 1 can, 170 g equals 2 cans, and 3 cans equals 255 g. For a full list of exposures in CEM, see Table 9-39 below. The weight fractions used were the same as EPA modeled for consumer exposures. See Section 10.3, which describes the consumer scenario inputs for inhalation modeling.

Table 9-39. Short Term Acute (15-minute TWA) and Chronic Inhalation Exposures to *trans*-1,2-Dichloroethylene for the Mechanics (Auto) SEG Derived from CEM.

Exposure Parameters			Short Term Acute Exposure ^a (15-minute TWA) in mg/m ³	Chronic Exposure ^b (8-hour TWA) in mg/mg ³
Weight Fraction in Product	Exposure Duration (minutes)	Amount of Product Used (g)		
3%	1.7	85	19	3.5
3%	5	255	71	13
51%	1.7	85	320	59
51%	3.4	170	730	130
90%	1.7	85	570	100
90%	5	255	2,100	380

^a Based on 8 exposure events per day with the noted exposure parameters.
^b Adjusted from 8-hour time-weighted average (TWA) based on exposure of 250 days per year.

9.2.8.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. The concentration evaluated for this dermal exposure ranges from 1 to 100% based on product information detailed in Appendix A.9. Table 9-40 summarizes the acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during manufacturing as a primary product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-40. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Commercial Aerosol Uses

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	2.7	12
	Acute Absorbed Dose (mg/kg-day)	3.4E-02	0.15
	Intermediate Absorbed Dose (mg/kg-day)	2.5E-02	0.11
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	2.3E-02	0.10

9.2.8.4 Information on Exposure Controls and Personal Protective Equipment

According to the *trans*-1,2-dichloroethylene test study report for the TDCE Consortium, workers and

ONUs were sampled at one facility performing aerosol degreasing. Technicians using spray flux remover and ONUs wore nitrile gloves, goggles or safety glasses, and smocks. No respiratory protection was reported; spraying occurred in an industrial spray booth with exhaust volume rate of 1,200 cfm ([Exponent, 2023](#)).

9.2.8.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during the use of cleaning/degreasing solvents ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 336110 – Automobile and Light Duty Motor Vehicle Manufacturing
- 336120 – Heavy Duty Truck Manufacturing
- 336211 – Motor Vehicle Body Manufacturing
- 336212 – Truck Trailer Manufacturing
- 336213 – Motor Home Manufacturing
- 336214 – Travel Trailer and Camper Manufacturing
- 336310 – Motor Vehicle Gasoline Engine and Engine Parts Manufacturing
- 336320 – Motor Vehicle Electrical and Electronic Equipment Manufacturing
- 336330 – Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing
- 336340 – Motor Vehicle Brake System Manufacturing
- 336350 – Motor Vehicle Transmission and Power Train Parts Manufacturing
- 336360 – Motor Vehicle Seating and Interior Trim Manufacturing
- 336370 – Motor Vehicle Metal Stamping
- 336390 – Other Motor Vehicle Parts Manufacturing
- 336411 – Aircraft Manufacturing
- 336412 – Aircraft Engine and Engine Parts Manufacturing
- 336413 – Other Aircraft Parts and Auxiliary Equipment Manufacturing
- 336414 – Guided Missile and Space Vehicle Manufacturing
- 336415 – Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
- 336419 – Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing
- 336611 – Ship Building and Repairing
- 336612 – Boat Building
- 336991 – Motorcycle, Bicycle, and Parts Manufacturing
- 336992 – Military Armored Vehicle, Tank, and Tank Component Manufacturing
- 336999 – All Other Transportation Equipment Manufacturing.

Table 9-41 summarizes the per site estimates for this OES based on the methodology described.

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Table 9-41. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-Dichloroethylene During the Use of Cleaning/Degreasing Solvents

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site ^a
336110 – Automobile and Light Duty Motor Vehicle Manufacturing	76	22
336120 – Heavy Duty Truck Manufacturing		
336211 – Motor Vehicle Body Manufacturing		
336212 – Truck Trailer Manufacturing		
336213 – Motor Home Manufacturing		
336214 – Travel Trailer and Camper Manufacturing		
336310 – Motor Vehicle Gasoline Engine and Engine Parts Manufacturing		
336320 – Motor Vehicle Electrical and Electronic Equipment Manufacturing		
336330 – Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing		
336340 – Motor Vehicle Brake System Manufacturing		
336350 – Motor Vehicle Transmission and Power Train Parts Manufacturing		
336360 – Motor Vehicle Seating and Interior Trim Manufacturing		
336370 – Motor Vehicle Metal Stamping		
336390 – Other Motor Vehicle Parts Manufacturing		
336411 – Aircraft Manufacturing		
336412 – Aircraft Engine and Engine Parts Manufacturing		
336413 – Other Aircraft Parts and Auxiliary Equipment Manufacturing		
336414 – Guided Missile and Space Vehicle Manufacturing		
336415 – Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing		
336419 – Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing		
336611 – Ship Building and Repairing		
336612 – Boat Building		
336991 – Motorcycle, Bicycle, and Parts Manufacturing		
336992 – Military Armored Vehicle, Tank, and Tank Component Manufacturing		
336999 – All Other Transportation Equipment Manufacturing		

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site ^a
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.9 Application of Paints and Coatings – OES #9

9.2.9.1 Exposure Groups and Worker Activities

EPA did not have sufficient metadata to assess exposure groups; therefore, the Agency assessed using the generic exposure groups of “spray application,” “unknown application method,” and ONU.

Worker exposure to *trans*-1,2-dichloroethylene may occur via inhalation of mist or vapors as well as dermal contact to vapors or liquid from use of paints and coatings during container cleaning and unloading, equipment cleaning, spraying or roll coating, and curing or drying activities. EPA did not find information that indicates the extent that engineering controls and worker PPE are used at facilities that use paint or coating formulations containing *trans*-1,2-dichloroethylene.

ONUs include supervisors, managers, and other employees who work in the application area but do not directly handle or apply *trans*-1,2-dichloroethylene products. ONUs are potentially exposed via inhalation while present in the application area; however, the Agency expects ONUs to have lower inhalation exposures than workers who handle or apply the products and no expected dermal exposures.

9.2.9.2 Occupational Inhalation Exposure Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was surrogate data from dichloromethane during use of paints and coatings. One dataset was obtained from OSHA facility inspections ([OSHA, 2019](#)) while EPA ([1985](#)) was a survey of exposure to dichloromethane during spray applications of paint; EPA acknowledges that this decades old data may not be representative of current practices. Finkel([2017](#)) submitted workplace monitoring data obtained from a FOIA (Freedom of Information Act) request of OSHA. The U.S. Department of Defense (DOD) provided five dichloromethane monitoring data points from painting operations during structural repair ([DOEHRS-IH, 2018](#)). Some data indicated that the paint was sprayed, while other data did not indicate the method of application. EPA did not identify any full-shift ONU PBZ samples. Therefore, the Agency used the central tendency from workers to represent ONU exposures.

From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. A vapor pressure correction was performed to account for differences in chemical vapor pressure. Mole fraction data were unavailable; therefore, the Agency assumed a mole fraction of 1. The results of these calculations are shown in the following table.

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Table 9-42. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Application of Paints and Coatings

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length ^e (minutes)	Maximum Sample Length ^e (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Spray Application ^c	27	25	480	480	15	80
Unknown Method ^d	271	271	16	560	2.7	57
ONU ^b – Combined	298	296	16	560	3.6	3.6

^a Limit of detection was not known.
^b Assumed ONU exposure was central tendency of worker exposure.
^c Surrogate data was dichloromethane with vapor pressure correction from OSHA (2019) and U.S. EPA (1985).
^d Surrogate data was dichloromethane with vapor pressure correction from DOEHRs-IH (2018) and Finkel (2017).
^e All monitoring samples that were used in full-shift calculations were rescaled to an 8-hour TWA by scaling by the sample time.

EPA also found short-term PBZ monitoring samples collected during the application of paints and coatings using dichloromethane (OSHA, 2019; DOEHRs-IH, 2018; NIOSH, 1981, 1973). From this monitoring data, EPA calculated the 50th and 95th percentile short-term TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario using the vapor correction factor. The results of these calculations are presented in Table 9-43.

Table 9-43. Short-Term Inhalation Exposures to *trans*-1,2-Dichloroethylene During Application of Paints and Coatings

Worker Description	Number of Samples	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	Short-Term TWA (ppm) ^c	
				Central Tendency	High-End
Spray Application ^a	11	15	50	3.9	20
Unknown Method ^b	9	15	72	1.2	24

^a Surrogate data was dichloromethane with vapor pressure correction from NIOSH (1973) and Love (1981)
^b Surrogate data was dichloromethane with vapor pressure correction from DOEHRs-IH (2018) and OSHA (2019)
^c Limit of detection was not known

Using the 8-hour TWA inhalation concentrations presented in Table 9-42, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-44 below.

Table 9-44. Full-Shift Inhalation Exposure Metrics for Application of Paints and Coatings

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Spray Application	10	54	7.6	40	7.1	37
Unknown Method	1.8	39	1.3	29	1.3	27
ONU – Combined	1.8	1.8	1.3	1.3	1.3	1.3

9.2.9.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. The concentration evaluated for this dermal exposure ranges from 1 to 85% based on product information detailed in Appendix A.9. Table 9-45 summarizes the acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during manufacturing as a primary product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-45. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Application of Paints and Coatings

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	3.3	11
	Acute Absorbed Dose (mg/kg-day)	4.1E-02	0.14
	Intermediate Absorbed Dose (mg/kg-day)	3.0E-02	0.10
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	2.8E-02	9.8E-02

9.2.9.4 Information on Exposure Controls and Personal Protective Equipment

No specific information on exposure controls or PPE was found for application of adhesives containing *trans*-1,2-dichloroethylene.

According to the GS Automobile OEM spray painting and ESD for Automobile Refinishing, OEM painting is typically conducted by robots and overspray collected in waterwash booths of downdraft or crossdraft design. In automobile refinishing, almost all spray coating operations are expected to involve a worker spraying the vehicle, typically in a ventilated spray booth with dry filters to collect overspray Generic Scenario for Automobile Spray Coating. Typical worker PPE at automotive refinishers includes half- or full-face respirators, latex or nitrile gloves, and safety glasses or goggles ([U.S. EPA, 2014a](#); [Science Applications International Corporation, 1996](#))

The ESD on Radiation Curable Coatings, Inks, and Adhesives states that typical PPE used in the workplace include fabric or non-woven long-sleeved shirts and pants, coveralls, and neoprene or rubber gloves. A rubber apron or rubber suit and rubber boots may also be worn in cases where there is potential for splashing on or penetration through clothing. Respiratory protection is used when necessary, especially when escape of spray particles into the work environment is unavoidable ([OECD, 2011](#)).

9.2.9.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during the use of industrial/commercial use of paints and coatings ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for the application of paints and coatings:

- 236220 – Commercial and Institutional Building Construction
- 237310 – Highway, Street, and Bridge Construction
- 238160 – Roofing Contractors
- 238190 – Other Foundation, Structure, and Building Exterior Contractors
- 238320 – Painting and Wall Covering Contractors
- 238330 – Flooring Contractors
- 238390 – Other Building Finishing Contractors
- 322220 – Paper Bag and Coated and Treated Paper Manufacturing
- 332812 – Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers
- 336110 – Automobile and Light Duty Motor Vehicle Manufacturing
- 336120 – Heavy Duty Truck Manufacturing
- 336211 – Motor Vehicle Body Manufacturing
- 336212 – Truck Trailer Manufacturing
- 336213 – Motor Home Manufacturing
- 336214 – Travel Trailer and Camper Manufacturing
- 336411 – Aircraft Manufacturing
- 336611 – Ship Building and Repairing
- 336612 – Boat Building
- 336991 – Motorcycle, Bicycle, and Parts Manufacturing
- 336992 – Military Armored Vehicle, Tank, and Tank Component Manufacturing
- 336999 – All Other Transportation Equipment Manufacturing
- 337122 – Nonupholstered Wood Household Furniture Manufacturing
- 811111 – General Automotive Repair
- 811114 – Specialized Automotive Repair
- 811121 – Automotive Body, Paint, and Interior Repair and Maintenance
- 811198 – All Other Automotive Repair and Maintenance.

Table 9-46 summarizes the per site estimates for this OES based on the methodology described.

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6383**Table 9-46. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-Dichloroethylene During the Application of Paints and Coatings**

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
236220 – Commercial and Institutional Building Construction	6	2
237310 – Highway, Street, and Bridge Construction		
238160 – Roofing Contractors		
238190 – Other Foundation, Structure, and Building Exterior Contractors		
238320 – Painting and Wall Covering Contractors		
238330 – Flooring Contractors		
238390 – Other Building Finishing Contractors		
322220 – Paper Bag and Coated and Treated Paper Manufacturing		
332812 – Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers		
336110 – Automobile and Light Duty Motor Vehicle Manufacturing		
336120 – Heavy Duty Truck Manufacturing		
336211 – Motor Vehicle Body Manufacturing		
336212 – Truck Trailer Manufacturing		
336213 – Motor Home Manufacturing		
336214 – Travel Trailer and Camper Manufacturing		
336411 – Aircraft Manufacturing		
336611 – Ship Building and Repairing		
336612 – Boat Building		
336991 – Motorcycle, Bicycle, and Parts Manufacturing		
336992 – Military Armored Vehicle, Tank, and Tank Component Manufacturing		
336999 – All Other Transportation Equipment Manufacturing		
337122 – Nonupholstered Wood Household Furniture Manufacturing		
811111 – General Automotive Repair		
811114 – Specialized Automotive Repair		
811121 – Automotive Body, Paint, and Interior Repair and Maintenance		
811198 – All Other Automotive Repair and Maintenance		

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.10 Adhesives and Sealants – OES #10

9.2.10.1 Exposure Groups and Worker Activities

EPA did not have sufficient metadata to assess exposure groups; therefore, the Agency assessed using the generic exposure groups of “spray application,” “non-spray application,” “unknown application method,” and ONU.

Worker exposure to *trans*-1,2-dichloroethylene may occur via inhalation of mist or vapors as well as dermal contact to vapors or liquid from use of coatings and sealants during container cleaning and unloading, equipment cleaning, spraying or roll coating, and curing or drying activities. EPA did not find information that indicates the extent that engineering controls and worker PPE are used at facilities that use adhesive or sealant formulations containing *trans*-1,2-dichloroethylene.

ONUs include supervisors, managers, and other employees who work in the application area but do not directly handle or apply *trans*-1,2-dichloroethylene products. ONUs are potentially exposed via inhalation while present in the application area; however, the Agency expects ONUs to have lower inhalation exposures than workers who handle or apply the products and no expected dermal exposures.

9.2.10.2 Occupational Inhalation Exposure Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was surrogate data from dichloromethane and 1-bromopropane during use of adhesives and sealants. EPA found full-shift data for dichloromethane in the following six references ([OSHA, 2019](#); [Finkel, 2017](#); [TNO \(CIVO\), 1999](#); [IPCS, 1996](#); [NIOSH, 1985](#); [U.S. EPA, 1985](#)) and 1-bromopropane data in five references ([OSHA, 2013](#); [Hanley et al., 2009](#); [NIOSH, 2003, 2002](#); [Reh et al., 2002](#)).

From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. A vapor pressure correction was performed to account for differences in chemical vapor pressure. Mole fraction data were unavailable; therefore, the Agency assumed a mole fraction of one. The results of these calculations are shown in Table 9-47.

Table 9-47. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Application of Adhesives and Sealants

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length ^g (minutes)	Maximum Sample Length ^g (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Spray Coating ^{c,d}	99	94	96	587	260	570
Non-Spray Coating ^e	100	82	192	480	2.3	65
Unknown Method ^f	468	468	16	572	6.0	150
ONU ^b – Combined	667	644	16	587	7.8	7.8
^a Limit of detection was not known.						
^b Assumed ONU exposure was central tendency of worker exposure.						

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Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length ^g (minutes)	Maximum Sample Length ^g (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
^c Surrogate data was dichloromethane with vapor pressure correction from TNO (1999), IPCS (1996), and U.S. EPA (1985).						
^d Surrogate data was 1-bromopropane with vapor pressure correction from NIOSH (2002), NIOSH (2003), Hanley (2009), NIOSH (2002), and OSHA (2013).						
^e Surrogate data was dichloromethane with vapor pressure correction from NIOSH (1985), U.S. EPA (1985), and OSHA (2019).						
^f Surrogate data was dichloromethane with vapor pressure correction from Finkel (2017).						
^g All monitoring samples that were used in full-shift calculations were rescaled to an 8-hour TWA by scaling by the sample time.						

EPA also found short-term PBZ monitoring samples collected during the use of adhesives and sealants using dichloromethane (OSHA, 2019; NIOSH, 1985) and 1-bromopropane (NIOSH, 2002). From this monitoring data, EPA calculated the 50th and 95th percentile short-term TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario using the vapor correction factor. The results of these calculations are presented in Table 9-48.

Table 9-48. Short-Term Inhalation Exposures to *trans*-1,2-Dichloroethylene During Application of Adhesives and Sealants

Worker Description	Number of Samples	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	Short-Term TWA (ppm)	
				Central Tendency	High-End
Spray Coating ^{a b}	40	15	17	37	170
Non-Spray Coating ^c	3	10	71	120	160

^a Surrogate data was dichloromethane with vapor pressure correction from OSHA(2019).

^b Surrogate data was 1-bromopropane with vapor pressure correction from NIOSH(2002).

^c Surrogate data was dichloromethane with vapor pressure correction from OSHA(2019) and NIOSH(1985).

Using the 8-hour TWA inhalation concentrations presented in Table 9-47, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-49 below.

Table 9-49. Full-Shift Inhalation Exposure Metrics for Application of Adhesives and Sealants

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Spray Coating	177	390	130	280	120	270
Non-Spray Coating	1.6	44	1.1	32	1.1	30
Unknown Method	4.1	100	3.0	75	2.8	70
ONU – Combined	5.3	5.3	3.9	3.9	3.6	3.6

9.2.10.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. The concentration evaluated for this dermal exposure ranges from 1 to 70% based on product information detailed in Appendix A.9. Table 9-50 summarizes the acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during manufacturing as a primary product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-50. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Application of Adhesives and Sealants

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	0.60	8.8
	Acute Absorbed Dose (mg/kg-day)	7.5E-03	0.11
	Intermediate Absorbed Dose (mg/kg-day)	5.5E-03	8.0E-02
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	5.1E-03	7.5E-02

9.2.10.4 Information on Exposure Controls and Personal Protective Equipment

No specific information on exposure controls or PPE was found for application of adhesives containing *trans*-1,2-dichloroethylene.

According to the ESD on the Use of Adhesives, the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Paper and Other Web Coating states that control technologies are utilized to control air releases ([OECD, 2015](#)). The capture systems collect fugitive emissions from solvents evaporating during coating application and solvent drying. The NESHAP suggests that other control devices, such as wet scrubbers and cyclones, may also be used; however, they are primarily for controlling airborne particulate matter. Data were not found on typical pollution prevention control technologies used for wastewater generated by facilities. Information for other media (*e.g.*, landfill or incineration) indicates that control technologies can vary widely across industries and across facilities within a single industry.

Typical PPE for the application and use of adhesive formulations focuses on minimizing exposure due to spray application or VOC emissions. Chemical PMN submissions submitted to EPA by adhesive chemical manufacturers show that all manufacturers recommend the use of gloves and safety glasses with a side shield or goggles. Approximately half of the submissions also recommended the use of some kind of ventilation and respirators if necessary ([OECD, 2015](#)).

9.2.10.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during the use of industrial/commercial use of adhesives and sealants ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for the use of adhesives and sealants:

- 6472 • 236220 – Commercial and Institutional Building Construction
- 6473 • 238190 – Other Foundation, Structure, and Building Exterior Contractors
- 6474 • 238310 – Drywall and Insulation Contractors
- 6475 • 238320 – Painting and Wall Covering Contractors
- 6476 • 238330 – Flooring Contractors
- 6477 • 238340 – Tile and Terrazzo Contractors
- 6478 • 238350 – Finish Carpentry Contractors
- 6479 • 238390 – Other Building Finishing Contractors
- 6480 • 811111 – General Automotive Repair
- 6481 • 811114 – Specialized Automotive Repair
- 6482 • 811121 – Automotive Body, Paint, and Interior Repair and Maintenance
- 6483 • 811122 – Automotive Glass Replacement Shops
- 6484 • 811191 – Automotive Oil Change and Lubrication Shops
- 6485 • 811198 – All Other Automotive Repair and Maintenance
- 6486 • 322220 – Paper Bag and Coated and Treated Paper Manufacturing
- 6487 • 334111 – Electronic Computer Manufacturing
- 6488 • 334112 – Computer Storage Device Manufacturing
- 6489 • 334118 – Computer Terminal and Other Computer Peripheral Equipment Manufacturing
- 6490 • 334220 – Radio and Television Broadcasting and Wireless Communications Equipment
- 6491 Manufacturing
- 6492 • 334290 – Other Communications Equipment Manufacturing
- 6493 • 334310 – Audio and Video Equipment Manufacturing
- 6494 • 334412 – Bare Printed Circuit Board Manufacturing
- 6495 • 334413 – Semiconductor and Related Device Manufacturing
- 6496 • 334416 – Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing
- 6497 • 334417 – Electronic Connector Manufacturing
- 6498 • 334418 – Printed Circuit Assembly (Electronic Assembly) Manufacturing
- 6499 • 334419 – Other Electronic Component Manufacturing
- 6500 • 335131 – Residential Electric Lighting Fixture Manufacturing
- 6501 • 335132 – Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing
- 6502 • 335139 – Electric Lamp Bulb and Other Lighting Equipment Manufacturing
- 6503 • 335210 – Small Electrical Appliance Manufacturing
- 6504 • 335220 – Major Household Appliance Manufacturing
- 6505 • 335311 – Power, Distribution, and Specialty Transformer Manufacturing
- 6506 • 335312 – Motor and Generator Manufacturing
- 6507 • 335313 – Switchgear and Switchboard Apparatus Manufacturing
- 6508 • 335314 – Relay and Industrial Control Manufacturing
- 6509 • 335910 – Battery Manufacturing
- 6510 • 335921 – Fiber Optic Cable Manufacturing
- 6511 • 335929 – Other Communication and Energy Wire Manufacturing
- 6512 • 335931 – Current-Carrying Wiring Device Manufacturing
- 6513 • 335932 – Noncurrent-Carrying Wiring Device Manufacturing
- 6514 • 335991 – Carbon and Graphite Product Manufacturing
- 6515 • 335999 – All Other Miscellaneous Electrical Equipment and Component Manufacturing
- 6516 • 336110 – Automobile and Light Duty Motor Vehicle Manufacturing
- 6517 • 336120 – Heavy Duty Truck Manufacturing

- 6518 • 336211 – Motor Vehicle Body Manufacturing
- 6519 • 336212 – Truck Trailer Manufacturing
- 6520 • 336213 – Motor Home Manufacturing
- 6521 • 336214 – Travel Trailer and Camper Manufacturing
- 6522 • 336310 – Motor Vehicle Gasoline Engine and Engine Parts Manufacturing
- 6523 • 336320 – Motor Vehicle Electrical and Electronic Equipment Manufacturing
- 6524 • 336330 – Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing
- 6525 • 336340 – Motor Vehicle Brake System Manufacturing
- 6526 • 336350 – Motor Vehicle Transmission and Power Train Parts Manufacturing
- 6527 • 336360 – Motor Vehicle Seating and Interior Trim Manufacturing
- 6528 • 336370 – Motor Vehicle Metal Stamping
- 6529 • 336390 – Other Motor Vehicle Parts Manufacturing
- 6530 • 336411 – Aircraft Manufacturing
- 6531 • 336412 – Aircraft Engine and Engine Parts Manufacturing
- 6532 • 336413 – Other Aircraft Parts and Auxiliary Equipment Manufacturing
- 6533 • 336414 – Guided Missile and Space Vehicle Manufacturing
- 6534 • 336415 – Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
- 6535 • 336419 – Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing
- 6536 • 336611 – Ship Building and Repairing
- 6537 • 336612 – Boat Building
- 6538 • 336991 – Motorcycle, Bicycle, and Parts Manufacturing
- 6539 • 336992 – Military Armored Vehicle, Tank, and Tank Component Manufacturing
- 6540 • 336999 – All Other Transportation Equipment Manufacturing.

6543 Table 9-51 summarizes the per site estimates for this OES based on the methodology described.

6544
6545 **Table 9-51. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-**
6546 **Dichloroethylene During the Commercial Use of Adhesives and Sealants**

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
236220 – Commercial and Institutional Building Construction	6	2
238190 – Other Foundation, Structure, and Building Exterior Contractors		
238310 – Drywall and Insulation Contractors		
238320 – Painting and Wall Covering Contractors		
238330 – Flooring Contractors		
238340 – Tile and Terrazzo Contractors		
238350 – Finish Carpentry Contractors		
238390 – Other Building Finishing Contractors		
811111 – General Automotive Repair		
811114 – Specialized Automotive Repair		

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NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
811121 – Automotive Body, Paint, and Interior Repair and Maintenance	6	2
811122 – Automotive Glass Replacement Shops		
811191 – Automotive Oil Change and Lubrication Shops		
811198 – All Other Automotive Repair and Maintenance		
322220 – Paper Bag and Coated and Treated Paper Manufacturing		
334111 – Electronic Computer Manufacturing		
334112 – Computer Storage Device Manufacturing		
334118 – Computer Terminal and Other Computer Peripheral Equipment Manufacturing		
334220 – Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing		
334290 – Other Communications Equipment Manufacturing		
334310 – Audio and Video Equipment Manufacturing		
334412 – Bare Printed Circuit Board Manufacturing		
334413 – Semiconductor and Related Device Manufacturing		
334416 – Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing		
334417 – Electronic Connector Manufacturing		
334418 – Printed Circuit Assembly (Electronic Assembly) Manufacturing		
334419 – Other Electronic Component Manufacturing		
335131 – Residential Electric Lighting Fixture Manufacturing		
335132 – Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing		
335139 – Electric Lamp Bulb and Other Lighting Equipment Manufacturing		
335210 – Small Electrical Appliance Manufacturing		
335220 – Major Household Appliance Manufacturing		
335311 – Power, Distribution, and Specialty Transformer Manufacturing		
335312 – Motor and Generator Manufacturing		
335313 – Switchgear and Switchboard Apparatus Manufacturing		
335314 – Relay and Industrial Control Manufacturing		
335910 – Battery Manufacturing		

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NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
335921 – Fiber Optic Cable Manufacturing	6	2
335929 – Other Communication and Energy Wire Manufacturing		
335931 – Current-Carrying Wiring Device Manufacturing		
335932 – Noncurrent-Carrying Wiring Device Manufacturing		
335991 – Carbon and Graphite Product Manufacturing		
335999 – All Other Miscellaneous Electrical Equipment and Component Manufacturing		
336110 – Automobile and Light Duty Motor Vehicle Manufacturing		
336120 – Heavy Duty Truck Manufacturing		
336211 – Motor Vehicle Body Manufacturing		
336212 – Truck Trailer Manufacturing		
336213 – Motor Home Manufacturing		
336214 – Travel Trailer and Camper Manufacturing		
336310 – Motor Vehicle Gasoline Engine and Engine Parts Manufacturing		
336320 – Motor Vehicle Electrical and Electronic Equipment Manufacturing		
336330 – Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing		
336340 – Motor Vehicle Brake System Manufacturing		
336350 – Motor Vehicle Transmission and Power Train Parts Manufacturing		
336360 – Motor Vehicle Seating and Interior Trim Manufacturing		
336370 – Motor Vehicle Metal Stamping		
336390 – Other Motor Vehicle Parts Manufacturing		
336411 – Aircraft Manufacturing		
336412 – Aircraft Engine and Engine Parts Manufacturing		
336413 – Other Aircraft Parts and Auxiliary Equipment Manufacturing		
336414 – Guided Missile and Space Vehicle Manufacturing		
336415 – Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing		
336419 – Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing		

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
336611 – Ship Building and Repairing	6	2
336612 – Boat Building		
336991 – Motorcycle, Bicycle, and Parts Manufacturing		
336992 – Military Armored Vehicle, Tank, and Tank Component Manufacturing		
336999 – All Other Transportation Equipment Manufacturing		
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.11 Blowing Agent in Spray Foam – OES #11

9.2.11.1 Exposure Groups and Worker Activities

EPA did not have sufficient metadata to assess exposure groups; therefore, the Agency assessed using the generic exposure groups of “spray application” and ONU. In addition, modeling was used to assess the commercial application of spray foam insulation products containing *trans*-1,2-dichloroethylene by contractors in residential spaces in alignment with similar analysis conducted in the consumer exposure assessment.

Worker exposure to *trans*-1,2-dichloroethylene may occur via inhalation of mist or vapors as well as dermal contact to vapors or liquid during activities related to spraying foam such as container cleaning and unloading, equipment cleaning, spraying, curing or drying activities. EPA did not find information that indicates the extent that engineering controls and worker PPE are used while spraying foams that contain *trans*-1,2-dichloroethylene as a blowing agent.

ONUs include supervisors, managers, and other employees who work in the application area but do not directly handle or apply *trans*-1,2-dichloroethylene products. ONUs are potentially exposed via inhalation while present in the application area; however, the Agency expects ONUs to have lower inhalation exposures than workers who handle or apply the products and no expected dermal exposures.

9.2.11.2 Occupational Inhalation Exposure Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was surrogate data from dichloromethane during spray foam blowing. The 8-hour TWA data are from various sources: IARC(2016), TNO (1999), IPCS (1996), Vulcan Chemicals (1991), NIOSH (1990), Cone Mills (1981), Cone Mills (1982), U.S. EPA (1985), Olin Chemicals (1987), and OSHA (2019). They cover activities such as application of mold release, foam manufacturing (blowing), blending, and sawing. Many different types of worker activities were listed but the actual source of exposure to methylene chloride was unclear. There appear to be diverse uses of dichloromethane in the polyurethane (PU) foam manufacturing industry, which may contribute to the wide range of exposure concentrations.

From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. A vapor pressure correction was performed to account for differences in chemical vapor pressure. Mole fraction data were unavailable; therefore, the Agency assumed a mole fraction of one. The results of these calculations are shown in the following table.

Table 9-52. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene to Blowing Agent in Spray Foam

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length ^d (minutes)	Maximum Sample Length ^d (minutes)	8-Hour TWA (ppm) ^c	
					Central Tendency	High-End
Worker ^c	84	83	240	480	42	220
ONU ^b					42	42

^a Limit of detection was not known.
^b Assumed ONU exposure was central tendency of worker exposure
^c Surrogate data was dichloromethane with vapor pressure correction from IARC (2016), TNO (1999), IPCS (1996), Vulcan Chemicals (1991), NIOSH (1990), Cone Mills (1981), Cone Mills (1982), U.S. EPA (1985), Olin Chemicals (1987), and OSHA (2019)
^d All monitoring samples that were used in full-shift calculations were rescaled to an 8-hour TWA by scaling by the sample time.

Table 9-53 summarizes the available short-term exposure data contained in U.S. EPA (1985).

Table 9-53. Short-Term Inhalation Exposures to *trans*-1,2-Dichloroethylene to Blowing Agent in Spray Foam

Worker Description	Number of Samples	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	Short-Term TWA (ppm) ^a	
				Central Tendency	High-End
Worker	8	30	360	4.3	14

^a Surrogate data was dichloromethane with vapor pressure correction
Dataset is from U.S. EPA (1985)

Using the 8-hour TWA inhalation concentrations presented in Table 9-52, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-54 below.

Table 9-54. Full-Shift Inhalation Exposure Metrics for Blowing Agent in Spray Foam

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Worker	28	150	21	110	19	100
ONU	28	28	21	21	19	19

Inhalation Exposure for Commercial Application of Spray Foam Products

EPA estimated worker exposures for the Propellants, non-motive (Blowing agent COU) using Indoor Environmental Concentrations in Buildings with Conditioned and Unconditioned Zones Version 1.1 (IECCU) (U.S. EPA, 2019c). A similar exposure scenario was modeled for consumers using the same products noted in Table 9-39. For more information on the consumer scenario along with a detailed overview of the model and the inputs used to estimate exposure, see Section 10.3.2. The only difference between the commercial and the consumer scenario was the number of houses modeled. For the

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commercial scenario, EPA assumed that the worker would be able to install the spray foam for 3 homes per day, assuming that each house takes 2 hours, and there was 1 hour of drive time allowed between the houses. The acute exposures are the same for both consumer and commercial scenarios because the 15-minute TWA was used for peak concentration. EPA assumes that the worker will be going to 3 different houses, and they will reach the peak concentration at each house. The chronic exposures were modeled using an 8-hour TWA based on 250 days per year. See the *Draft Consumer and Commercial Exposure Analysis and Risk Calculator for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026f](#)) for a full overview of all model inputs.

Table 9-55. Acute and Chronic Inhalation Exposures for the Commercial Application of Spray Foam Products

Product or Article	Exposure Parameters		Short Term Exposure ^a (15-min TWA) in mg/m ³	Chronic Exposure ^b (8-hour TWA) in mg/mg ³
	Weight Fraction in Product	Area of Application		
Spray Foam – Gap Filler	0.05 %	Perimeter of 4 walls	35	8.9
Spray Foam – Open Cell	0.025%	Area of 4 walls	1,000	370

^a Based on exposure of 6 hours per 8-hour workday.
^b Adjusted from 8-hr TWA based on exposure of 250 days per year.

9.2.11.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. The concentration evaluated for this dermal exposure ranges from one to five% based on product information detailed in Appendix A.9. Table 9-56 summarizes the acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during manufacturing as a primary product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-56. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Blowing Agent in Spray Foam

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	0.21	0.68
	Acute Absorbed Dose (mg/kg-day)	2.6E-03	8.5E-03
	Intermediate Absorbed Dose (mg/kg-day)	1.9E-03	6.2E-03
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	1.8E-03	5.8E-03

9.2.11.4 Information on Exposure Controls and Personal Protective Equipment

No specific information on exposure controls or PPE was found for the use of *trans*-1,2-dichloroethylene blowing agents.

According to the Industry Profile for the Flexible Polyurethane Foam Industry and the Industry Profile for the Rigid Polyurethane Foam Industry, many polyurethane manufacturers incorporate engineering

controls such as enclosures or LEV due to exposure limits for diisocyanates and methylene chloride. Supplemental PPE includes eye protection, respiratory protection, and gloves and suits ([U.S. EPA, 2004a, b](#))

For spray polyurethane foam insulation, typical engineering controls include work zone containment and ventilation. The Alliance for the Polyurethanes Industry (API) offers guidelines for selecting appropriate protective equipment when handling diisocyanates or polyols, which include eye protection, respiratory protection, and proper selection of chemical resistant gloves and suits ([U.S. EPA, 2021b](#)).

9.2.11.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during use as a blowing agent ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 238310 – Drywall and Insulation Contractors
- 238160 – Roofing Contractors
- 238390 – Other Building Finishing Contractors
- 238290 – Other Building Equipment Contractors.

Table 9-57 summarizes the per site estimates for this OES based on the methodology described.

Table 9-57. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-Dichloroethylene During Use of Blowing Agent in Spray Foam

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
238310 – Drywall and Insulation Contractors	6	1
238160 – Roofing Contractors		
238390 – Other Building Finishing Contractors		
238290 – Other Building Equipment Contractors		
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.12 Laboratory Use – OES #12

9.2.12.1 Exposure Groups and Worker Activities

During the use of *trans*-1,2-dichloroethylene as a laboratory chemical, workers are potentially exposed to the chemical during the following activities: transferring *trans*-1,2-dichloroethylene from transport containers to labware, sampling/analyses, and container/equipment cleaning. During these activities workers may be exposed via inhalation of vapor or dermal contact with *trans*-1,2-dichloroethylene.

ONUs include supervisors, managers, and other employees who work at the laboratory, where the laboratory activities occur, but do not directly handle *trans*-1,2-dichloroethylene. Therefore, EPA expects the ONUs to have lower inhalation exposures, lower vapor-through-skin uptake (vapor

absorption through skin), and no dermal exposures compared to workers who handle *trans*-1,2-dichloroethylene as a laboratory chemical.

9.2.12.2 Occupational Inhalation Exposure Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was analogous data from the manufacturing as a primary product OES. For this scenario, inhalation data were provided via a test order submission from the TDCE Consortium ([Exponent, 2023](#)). Within this data set, EPA identified 6 full-shift PBZ samples for laboratory technicians. These laboratory technicians conducted routine daily tasks such as preparing samples for analysis, preparing chemical solutions or standards, and performing data input, interpretation, and analysis. Some activities, such as sample collection from production areas, may not occur in a commercial lab setting; however, the Agency assumes that the other tasks described for laboratory technicians in a manufacturing setting would be similar to tasks performed by laboratory technicians in a commercial laboratory setting. EPA did not identify any ONU PBZ samples. Therefore, EPA used the central tendency from workers to represent ONU exposures.

Table 9-58. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Laboratory Use

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Laboratory Technician – Batch Manufacturing	6	0	645	671	1.3E–02	1.3E–02
ONU ^b					1.3E–02	1.3E–02

^a Limit of detection ranged from <0.02 to <0.04 ppm, depending on sample duration.
^b Assumed ONU exposure was central tendency of worker exposure
Dataset is from the TDCE Consortium Test Order ([Exponent, 2023](#)).

Using the 8-hour TWA inhalation concentrations presented in Table 9-58, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-59 below.

Table 9-59. Full-Shift Inhalation Exposure Metrics for Laboratory Use

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Laboratory Technician – Batch Manufacturing	8.5E–03	8.8E–03	6.3E–03	6.4E–03	5.8E–03	6.0E–03
ONU	8.5E–03	8.5E–03	6.3E–03	6.3E–03	5.8E–03	5.8E–03

9.2.12.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. The concentration evaluated for this dermal exposure ranges from 20 to 100% based on product information detailed in Appendix A.9. Table 9-60 summarizes acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-

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1,2-dichloroethylene during manufacturing as a primary product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-60. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Laboratory Use

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	1.9	11
	Acute Absorbed Dose (mg/kg-day)	2.4E-02	0.14
	Intermediate Absorbed Dose (mg/kg-day)	1.8E-02	0.10
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	1.3E-02	7.7E-02

9.2.12.4 Information on Exposure Controls and Personal Protective Equipment

The *trans*-1,2-dichloroethylene test study report for the TDCE Consortium, provided information on exposure controls and PPE used by laboratory technicians at one chemical manufacturing facility. Laboratory technicians conducted benchtop activities inside fume hoods with no respiratory protection, inside a room under general ventilation (6 ACH). ONUs generally worked outdoors with no respiratory protection. All workers and ONUs wore nitrile or leather/cut resistant gloves, flame resistant clothing, and goggles or safety glasses ([Exponent, 2023](#))

9.2.12.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during use as a laboratory chemical ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 541713 – Research and Development in Nanotechnology
- 541714 – Research and Development in Biotechnology (except Nanobiotechnology)
- 541380 – Testing Laboratories and Services
- 541715 – Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology).

Table 9-61 summarizes the per site estimates for this OES based on the methodology described.

Table 9-61. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-Dichloroethylene During Use of Laboratory Chemicals

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
541713 – Research and Development in Nanotechnology	6	10
541714 – Research and Development in Biotechnology (except Nanobiotechnology)		
541380 – Testing Laboratories and Services		
541715 – Research and Development in the		

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology)		
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.13 Refrigerant Flush – OES #13

9.2.13.1 Exposure Groups and Worker Activities

Worker exposure to *trans*-1,2-dichloroethylene may occur via inhalation of vapors as well as dermal contact to vapors or liquid during activities related to the flushing and replacement of refrigerants such as container cleaning and unloading, and equipment cleaning activities. EPA did not find information that indicates the extent that engineering controls and worker PPE are used during the flushing and replacement of refrigerants that contain *trans*-1,2-dichloroethylene.

ONUs include supervisors, managers, and other employees who work at the facility, where the refrigerant flush activities occur, but do not directly handle *trans*-1,2-dichloroethylene. Therefore, EPA expects the ONUs to have lower inhalation exposures, lower vapor-through-skin uptake (vapor absorption through skin), and no dermal exposures compared to workers who handle *trans*-1,2-dichloroethylene as a refrigerant chemical.

9.2.13.2 Occupational Inhalation Exposure Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was analogous data from the miscellaneous non-aerosol industrial and commercial uses OES. For this scenario, inhalation data were provided via a test order submission from the TDCE Consortium ([Exponent, 2023](#)). Within this data set, EPA identified 22 full-shift PBZ samples. The Agency did not identify any ONU PBZ samples. Therefore, EPA used the central tendency from workers to represent ONU exposures.

From this monitoring data, EPA calculated the 50th and 95th percentile 8-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. The results of these calculations are presented in the following table.

Table 9-62. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Refrigerant and Refrigerant Flush

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length (minutes)	Maximum Sample Length (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Worker	22	22	435	714	6.1	22
ONU ^b					6.1	6.1

^a Limit of detection ranged from <0.02 to <0.04 ppm, depending on sample duration.

^b Assumed ONU exposure was central tendency of worker exposure

All datasets are from the TDCE Consortium Test Order ([Exponent, 2023](#)).

Using the 8-hour TWA inhalation concentrations presented in Table 9-62, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily

concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-63 below.

Table 9-63. Full-Shift Inhalation Exposure Metrics for Refrigerant and Refrigerant Flush

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Worker	4.1	15	3.0	11	2.8	10
ONU	4.1	4.1	3.0	3.0	2.8	2.8

9.2.13.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. The concentration evaluated for this dermal exposure ranges from 25 to 90% based on product information detailed in Appendix A.9. Table 9-64 summarizes the acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during manufacturing as a primary product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-64. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Refrigerant and Refrigerant Flush

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	4.0	13
	Acute Absorbed Dose (mg/kg-day)	5.0E-02	0.16
	Intermediate Absorbed Dose (mg/kg-day)	3.7E-02	0.12
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	3.4E-02	0.11

9.2.13.4 Information on Exposure Controls and Personal Protective Equipment

No specific information on exposure controls and PPE for refrigerant flush was found. The *trans*-1,2-dichloroethylene test study report for the TDCE Consortium provided some information for flight mechanics performing flush cleaning at one facility. The flight mechanics and ONUs wore nitrile gloves, goggles or safety glasses, but no use of respiratory protection or LEV was reported ([Exponent, 2023](#)).

9.2.13.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during use as a refrigerant flush ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 333415 – Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial

Refrigeration Equipment Manufacturing

- 238220 – Plumbing, Heating, and Air-Conditioning Contractors
- 811310 – Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance
- 811412 – Appliance Repair and Maintenance
- 423740 – Refrigeration Equipment and Supplies Merchant Wholesalers.

Table 9-65 summarizes the per site estimates for this OES based on the methodology described.

Table 9-65. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-Dichloroethylene During Use of Refrigerant and Refrigerant Flush

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
333415 – Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	6	1
238220 – Plumbing, Heating, and Air-Conditioning Contractors		
811310 – Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance		
811412 – Appliance Repair and Maintenance		
423740 – Refrigeration Equipment and Supplies Merchant Wholesalers		
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.14 Processing Aid in Semiconductor Manufacturing – OES #14

As described in Section 4.2.14, *trans*-1,2-dichloroethylene is received in hermetically sealed containers and fed into a closed system where it is completely reacted away. EPA believes that workers are not exposed to *trans*-1,2-dichloroethylene during semiconductor manufacturing and, therefore, considered the exposure pathway to be incomplete and did not assess exposure for this OES.

9.2.15 Waste Handling, Disposal, Treatment, and Recycling – OES #15

9.2.15.1 Exposure Groups and Worker Activities

EPA did not have sufficient metadata to assess exposure groups; therefore, the Agency assessed using the generic exposure groups of “worker” and ONU”.

Workers are potentially exposed to *trans*-1,2-dichloroethylene via inhalation of vapors or dermal contact with liquids during the unloading and cleaning of transport containers. EPA did not find information that indicates the extent that engineering controls and worker PPE are used at facilities that handle, treat, and dispose of waste containing *trans*-1,2-dichloroethylene.

ONUs for this scenario include supervisors, managers, and other employees that may be in the waste handling or treatment area. ONUs do not directly handle the chemical and are therefore expected to have lower inhalation exposures, and no dermal exposures through contact with liquids or solids, than

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workers that engage in tasks related to the handling or treatment of waste containing *trans*-1,2-dichloroethylene.

9.2.15.2 Occupational Inhalation Exposure Results

For this scenario, the highest method from the exposure assessment hierarchy that was available was existing 1,2-dichloroethylene area monitoring data from systematic review for landfills ([ATSDR, 1996](#)), existing dichloromethane PBZ monitoring data from systematic review for incinerators ([DOEHRS-IH, 2018](#); [Finkel, 2017](#); [U.S. EPA, 1985](#)), and existing 1,2-dichloroethane PBZ data from systematic review for POTW and non-POTW WWT ([Lehtinen and Veijanen, 2011](#)). EPA used the central tendency and high-end geometric means to represent 50th percentile and 95th percentile potential occupational inhalation exposures, respectively, for these scenarios. The results of these calculations are shown in Table 9-66.

Table 9-66. Full-Shift Inhalation Exposures to *trans*-1,2-Dichloroethylene During Waste Handling, Treatment, and Disposal

Worker Description	Number of Samples	Number of Detected Samples ^a	Minimum Sample Length ^f (minutes)	Maximum Sample Length ^f (minutes)	8-Hour TWA (ppm)	
					Central Tendency	High-End
Worker – Landfill ^c	3	3	480	480	2.0E-02	0.29
Worker – Incineration ^d	22	22	15	495	0.51	18
Worker – POTW and Non-POTW ^e	3	3	40	100	0.37	0.99
ONU ^b – Combined	28	28	15	495	0.47	0.47
ONU = occupational non-user; POTW = publicly owned treatment works; TWA = time-weighted average ^a The limit of detection is not known. ^b Assumed ONU exposure was central tendency of worker exposure. ^c Area monitoring data for 1,2-dichloroethylene from ATSDR (1996). ^d Surrogate data was dichloromethane with vapor pressure correction from U.S. EPA (1985), DOEHRs (2018), and Finkel (2017). ^e Surrogate data was 1,2-dichloroethane with vapor pressure correction from Lehtinen (2011). ^f All monitoring samples that were used in full-shift calculations were rescaled to an 8-hour TWA by scaling by the sample time.						

Using the 8-hour TWA inhalation concentrations presented in Table 9-67, EPA calculated the acute concentration (AC), intermediate average daily concentration (ADC_{intermediate}), and average daily concentration (ADC), as described in Section 9.1.6. The results of these calculations are shown in Table 9-67 below.

Table 9-67. Full-Shift Inhalation Exposure Metrics for Waste Handling, Treatment, and Disposal

Exposure Group	Acute Exposure Concentrations (AC)		Intermediate Average Daily Concentration (ADC _{intermediate})		Average Daily Concentration (ADC)	
	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)
Worker – Landfill	1.4E-02	0.20	9.9E-03	0.14	9.3E-03	0.14
Worker – Incineration	0.35	12	0.26	8.8	0.24	8.2
Worker – POTW and non-POTW	0.25	0.67	0.19	0.49	0.17	0.46
ONU – Combined	0.32	0.32	0.24	0.24	0.22	0.22

9.2.15.3 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the dermal approach outlined in Section 9.1.4 above and Appendix A.9. The concentration evaluated for this dermal exposure ranges from 0.01 to 100% based on the concentration ranges of upstream OESs. Table 9-68 summarizes acute absorbed dose rate, acute absorbed dose, intermediate absorbed dose, and chronic absorbed dose, non-cancer, for *trans*-1,2-dichloroethylene during manufacturing as a primary product. The high-end exposure doses are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. OES-specific parameters for dermal exposures are described in Appendix A.9.

Table 9-68. Summary of Dermal Exposure Doses to *trans*-1,2-Dichloroethylene for Waste Handling, Treatment, and Disposal

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute Absorbed Dose Rate (mg/day)	3.1	14
	Acute Absorbed Dose (mg/kg-day)	3.8E-02	0.17
	Intermediate Absorbed Dose (mg/kg-day)	2.8E-02	0.13
	Chronic Absorbed Dose, non-cancer (mg/kg-day)	2.6E-02	0.12

9.2.15.4 Information on Exposure Controls and Personal Protective Equipment

EPA did not find information that indicates the extent that engineering controls and worker PPE are used at landfill, incineration, and WWT facilities.

9.2.15.5 Estimates of Number of Workers and Occupational Non-Users

EPA used data from BLS and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *trans*-1,2-dichloroethylene during disposal ([U.S. BLS, 2023](#); [U.S. Census Bureau, 2017](#)). As further described in Section 9.1.8, this approach involved first identifying the relevant NAICS codes for the OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes, from which total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix E includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 221320 – Sewage Treatment Facilities
- 562213 – Solid Waste Landfill
- 562211 – Hazardous Waste Treatment and Disposal

- 327310 – Cement Manufacturing
- 327992 – Ground or Treated Mineral and Earth Manufacturing
- 562213 – Solid Waste Combustors and Incinerators

Table 9-69 summarizes the per site estimates for this OES based on the methodology described.

Table 9-69. Estimated Average Number of Workers per Site Potentially Exposed to *trans*-1,2-Dichloroethylene During Waste Handling, Treatment, and Disposal

NAICS Code	Potentially Exposed Workers per Site ^a	Potentially Exposed ONUs per Site
562211 – Hazardous Waste Treatment and Disposal	10	11
327310 – Cement Manufacturing		
327992 – Ground or Treated Mineral and Earth Manufacturing		
562213 – Solid Waste Combustors and Incinerators		
562213 – Solid Waste Landfill	1	5
221320 – Sewage Treatment Facilities	1	1
^a Number of workers and occupational non-users (ONUs) per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.		

9.2.16 Distribution in Commerce – OES #16

Exposures associated with Distribution in Commerce OES can result from loading at the producing site, leaks and spills that can occur during transportation, releases and exposures that can occur during temporary warehousing/storage on the way to delivery to customer site, and then unloading at the customer site.

EPA does not currently have a methodology for quantitatively estimating exposures associated with distribution in commerce. For purposes of assessment in this risk evaluation, the Distribution in Commerce COU consists of the moving of products and/or articles containing *trans*-1,2-dichloroethylene between manufacturing, processing, and use sites, or the transportation of *trans*-1,2-dichloroethylene containing wastes to recycling sites or for final disposal. Loading/unloading of *trans*-1,2-dichloroethylene (loading/unloading) is evaluated within the relevant use-specific COUs/OESs (*e.g.*, manufacturing, repackaging, processing), not this standalone Distribution in commerce OES. EPA expects that under standard operating procedures, there is negligible potential for releases during transportation of the product in commerce. Therefore, no occupational exposures are reasonably expected to occur.

Loading at the Producing Site

This is assessed as part of the OES that produces *trans*-1,2-dichloroethylene product or formulations.

Leaks and Spills That Occur During Transportation

TSCA Risk Evaluations do not cover unpredictable catastrophic accidents but assess leaks and spills that might be expected to regularly and predictably occur during transportation. See Section 4.

Temporary Warehousing/Storage

EPA has mapped facility release data (see Section 4). Releases from sources within a facility can lead to exposures to workers at the facility. For example, fugitive emissions can lead to inhalation exposure.

Unloading at the Customer Site

This is assessed as part of the OES that receives *trans*-1,2-dichloroethylene product and formulations.

9.3 Weight of Scientific Evidence Conclusions for Occupational Exposure Assessment

For each OES, EPA considered the (1) assessment approach; (2) quality of the data and models; and (3) strengths, limitations, assumptions, and key sources of uncertainties in the assessment results to determine a weight of scientific evidence rating. EPA also considered factors that increase or decrease the strength of the evidence supporting the release estimate (*e.g.*, quality of the data/information), the applicability of the release data to the OES (*e.g.*, temporal relevance, locational relevance), and the representativeness of the estimate for the whole industry. The Agency used the descriptors of robust, moderate, slight, or indeterminant to categorize the available scientific evidence using its best professional judgment, according to the 2021 Draft Systematic Review Protocol ([U.S. EPA, 2021c](#)). For example, a conclusion of moderate is appropriate where exposure data are generated from a generic model with high data quality and some chemical-specific or industry-specific inputs, such that the exposure estimate is a reasonable representation of potential sites within the OES. A conclusion of slight is appropriate where there is limited information that does not sufficiently cover all sites within the OES, and the assumptions and uncertainties are not fully known or documented. See the Draft Systematic Review Protocol for additional information on weight of scientific evidence conclusions.

Weight of scientific evidence ratings for the occupational exposure estimates for each OES, including details on the basis EPA used to determine the rating, are provided in the sections and tables that follow.

EPA estimated occupational exposure using several sources of air monitoring data; however, the source used the most in this assessment was an inhalation exposure monitoring study submitted to the Agency by the TDCE Consortium in response to a test order ([Exponent, 2023](#)). These data were determined to have overall data quality ratings of high through EPA's systematic review process. Other studies used had data quality ratings of high or medium.

9.3.1 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for the Release Assessment

Table 9-70 summarizes EPA's overall confidence in the occupational exposure estimates for each OES.

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Table 9-70. Weight of Scientific Evidence Conclusion in Exposure Estimates

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates	Confidence Rating
Manufacturing as a Primary Product	Evidence Found: For this OES, EPA used inhalation monitoring data from a facility that manufactures <i>trans</i>-1,2-dichloroethylene as a primary product provided via a test order submission from the TDCE Consortium (Exponent, 2023). Strengths: The primary strengths of the inhalation occupational exposure estimates for this OES include the use of personal breathing zone samples directly applicable to this OES, which are preferable to other assessment approaches such as modeling or the use of OELs, and the high number of samples available for workers and ONUs. EPA used full-shift PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process. The data included 29 worker and 37 ONU full-shift PBZ samples at 1 manufacturing facility. Out of the 66 total samples, 26 were below the method detection limit. Another strength is that the monitoring data was collected in accordance with sampling plan that has been reviewed and approved by EPA, and includes all of the agreed upon metadata. Limitations/Assumptions/Uncertainties: There were data in the test order summary report that indicated that certain tasks (those done by the Outside Lead Operator/B-Operator – Batch Manufacturing, Operator – Distillation Operation, and Laboratory Technician – Batch Manufacturing) are done on a daily basis, while the tasks that are completed by the Shipping/Warehouse Worker – Batch Manufacturing were periodic, without providing more detail. Overall, EPA assumed 250 exposure days/year based on <i>trans</i>-1,2-dichloroethylene exposure each working day for a typical worker schedule. Weight of Scientific Evidence Conclusion: Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment provides robust confidence in the estimate of exposures for workers and ONUs.	Robust
Manufacturing as a Byproduct	Evidence Found: EPA did not identify monitoring data for the manufacturing of <i>trans</i>-1,2-dichloroethylene as a byproduct. Based on available data, EPA used analogous data from the manufacturing of <i>trans</i>-1,2-dichloroethylene as a primary product provided via a test order submission from the TDCE Consortium (Exponent, 2023). Strengths: The primary strengths of the inhalation occupational exposure estimates for this OES include the use of personal breathing zone samples, the high number of samples available for workers and ONUs. EPA used full-shift PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process. The data included 29 worker and 37 ONU full-shift PBZ samples at 1 manufacturing facility. Out of the 66 total samples, 26 were below the method detection limit. Another strength is that the monitoring data was collected in accordance with sampling plan that has been reviewed and approved by EPA, and includes all of the agreed upon metadata.	Moderate

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates	Confidence Rating
	Limitations/Assumptions/Uncertainties: EPA is uncertain about the similarity of worker exposures when comparing manufacturing as a byproduct vs. manufacturing as a primary product. This is because byproducts may not be produced at a high concentration as primary products are and byproducts are not typically isolated like primary products. There is also uncertainty about similarities in frequency of workers exposure during the two types of manufacturing. Weight of Scientific Evidence Conclusion: Based on the strengths and limitations outlined above, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures for workers and ONUs.	
Repackaging	Evidence Found: For this OES, EPA used inhalation monitoring data from facilities that package <i>trans</i>-1,2-dichloroethylene formulations provided via a test order submission from the TDCE Consortium (Exponent, 2023). EPA also used short-term surrogate monitoring data from workers filling drums with dichloromethane (Unocal Corporation, 1987). Strengths: The primary strengths of the inhalation occupational exposure estimates for this OES include the use of personal breathing zone samples directly applicable to this OES, which are preferable to other assessment approaches such as modeling or the use of OELs, and the high number of samples available for workers and ONUs. EPA used full-shift PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process. Another strength is that the data used from TDCE Consortium were <i>trans</i>-1,2-dichloroethylene specific from multiple facilities that processes the chemical into formulations, mixtures, or reaction products; the data included 15 worker full-shift PBZ samples at 2 facilities. Out of the 15 total samples, 3 were below the method detection limit. Another strength is that the monitoring data was collected in accordance with sampling plan that has been reviewed and approved by EPA, and includes all of the agreed upon metadata. Limitations/Assumptions/Uncertainties: The primary limitation was that the monitoring data captured packaging activities after a new formulation of <i>trans</i>-1,2-dichloroethylene was created, rather than the repackaging of the chemical without reformulation as is the intent of this OES. It is uncertain how similar packaging activities are to repackaging activities. The short-term surrogate monitoring data from workers filling drums with dichloromethane is more than thirty years old and may not be representative of current industrial practices, which limits the usefulness of the data. Weight of Scientific Evidence Conclusion: Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures for workers and ONUs.	Moderate
Processing as a	Evidence Found: EPA did not identify monitoring data for the processing of <i>trans</i>-1,2-dichloroethylene as a	Moderate

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates	Confidence Rating
Reactant	reactant. Based on available data, EPA used analogous data from the manufacturing of <i>trans</i>-1,2-dichloroethylene as a primary product provided via a test order submission from the TDCE Consortium (Exponent, 2023). EPA also used short-term surrogate monitoring data from workers using dichloromethane as a reactant (TNO (CIVO), 1999; Olin, 1979). Strengths: The primary strengths of the inhalation occupational exposure estimates for this OES include the use of personal breathing zone samples, the high number of samples available for workers and ONUs. EPA used full-shift PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process. The data included 29 worker and 37 ONU full-shift PBZ samples at 1 manufacturing facility. Out of the 66 total samples, 26 were below the method detection limit. Another strength is that the monitoring data was collected in accordance with sampling plan that has been reviewed and approved by EPA, and includes all of the agreed upon metadata. Limitations/Assumptions/Uncertainties: EPA is uncertain about the similarity of worker exposures when comparing processing as a reactant vs. manufacturing as a primary product. This is because reactants are typically not found in the product stream at high concentrations like they are when they are primary products are. The short-term surrogate monitoring data from workers using dichloromethane as a reactant is more than twenty years old and may be representative of current industrial practices, which limits the usefulness of the data. Weight of Scientific Evidence Conclusion: Based on the strengths and limitations outlined above, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures for workers and ONUs.	
Incorporation into Formulation, Mixture, or Reaction Product	Evidence Found: For this OES, EPA used inhalation monitoring data from facilities that processes <i>trans</i>-1,2-dichloroethylene into formulations, mixtures, or reaction products provided via a test order submission from the TDCE Consortium (Exponent, 2023). Strengths: The primary strengths of the inhalation occupational exposure estimates for this OES include the use of personal breathing zone samples directly applicable to this OES, which are preferable to other assessment approaches such as modeling or the use of OELs, and the high number of samples available for workers and ONUs. EPA used full-shift PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process. Another strength is that the data used from TDCE Consortium were <i>trans</i>-1,2-dichloroethylene specific from multiple facilities that processes the chemical into formulations, mixtures, or reaction products; the data included 70 worker and 60 ONU full-shift PBZ samples at 5 facilities. Out of the 130 total samples, 26 were below the method detection limit. Another strength is that the monitoring data was collected in accordance with sampling plan that has been reviewed and approved by EPA, and includes all of the agreed upon metadata.	Robust

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates	Confidence Rating
	Limitations/Assumptions/Uncertainties: There were data in the test order summary report that indicated that certain tasks (Packaging Operator – Container Packaging (3M 1) and Process Operator (3M 1)) are done on a daily basis, while others are done less frequently. Overall, EPA assumed 250 exposure days/year based on <i>trans</i>-1,2-dichloroethylene exposure each working day for a typical worker schedule. Weight of Scientific Evidence Conclusion: Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment provides robust confidence in the estimate of exposures for workers and ONUs.	
Vapor Degreasing	Evidence Found: For this OES, EPA used inhalation monitoring data from two facilities that uses <i>trans</i>-1,2-dichloroethylene as a vapor degreasing solvent provided via a test order submission from the TDCE Consortium (Exponent, 2023). Strengths: The primary strengths of the inhalation occupational exposure estimates for this OES include the use of personal breathing zone samples directly applicable to this OES, which are preferable to other assessment approaches such as modeling or the use of OELs, and the high number of samples available for workers and ONUs. EPA used full-shift PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process. The data included 20 worker and 11 ONU full-shift PBZ samples at two facilities. Out of the 31 total samples, none were below the method detection limit. Another strength is that the monitoring data was collected in accordance with sampling plan that has been reviewed and approved by EPA, and includes all of the agreed upon metadata. Limitations/Assumptions/Uncertainties: This is a single data set for two facilities and it is not known whether the operations and equipment are representative of other facilities in the OES. Weight of Scientific Evidence Conclusion: Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment provides robust confidence in the estimate of exposures for workers and ONUs.	Robust
Misc. Non-Aerosol Industrial and Commercial Uses (Cleaning and Degreasing Agents, Lubricants and Greases, Mold Release)	Evidence Found: For this OES, EPA used inhalation monitoring data from three facilities that use <i>trans</i>-1,2-dichloroethylene as a non-aerosol solvent for cleaning and degreasing provided via a test order submission from the TDCE Consortium (Exponent, 2023). Strengths: The primary strengths of the inhalation occupational exposure estimates for this OES include the use of personal breathing zone samples directly applicable to this OES, which are preferable to other assessment approaches such as modeling or the use of OELs, and the high number of samples available for workers and ONUs. EPA used full-shift PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process. The data included 22	Robust

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates	Confidence Rating
	worker and 14 ONU full-shift PBZ samples at a facility. Out of the 36 total samples, 4 were below the method detection limit. EPA also obtained 17 short-term from the same test order submission. Another strength is that the monitoring data was collected in accordance with sampling plan that has been reviewed and approved by EPA, and includes all of the agreed upon metadata. Limitations/Assumptions/Uncertainties: EPA did not find data for lubricants and greases sub-OES or the mold release sub-OES. This data set is for three facilities and it is not known whether the operations and equipment are representative of other facilities in the OES. Weight of Scientific Evidence Conclusion: Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment provides robust confidence in the estimate of exposures for workers and ONUs.	
Commercial Aerosol Products (Aerosol Degreasing, Aerosol Lubricants, Mold Release)	Evidence Found: For this OES, EPA used inhalation monitoring data from two facilities that use <i>trans</i>-1,2-dichloroethylene as an aerosol solvent for cleaning and degreasing provided via a test order submission from the TDCE Consortium (Exponent, 2023). In addition, modeling was used to supplement analysis of the exposure to mechanics in an autobody shop for the lubricants and degreasing COU, which was not captured in the test order data. Strengths: The primary strengths of the inhalation occupational exposure estimates for this OES include the use of personal breathing zone samples directly applicable to this OES, which are preferable to other assessment approaches such as modeling or the use of OELs, and the high number of samples available for workers and ONUs. EPA used full-shift PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process. The data included 16 worker and 2 ONU full-shift PBZ samples at a facility. Out of the 18 total samples, none were below the method detection limit. EPA also obtained 2 short-term from the same test order submission. Another strength is that the monitoring data was collected in accordance with sampling plan that has been reviewed and approved by EPA, and includes all of the agreed upon metadata. For the modeling analysis of mechanics in autobody shops, the product compositions were pulled from a range of available SDS. Limitations/Assumptions/Uncertainties: EPA did not find data for lubricants and greases sub-OES or the mold release sub-OES. This data set is for two facilities and it is not known whether the operations and equipment are representative of other facilities in the OES. Therefore, modeling was used to estimate exposure for mechanics in autobody shops, which required making assumptions about frequency and duration of use. Weight of Scientific Evidence Conclusion: Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment provides robust confidence in the estimate of	Robust

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates	Confidence Rating
	exposures based on the test order data EPA has concluded that there is moderate confidence in the modeled inhalation exposures for mechanics in autobody shops.	
Application of Paints and Coatings	Evidence Found: EPA did not identify inhalation exposure monitoring data related to the use of <i>trans</i>-1,2-dichloroethylene during the application of paints and coatings. Based on available data, EPA used surrogate data from dichloromethane during the application of paints and coatings. The dataset collected monitoring data from four studies, including OSHA facility inspections and defense occupational and environmental health readiness system data, contained 27 full-shift worker samples encompassing facilities using dichloromethane during the application of paints and coatings. The studies had a medium to high data quality rating from the systematic review process. Strengths: The primary strength of these data is the use of personal breathing zone data, some of the data indicate method of application, and they are expected to be applicable to <i>trans</i>-1,2-dichloroethylene activities. Limitations/Assumptions/Uncertainties: The primary limitation of this assessment is that it is based on data from a different chemical, which will cause inherent uncertainties due to differences in the chemical properties and possibly handling. For example, <i>trans</i>-1,2-dichloroethylene and dichloromethane have different vapor pressures (331 mmHg for <i>trans</i>-1,2-dichloroethylene vs. 435 mmHg for dichloromethane). Another limitation is that because the majority of the monitoring data was collected more than twenty years ago, there is uncertainty in whether worker practices and controls have changed for these activities at these facilities affecting the potential for exposure. EPA assumed 250 exposure days/year based on exposure each working day for a typical worker schedule. It is uncertain whether this captures actual worker schedules and exposures. Weight of Scientific Evidence Conclusion: Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the central tendency estimate of exposures for workers and ONUs.	Moderate
Adhesives and Sealants	Evidence Found: EPA did not identify inhalation exposure monitoring data related to the use of <i>trans</i>-1,2-dichloroethylene during the use of adhesives and sealants. Based on available data, EPA used surrogate data from dichloromethane and 1-bromopropane during use of adhesives and sealants. The dataset collected monitoring data from ten studies, including NIOSH HHEs and OSHA facility inspections, contained 667 full-shift worker samples encompassing facilities using dichloromethane and 1-bromopropane in adhesive and coating applications. The studies had a medium to high data quality rating from the systematic review process. Strengths: The primary strength of these data is the use of personal breathing zone data, some of the data indicate method of application, and they are expected to be applicable to <i>trans</i>-1,2-dichloroethylene	Moderate

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates	Confidence Rating
	activities. Limitations/Assumptions/Uncertainties: The primary limitation of this assessment is that it is based on data from a different chemical, which will cause inherent uncertainties due to differences in the chemical properties and possibly handling. For example, <i>trans</i>-1,2-dichloroethylene, dichloromethane, and 1-bromopropane have different vapor pressures (331 mmHg for <i>trans</i>-1,2-dichloroethylene vs. 435 mmHg for dichloromethane vs. 146 mmHg for 1-bromopropane). Another limitation is that because the majority of the monitoring data was collected more than thirty years ago, there is uncertainty in whether worker practices and controls have changed for these activities at these facilities affecting the potential for exposure. EPA assumed 250 exposure days/year based on exposure each working day for a typical worker schedule. It is uncertain whether this captures actual worker schedules and exposures. Weight of Scientific Evidence Conclusion: Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the central tendency estimate of exposures for workers and ONUs.	
Blowing Agent in Spray Foam	Evidence Found: EPA did not identify inhalation exposure monitoring data related to the use of <i>trans</i>-1,2-dichloroethylene as a blowing agent during the spraying of foam and modeling for estimating exposure within a residential setting. Based on available data, EPA used surrogate data from dichloromethane during the spraying of foam. The dataset collected monitoring data from ten studies, including OSHA facility inspections and a NIOSH HHE, contained 84 full-shift worker samples encompassing facilities using dichloromethane during the spraying of foam. The studies had a medium to high data quality rating from the systematic review process. Strengths: The primary strength of these data is the use of personal breathing zone data and they are expected to be applicable to <i>trans</i>-1,2-dichloroethylene activities. For the modeling analysis of blowing insulation in residential settings, the product compositions were pulled from a range of available SDS. Limitations/Assumptions/Uncertainties: The primary limitation of this assessment is that it is based on data from a different chemical, which will cause inherent uncertainties due to differences in the chemical properties and possibly handling. For example, <i>trans</i>-1,2-dichloroethylene and dichloromethane have different vapor pressures (331 mmHg for <i>trans</i>-1,2-dichloroethylene vs. 435 mmHg for dichloromethane). Another limitation is that because the majority of the monitoring data was collected more than thirty years ago, there is uncertainty in whether worker practices and controls have changed for these activities at these facilities affecting the potential for exposure. EPA assumed 250 exposure days/year based on exposure each working day for a typical worker schedule. It is uncertain whether this captures actual worker schedules and exposures. For the modeling conducted for blowing insulation in residential settings, assumptions about the frequency and duration of use were similarly estimated.	Moderate

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates	Confidence Rating
	Weight of Scientific Evidence Conclusion: Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the central tendency estimate of exposures for workers and ONUs.	
Laboratory Use	Evidence Found: For this OES, EPA used inhalation monitoring data from the laboratory at a facility that manufactures <i>trans</i>-1,2-dichloroethylene as a primary product provided via a test order submission from the TDCE Consortium (Exponent, 2023). Strengths: The primary strengths of the inhalation occupational exposure estimates for this OES include the use of personal breathing zone samples directly applicable to this OES, which are preferable to other assessment approaches such as modeling or the use of OELs. EPA used full-shift PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process. The data included six worker full-shift PBZ samples at 1 manufacturing facility. All of the 6 samples were below the method detection limit. Another strength is that the monitoring data was collected in accordance with sampling plan that has been reviewed and approved by EPA, and includes all of the agreed upon metadata. Limitations/Assumptions/Uncertainties: There is uncertainty about how representative worker activities and exposures at a laboratory within a manufacturing plant are of other laboratories that use <i>trans</i>-1,2-dichloroethylene, which could have a very diverse set of procedures and exposures. Weight of Scientific Evidence Conclusion: Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures for workers and ONUs.	Moderate
Refrigerant Flush	Evidence Found: EPA did not identify monitoring data for the use of <i>trans</i>-1,2-dichloroethylene for refrigerant flushing. Based on available data, EPA used analogous data from the use of <i>trans</i>-1,2-dichloroethylene as a miscellaneous non-aerosol product provided via a test order submission from the TDCE Consortium (Exponent, 2023). Strengths: EPA used full-shift PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process. The data included 22 worker full-shift PBZ samples. Out of the 22 total samples, none were below the method detection limit. Another strength is that the monitoring data was collected in accordance with sampling plan that has been reviewed and approved by EPA, and includes all of the agreed upon metadata. Limitations/Assumptions/Uncertainties: EPA is uncertain about the similarity of worker exposures when comparing use of a cleaner/degreaser vs. use during the flushing of refrigerants, including the duration and	Moderate

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates	Confidence Rating
	frequency of such actions. Weight of Scientific Evidence Conclusion: Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the estimate of exposures for workers and ONUs.	
Waste Handling, Disposal, Treatment, and Recycling	Evidence Found: EPA did not identify monitoring data for the waste handling, treatment, and disposal of <i>trans</i>-1,2-dichloroethylene. Based on available data, EPA used surrogate data from 1,2-dichloroethane and dichloromethane with area monitoring data for 1,2-dichloroethylene to cover the various sub-disciplines. Strengths: The primary strength of these data is the availability of monitoring data. Limitations/Assumptions/Uncertainties: EPA is uncertain about if the exposures monitored at the facilities are representative of all facilities in the OES. Another limitation is that because the majority of the monitoring data was collected more than thirty years ago, there is uncertainty in whether worker practices and controls have changed for these activities at these facilities affecting the potential for exposure. Weight of Scientific Evidence Conclusion: Based on the strengths and limitations outlined above, EPA has concluded that the weight of scientific evidence for this assessment provides moderate confidence in the central tendency estimate of exposures for workers and ONUs.	Moderate
Dermal Exposure	EPA estimated dermal exposures using modeling methodologies, which are supported by moderate evidence. The Agency used the EPA Dermal Exposure to Volatile Liquids combined with Monte Carlo modeling to calculate the dermal retained dose. EPA used test order data (TDCE Consortium, 2023) on <i>trans</i>-1,2-dichloroethylene for the fraction absorption parameter that was statistically adjusted by EPA (see the <i>Draft Dermal Absorption Calculations for trans-1,2-Dichloroethylene</i> (U.S. EPA, 2026i)) and OES-specific data for the weight percent parameter in the model. Strengths: A strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential exposure values is more likely than a discrete value to capture actual exposure at sites. Limitations/Assumptions/Uncertainties: The primary limitations are the uncertainty in the representativeness of values toward the true distribution of potential dermal exposures and the uncertainty about the amount of chemical that is initially loaded onto the skin. Therefore, the weight of scientific evidence for the modeling methodologies specifically for all OES is moderate. Note that EPA did not assess dermal exposures to ONUs as EPA does not expect ONUs to directly handle <i>trans</i>-1,2-dichloroethylene as part of their duties, and thus ONUs are not expected to have routine dermal exposures during the course of their work. Depending on the COU, ONUs may have incidental dermal	Moderate

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates	Confidence Rating
	exposures due to surface contamination, but EPA did not consider these exposures to be significant and thus they were not assessed.	
COU = condition of use; OES = occupational exposure scenario		

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10 CONSUMER EXPOSURE ASSESSMENT

This consumer assessment is in support of the TSCA Draft Risk Evaluation for *trans*-1,2-dichloroethylene ([U.S. EPA, 2026t](#)). It describes the assessment of consumer exposures to *trans*-1,2-dichloroethylene resulting from relevant COUs. Table 10-1 lists COUs with known *trans*-1,2-dichloroethylene in consumer product and articles. The consumer uses assessed include cleaning agents such as degreasers and flux removers. *trans*-1,2-Dichloroethylene is also used as a propellant in polyurethane foam building insulation.

Following the publication of the *Final Scope of the Risk Evaluation for trans-1,2-Dichloroethylene; CASRN 156-60-5* ([U.S. EPA, 2020b](#)), a data gap analysis of the systematic review data pool was undertaken to support the consumer assessment. Data on emissions of *trans*-1,2-dichloroethylene from application of spray foam was not found. Having data that quantify *trans*-1,2-dichloroethylene transfer from foam to air is important for evaluating potential chemical availability for inhalation exposure. Because of this data gap and the value that it can add to the assessment, EPA issued a test order under section 4 of TSCA in March 2022. Among other items, recipients of the test order were required to conduct a chamber study to quantify the potential consumer exposure to *trans*-1,2-dichloroethylene in a polyurethane foam sealant according to *U.S. EPA Indoor Exposure Product Testing, Version 2.0, Protocol 1 and 3* ([\[Company Withheld\], 2023](#)), [EPA-HQ-OPPT-2018-0465-0065](#)). All test order recipients submitted a final study plan for EPA review and approval prior to commencement of testing. EPA also reviewed all testing data for quality assurance and adherence to good laboratory practices. The recipients were 3M CO, BASF CORP, Chemical Compounding CO, Dow Inc, Huntsman Corp, Microcare, LLC, Occidental Chemical Holding CORP, Olin CORP, The Boeing CO, Unistar Chemical, Versum Materials Inc, and Westlake Chemical CORP.

The subsections that follow elaborate how the test results were applied in this draft consumer exposure assessment.

The presence of *trans*-1,2-dichloroethylene in products indicates there is potential for exposure to consumer users and/or bystanders (non-users that are incidentally exposed to the product or article). The magnitude of these exposures and the relative contributions of various exposure pathways and routes have not yet been well characterized, which is why test orders were issued ([EPA-HQ-OPPT-2018-0465-0065](#)). Due to the lack of comprehensive data on various parameters and the expected variability in exposure pathways, this consumer exposure assessment used conservative assumptions to estimate potential exposures associated with *trans*-1,2-dichloroethylene across COUs to various age groups.

Table 10-1. Consumer Conditions of Use (COU) Table

Life Cycle Stage	COU	Subcategory of COU	References
Consumer	Cleaning agent	Aerosol spray/degreaser	U.S. EPA (2020b, 2020c)
		Flux remover	U.S. EPA (2020b, 2020c)
	Propellants, non-motive (Blowing agent)	Polyurethane foam building insulation	U.S. EPA (2020b, 2020c)

10.1 Approach and Methodology

The consumer exposure assessment considered different scenarios based on available information about

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the types of products and articles containing *trans*-1,2-dichloroethylene, their chemical content, and any use patterns to inform exposure estimates. The main steps in performing the *trans*-1,2-dichloroethylene consumer exposure assessment are summarized below:

1. Identification and mapping of product examples following the consumer COU table.
2. Compilation of products according to manufacturer's use instructions to determine patterns of use.
3. Selection of exposure routes and exposed populations according to product use descriptions.
4. Identification of data gaps and further search to fill gaps with studies, chemical surrogates or product proxies, or professional judgment.
5. Selection of appropriate modeling tools based on available information and chemical properties.
6. Gathering of input parameters per exposure scenario.
7. Parameterization of selected modeling tools and generation of exposure estimates for the relevant scenarios, routes, and population groups.

Consumer products containing *trans*-1,2-dichloroethylene were matched with COUs appropriate for the anticipated use of the item. Table 10-2 summarizes the consumer exposure scenarios by COU for each product example(s), including the relevant exposure routes and whether the analysis was done qualitatively or quantitatively. A qualitative analysis was performed when available data indicated that a given exposure scenario would have low or minimal exposures, or if there was a similar exposure scenario with similar weight fractions, room of exposure, or time exposed to product, that would be considered protective of the user or bystander. For example, EPA assessed the indoor foam sealant with similar weight fractions and frequency of use, it was assumed that the indoor scenario would be protective of the outdoor use of the roof tile foam adhesive. In addition, the other product found was only for commercial use. For more information on the qualitative analysis see Section 10.2.2.1. A quantitative analysis was conducted when the exposure route was deemed relevant based on use description and sufficient data were available to parameterize the model. In a quantitative analysis, exposures from the consumer COUs were estimated by modeling. Each product was individually assessed to determine whether all or some exposure routes were applicable, and approaches were developed accordingly.

trans-1,2-Dichloroethylene is a VOC that transitions readily from liquid and solid consumer goods to the air. Once emitted to the air, partitioning to airborne dust and particulate matter is expected to be negligible (Section 3.2). As such, *trans*-1,2-dichloroethylene exposure via inhalation of gas-phase emissions and aerosols was evaluated through modeling. Inhalation or ingestion of airborne/suspended and settled dust were not evaluated because of the chemical's volatility. Exposure via inhalation during use of liquid cleaning agent products was modeled using EPA's CEM Version 4.0 ([U.S. EPA, 2023](#)). While this model was designed to model exposures to semi-volatile organic compounds (SVOCs), the equations used for liquid and paste products are appropriate for both SVOCs and VOCs. CEM does not have a scenario or emission model that represents polyurethane spray foam sealant. For polyurethane foam sealant products, exposure via inhalation was modeled in EPA's Indoor Environmental Concentrations in Buildings with Conditioned and Unconditioned Zones (IECCU) Model Version 1.1 ([U.S. EPA, 2019d](#)) to integrate test order emission data and best match the emission profile seen in the test itself.

Exposure through dermal contact was modeled using a fraction absorbed (mass-limited) approach. The oral route was not modeled because the possibility of mouthing based on product use descriptions is low.

For dermal and inhalation exposures, EPA used low, medium, and high exposures for each given condition of use, values for critical input parameters (e.g., weight fraction, duration of use, mass of product used, dermal surface area) where possible. This document presents the main inputs (e.g., weight fraction, duration, use frequency) for the consumer analysis, whereas all inputs, sources of information, assumptions, and exposure scenario descriptions are available in the supplemental file *Draft Consumer and Commercial Exposure Analysis and Risk Calculator for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026f](#)).

Acute exposures, which occur for 1 day or less, were estimated for inhalation only because acute toxicity by the dermal route is not expected based on the exposure scenarios identified. For the COUs identified, the exposure times for the cleaning agent were modeled for 1, 2, and 4 minutes only. For more information, see the *Draft Human Health and Environmental Hazard Assessment for trans-1,2-dichloroethylene* ([U.S. EPA, 2026m](#)). Intermediate exposures, which can have a duration of 30 days, were estimated for both inhalation and dermal routes. Chronic exposure estimates, which may have a duration of 1 year, were not modeled because EPA does not expect consumer exposure to be chronic in nature as product use patterns for the product categories evaluated in the draft TSD tend to be infrequent with relatively short durations of use. Product use instructions or descriptions, consumer reviews, or professional judgment were used to estimate the number of events per day (acute) and number of events per month (intermediate). For more information, see the *Draft Human Health and Environmental Hazard Assessment for trans-1,2-dichloroethylene* ([U.S. EPA, 2026m](#)).

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Table 10-2. Summary of Consumer COUs, Exposure Scenarios, and Exposure Routes

Consumer COU	Consumer COU Subcategory	Product/Article	Exposure Scenario and Route	Evaluated Routes				
				Inhalation	Dermal	Ingestion ^a		
						Dust (Air)	Dust (Surface)	Mouthing
Cleaning agent	Cleaner/ degreaser (aerosol and non-aerosol)	Degreasers for mechanical equipment and components	Application of product in house (garage) via aerosol spray can; Direct dermal contact during use; Inhalation of emissions during and after use	QT (CEM)	QT	QL	QL	QL
		Flux remover and contact cleaners for electronics	Application of product in house (utility room) via aerosol spray can; Direct dermal contact during use; Inhalation of emissions during and after use	QT (CEM)	QT	QL	QL	QL
Propellants, non-motive (Blowing agent)	Polymer foam building insulation	Gap filler and sealant (1 component cylinder)	Application of product in house (attic) via pressurized foam spray; Direct dermal contact during use; Inhalation of emissions during and after use	QT (IECCU)	QT	QL	QL	QL
		Open cell non-structural sealant (2 component cylinder)	Application of product in house (attic) via pressurized foam spray; Direct dermal contact during use; Inhalation of emissions during and after use	QT (IECCU)	QT	QL	QL	QL
		Closed cell rigid foam system (2 component cylinder; professional application only)	Inhalation of emissions during and after use for bystanders only. This type of system is only installed by professionals. Therefore, all consumers would be considered bystanders; bystanders assessed by the open cell non-structural sealant scenario above.	QL	QL	QL	QL	QL
		Roof tile adhesive (1 component cylinder)	Application of product outdoors via pressurized foam spray; Direct dermal contact during use; Inhalation of emissions during use.	QL	QL	QL	QL	QL
CEM = assessed using the model CEM; IECCU = assessed using the model IECCU; QL = qualitative consideration; QT = quantitative consideration. Exposure by route deemed unlikely because of physicochemical characteristics of <i>trans</i> -1,2-dichloroethylene and/or expected use patterns. ^a The oral (ingestion) route was not modeled because the possibility of mouthing based on product use descriptions is low. Also, the physical-chemical properties (<i>i.e.</i> , vapor pressure) indicate that there is no partitioning from the gas phase to the particulate phase.								

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10.2 *trans*-1,2-Dichloroethylene Content in Consumer Products

The best available data sources used for *trans*-1,2-dichloroethylene content in U.S. consumer goods were (1) SDSs for specific products or articles with reported *trans*-1,2-dichloroethylene content and test order data, (2) peer-reviewed literature providing measurements of *trans*-1,2-dichloroethylene in consumer goods purchased in the United States, and (3) government reports and databases originating in the United States with manufacturer reported concentrations.

EPA evaluated the products identified to ensure that data represented items currently available to U.S. consumers. Where possible, SDSs were cross-checked with company websites to ensure each product could reasonably be purchased by consumers. In addition to weight fractions, EPA obtained additional information about physical characteristics and potential uses of specific products from technical specifications, manufacturer websites, and vendor websites. These data were used in the assessment to define exposure scenarios. SDS are not required to be submitted by manufacturers for consumer products. The number of SDSs do not equate to product sales in the United States. In addition, the number of SDSs with higher or lower weight fractions do not equate to whether the weight fractions in a specific product are more representative of the products in the market.

The following section summarizes *trans*-1,2-dichloroethylene content identified for specific products and the relevant exposure routes for each product. Additional detail about the use of each product is provided in Appendix G.

10.2.1 Cleaning Agent COU

Aerosol Spray/Degreaser

Seven SDSs aerosol spray/degreaser products were identified which can reasonably be purchased by consumers in the United States. The products, sold online or in auto part stores, are available in 13- to 20-ounce aerosol cans, are used to dissolve grease, oil, and sludge from mechanical equipment and components such as air tools, mechanical brakes, clutches, chains, motor, and parts. A consumer may utilize this type of product while repairing or maintaining their vehicle. Other advertised characteristics include quick evaporation, no residue, no flash, or fire point, and may be used on sensitive plastics. The products contain 3 to 90% *trans*-1,2-dichloroethylene (average of 51%) and product densities range from 1.24 to 1.35 g/cm³ (average of 1.28 g/cm³). The weight fractions used in the assessment for low, medium, and high are 0.030, 0.51, and 0.90, respectively. These weight fractions are the minimum, mean and maximum from the available percentages listed in the SDSs. Three of the products have ranges of *trans*-1,2-dichloroethylene from 70 to 90%. Two products have ranges of *trans*-1,2-dichloroethylene from 40 to 50%. One product has a range of 20 to 30% and the other has a range of 3 to 5%.

Flux Remover

Fourteen aerosol flux remover/contact cleaners were identified which can reasonably be purchased by consumers. The products, sold on public websites in 5- to 20-ounce aerosol cans, are advertised to remove dirt, moisture, dust, flux, or oxides from the internal components of electronic or precision equipment, such printed circuit boards, barcode instruments, switch boxes, gear relays, and electronic motor controllers. The products are advertised as non-flammable and eliminate the need for brushing and scrubbing, although an attached brush on some products may be used. These types of products may be purchased by a hobbyist that would be repairing a motherboard or building custom peripherals for a desktop computer. The products contain between 1 to 80% of *trans*-1,2-dichloroethylene (average of 36%) and product densities range from 0.92 to 1.5 g/cm³ (average of 1.27 g/cm³). The weight

fractions used in the assessment for low, medium, and high are 0.01, 0.36, and 0.8 respectively. These weight fractions are the minimum, mean and maximum from the available percentages listed in the SDS. Eight of the products have ranges of *trans*-1,2-dichloroethylene from 40% – 80%. Two of the products have ranges between 1-10%, and one product has a range of the chemical between 5-10%. One has a reported range of 5-20%. Two products have ranges between 15-30%.

For more information on the SDS identified for this COU, refer to the *Draft Consumer and Commercial Exposure Analysis and Risk Calculator for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026f](#)).

10.2.2 Propellants, Non-Motive (Blowing Agent) COU

Gap Filler Foam Insulation

Two Touch N Seal Quick Cure Cylinder foam products for filling gaps were identified as containing *trans*-1,2-dichloroethylene. These include Touch N Seal Quick Cure Cylinder Reduced Expansion PU Foam Sealant ([D. A. P. Global, 2022b 2022, 13289127](#)) (as identified in the *U.S. EPA Indoor Exposure Product Testing, Version 2.0, Protocol 1 and 3* ([\[Company Withheld\], 2023](#)), [EPA-HQ-OPPT-2018-0465-0065](#)), and Touch N Seal Quick Cure Cylinder High Yield PU Foam Sealant ([Convenience Products, 2017 13289128](#)). Both products contain 1 to 5% *trans*-1,2-dichloroethylene. Currently, neither product appears to be available for purchase, although the High Yield product has an Amazon.com listing. Although the product isn't available for purchase, the active listing and recent SDS support EPA's determination that this product continues to be a reasonably foreseen use. Similar Touch N Seal products are listed online, ([D. A. P. Global, 2022a 13289385](#)), but they do not contain *trans*-1,2-dichloroethylene according to their SDS. The product is labeled for professional use, but it was recently available for sale on a public website and was included in the final report of consumer product chamber emissions from the manufactures ([EPA-HQ-OPPT-2018-0465-0071](#)). Because this product was previously available online for purchase and there are public SDS from 2022, this scenario was quantitatively assessed. The technical data sheets for these surrogate products, which are available in 10- or 16-pound cylinders, were used to help inform modeling decisions (*i.e.*, product yield).

The *U.S. EPA Indoor Exposure Product Testing, Version 2.0, Protocol 1 and 3* ([\[Company Withheld\], 2023](#)), [EPA-HQ-OPPT-2018-0465-0065](#)), describes the Quick Cure product as intended for use in filling gaps and voids in the building envelope to block air, moisture, and insects. It is noted to bond to building materials including wood, metal, concrete, plastic, insulating foam boards, and dry wall, giving it a wide range of potential uses. For this scenario, the maximum 5% weight fraction was modeled as a conservative assumption, and the resultant MOEs were above the benchmark, therefore additional refinement of exposure modeling was not necessary.

Open Cell Foam Insulation

One open cell foam insulation product was identified as containing *trans*-1,2-dichloroethylene: DAP Touch 'n Seal Low Density (1.0%) Spray Foam. This is a two component product, with the B-side containing 1 to 5% *trans*-1,2-dichloroethylene ([DAP Foam Inc., 2018b](#)). The A-side does not contain *trans*-1,2-dichloroethylene. The two components are combined in a 1:1 ratio using a foam insulation sprayer, resulting in a theoretical 0.05 to 2.5% *trans*-1,2-dichloroethylene in the final foam product. The maximum weight fraction of 2.5% was used to model inhalation exposure in IECCU as a conservative approach. Currently, this product is not listed on the DAP website (<https://www.dap.com/products-projects/our-brands/touch-n-seal/>; accessed July 28, 2026) and does not appear to be available for purchase. EPA quantitatively assessed this product identified in the use report ([U.S. EPA, 2020c](#)) during in the final scope as a reasonably foreseen use. Similar Touch N Seal products are listed on the DAP website, but they do not contain *trans*-1,2-dichloroethylene according to their

SDS. The technical data sheets for these products however, were used as a surrogate to help inform modeling decisions (*i.e.*, application methods and product yield).

The open cell foam insulation product is advertised for use in residential, commercial, industrial, and agricultural applications as part of a “flash and batt” application in which this foam is applied directly to the external wall and then fiber insulation (fiberglass or cellulose) is installed on top of the cured foam. This application is expected to seal the building envelope more effectively than fiber insulation alone.

10.2.2.1 Qualitative Assessments for Propellants, Non-Motive (Blowing Agent)

Closed Cell Rigid Spray Foam System

EPA assessed the closed cell rigid spray foam system ([Johns Manville International Inc., 2026](#)) qualitatively. The closed cell rigid foam insulation system may be applied in residential buildings; however, the products are only available for purchase by professionals, and they require specialty application equipment. The specialty equipment is only available for purchase by a professional. Therefore, exposure potential to a consumer user is considered unlikely and was not quantitatively assessed. Three closed cell polyurethane foam building insulation products were identified which contain *trans*-1,2 dichloroethylene. All products contain 1 to 5% *trans*-1,2-dichloroethylene in one component of a two component product, similar to the open cell polyurethane foam building insulation. The products are commonly used as a thermal insulation, air barrier, vapor barrier, and water resistive barrier for commercial, industrial, and residential buildings. The technical data sheets notes that the product is sold in 55-gallon drums and indicates that residential occupancy should not be resumed for 24 hours after spraying ([Johns Manville International Inc., 2026](#)). Bystanders represent residents of the home who may re-enter after application and would receive similar exposure as for the open cell foam scenario, which was quantitatively assessed. The scenario for bystanders was not refined, because the MOEs were above the benchmark after 2 hours. If the technical datasheet is adhered to, there should be no one in the home for 24 hours after the spray foam is installed further reducing the consumer exposure in this type of scenario.

Roof Tile Foam Adhesive

EPA assessed the roof tile foam adhesive qualitatively. The roof tile adhesive product, Touch ‘N Seal Storm Bond 1K PU Roof Tile Adhesive – Cylinder ([D. A. P. Global, 2022c](#)) was identified as containing *trans*-1,2 dichloroethylene. The product is a one-component polyurethane foam packaged in a 23-pound cylinder. The product is advertised for spot repairs of clay and concrete roof tile on approved substrates ([D. A. P. Global, 2022c](#)). Although the roof tile adhesive product may be applied by consumers, the exposure potential in an outdoor scenario is considerably less than an indoor scenario, which was quantitatively assessed through the gap filler and open cell foam insulation scenarios in the attic space in the house. EPA also assumed no ventilation in the attic, which would be very different in an outdoor setting. The tile foam adhesive is applied in the same manner as the spray foam gap filler product. The weight fractions are between 1 to 5% and the same for both the gap filler and the roof tile foam adhesive. The time spent is assumed to be 2 hours for both products and the mass of product is assumed to be (4,535.92 g) because they are purchased in similar container sizes. In addition, the scenarios being closely aligned, the gap filler scenario was not refined, because the MOEs were above the benchmark. Because this scenario is an outdoor scenario, the MOEs would also be above the benchmark.

10.3 Inhalation Exposure Modeling

10.3.1 Cleaning Agent COU

CEM Version 4.0 ([U.S. EPA, 2023a](#)) was selected to estimate inhalation exposures for the Cleaning Agent COU. The products assessed under the Cleaning agent COU include aerosol spray/degreasers and flux removers.

The advantages of using CEM to assess exposures to consumers and bystanders, if applicable, are as follows:

- has been peer reviewed ([ERG, 2016](#));
- accommodates the distinct inputs available for the products and articles containing *trans*-1,2-dichloroethylene, such as weight fractions, product density, room of use, and frequency and duration of use;
- allows calculation of inhalation exposure for product users in close proximity to products; and
- uses the same calculation engine to compute indoor air concentrations from a *trans*-1,2-dichloroethylene-containing source as the higher-tier Multi-Chamber Concentration and Exposure Model but does not require measured chamber emission values (which are not available for the degreaser and flux remover products).

CEM Version 4.0 is deterministic, generating point exposure estimates (air concentrations and doses) based on user-provided input parameters and assumptions (or defaults). The model contains a variety of pre-populated scenarios for specific product and article categories, and users can also customize scenarios if the pre-populated scenarios are not suitable. User inputs for physical and chemical properties are used to calculate emission profiles. There are multiple emission calculation profiles for products within CEM (E1–E5) that represent specific use conditions and properties of various products. A description of these models is summarized in the CEM User Guide and associated appendices ([U.S. EPA, 2023a](#)).

CEM Version 4.0 uses a two-zone representation of the building of use when predicting indoor air concentrations from product use. Zone 1 corresponds to the room where the product is used, while zone 2 represents the remainder of the building. Each zone is assumed to be well-mixed. The model allows for further division of Zone 1 into a near-field and far-field to accommodate situations where a higher concentration of product is expected very near the product user during the period of use. Zone 1 near-field represents the breathing zone of the user at the location of the product use, while Zone 1 far-field represents the remainder of the Zone 1 room. The modeled concentrations in the two zones are a function of the time-varying emission rate in zone 1, the volumes of Zones 1 and 2, the air flows between each zone and outdoor air, and the air flows between both zones. Following product use, the user and bystander may follow one of three pre-defined activity patterns: full time employment outside the home, part time employment outside the home, and stay-at-home. The activity use pattern determines which zone is relevant and the duration of the exposures. The user and bystander inhale airborne concentrations within these zones, which can vary over time, resulting in the overall estimated exposure for each individual.

10.3.1.1 CEM Models

Table 10-3 presents a crosswalk between the COU subcategories and CEM models used for each product scenario. The CEM emission model E3, “Emission from product sprayed” was selected as the best available emission model for both the aerosol spray/degreaser and the flux remover. This model assumes a small percentage of a product (6%) is aerosolized and therefore immediately available for uptake by inhalation. The inhalation model selected was P_INH2 “Inhalation of Product Used in

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Environment (Near-Field / Far-Field)”. The near-field modeling option was selected to account for a small personal breathing zone around the user, during product use in which concentrations are higher, rather than employing a single well-mixed room. A near-field volume of 1 m³ was selected.

Table 10-3. Overview of Cleaning Agent – Cleaner/Degreaser (Aerosol and Non-Aerosol) COU Consumer Emission Modeling

Consumer COU Category	Consumer COU Subcategory	Product Modeled	Emission and Inhalation Model	CEM Saved Analysis ^a
Cleaning agent	Cleaning agent; Cleaner/degreaser (Aerosol and non-aerosol)	Degreasers for mechanical equipment and components	E3, P_INH2 (Near/Far)	Degreasers
	Cleaning agent; Cleaner/degreaser (Aerosol and non-aerosol)	Flux remover and contact cleaners for electronics	E3, P_INH2 (Near/Far)	Degreasers

^a The Saved Analysis “Degreasers” was selected as the starting point to develop the exposure scenarios for the Cleaning Agent COU. Some inputs, however, were modified to reflect chemical-specific parameters and product-specific use patterns. See [CEM User Guide](#) (accessed July 29, 2026) for more information.

10.3.1.2 Model Inputs and Parameterizations

The inhalation model inputs were used for the Cleaning Agent COU. The parameters cited below apply to both the degreasers for mechanical equipment and components and the flux remover and contact cleaner for electronics. Higher concentrations of *trans*-1,2-dichloroethylene in air increases inhalation exposure. This can result from product formulations or use patterns that provide greater emissions, as well as environment specific characteristics such as smaller room volume and lower ventilation rates. In CEM Version 4.0, key parameters influencing emission rates include weight fraction of *trans*-1,2-dichloroethylene in the product, duration of product use, mass of product used, and frequency of product use. Any increase in these parameters results in higher chemical exposure from product use. To capture a range of potential exposure levels, these inputs were varied to create low-, medium-, and high-intensity use scenarios. Other parameters such as chemical properties, building volume, air exchange rate, as well as user and bystander activity patterns (*i.e.*, movements around the home) were held constant across all intensities. Detailed descriptions on the derivation of these inputs are provided below and a summary of values can be found in Table 10-4.

Product User and Activity Pattern

The user was assumed to be an adult, young adult, or young teen. Children under 10 years of age are assumed to be bystanders who are not in the direct vicinity of the products during use. The stay-at-home activity pattern was selected for this assessment for all scenarios as the most conservative behavior pattern. For the “Stay-at-Home” activity pattern used in these analyses, both users and bystanders are assumed to be in the home for most of the day (20 hours). While the product is only emitted for the duration of use (see below), the user is in the room of use for the entire hour after the start of product application, then returns to the regular activity pattern selected. The application start time selected was 9 a.m., which is the CEM default.

Weight Fraction

The weight fraction was a varied input, using the minimum, mean, and maximum values for the low-, medium-, and high-intensity exposure scenarios, respectively. Weight fractions were obtained from the identified SDSs, as outlined in Section 10.2. Values of 3, 51, and 90% were used for aerosol spray/degreasers and values of 1, 36, and 80% were used for flux removers.

Mass of Product Used

The mass of product used was a varied input, using CEM defaults for the Degreaser saved analysis in CEM; for more information on the saved analysis see the CEM Users Guide ([U.S. EPA, 2023a](#)). Values of 50, 100, and 200 g were used for the low-, medium-, and high-intensity exposure scenarios, respectively. These amounts equate to approximately 1, 15, and 30% of the can (assuming an 18-ounce can with a product density of 1.275 g/cm³).

Duration of Use

The duration of product use was a varied input, set to 1, 2, and 4 minutes for the low-, medium-, and high-intensity exposure scenarios, respectively. This duration is based on a release rate of 480 g/minute for the product, obtained from [CRC marketing materials for T-Force® Next Generation Degreaser](#) (accessed July 29, 2026). A spray rate of 480 g/minute would result in a duration of under 1 minute for all scenarios. Thus, a duration of 1 minute was selected for the low mass of 50 g and scaled to 2 and 4 minutes for the medium- and high-intensity exposure scenarios. According to the manufacturing website, the CRC degreasing products are recommended for use on motors, pumps, generators, hoists, compressors, mechanical equipment, corroded machinery, air tools, mechanical brakes and clutches, chains, wire ropes, bearings, dies and molds. It is conceivable that a home mechanic may be spraying one part at a time from the parts that are still a part of the engine or may lay out several parts to spray and then allow the degreaser some time to remove grease. [The American Manufacturer of Automotive Chemicals website](#) (accessed July 29, 2026) note that some “elbow grease” may be needed to remove the grease in addition to spraying the degreaser. Given the conditions noted online, the mass would not be used in 1 minute.

Frequency of Use

The use frequency was set to one event per day for acute exposure. For intermediate exposures, frequency of use was a varied input, set to 2, 5, and 10 days per month based on intended product usage in the *Exposure Factors Handbook* and using manufacturer product descriptions. EPA’s Handbook lists several types of products that could be associated with degreasers including engine degreasers (4.18–13.72 uses/year), carburetor cleaners (3.77–7.1 uses/year), and transmission cleaners (2.28–3.55 uses/year). According to one website, a consumer should degrease their active engine bays two times per year. There were also recommendations from a [consumer forum](#) (accessed July 29, 2026) on using degreasers when you are actively servicing the vehicle (e.g., brake pad replacements, suspension upgrades). Because a consumer could own multiple vehicles and be working as a hobbyist on another vehicle, EPA provided a range of frequencies as noted above because there was no consensus on exact frequencies per vehicle.

Environmental Parameters

Using professional judgment to align the product use description to the most likely indoor use space, the room of use (Zone 1) was selected as the garage for the aerosol spray/degreasers and the utility room for the flux removers. The room of use affects the time occupants spend in the environment where products are actively emitting *trans*-1,2-dichloroethylene, the total volume of air in the room, and ventilation rates.

CEM applies default air exchange rates for buildings from the EPA’s *Exposure Factors Handbook* ([U.S. EPA, 2011](#)). The default interzonal air flows (volumetric air flow between zones 1 and 2 during and after product usage) are a function of the overall air exchange and volume of the building as well as the openness of the room, which is characterized in a regression approach for closed rooms and open rooms ([U.S. EPA, 2023a](#)). More open rooms (e.g., kitchens, living rooms, garages) have an interzonal ventilation rate of 109 m³ per hour, while more enclosed rooms (e.g., bedrooms, bathrooms, utility

7297 rooms) have a rate of 107 m³ per hour. CEM defaults were used for all use environment parameters,
7298 including building volume (492 m³), room of use volume (garage = 90 m³ and utility room = 36 m³), air
7299 exchange rate in Zone 1 and Zone 2 (0.45 hour⁻¹), and interzonal air flow (garage = 109 m³/hour
7300 and utility room = 107 m³/hour).

Table 10-4. Summary of Key Parameters for Inhalation Exposure to *trans*-1,2-Dichloroethylene for Cleaning Agent COU Modeled in CEM Version 4.0

Product	Exposure Scenario Level	Weight Fraction ^a (%)	Duration of Use ^b (mins)	Product Mass Used ^c (g)	Acute Freq. of Use ^c (day ⁻¹)	Int. Freq. of Use ^{d,e} (day/month)	Use Environment ^d ; Volume (m ³) ^c	Air Exchange Rate, Zone 1 and Zone 2 ^c (hour ⁻¹)	Interzone Ventilation Rate (m ³ /h) ^c
Degreasers for mechanical equipment and components	Low	3	1	200	1	2	Garage; 90	0.45	108.978
	Medium	51	2	100		5			
	High	90	4	50		10			
Flux remover and contact cleaners for electronics	High	1	1	200	1	2	Utility room; 20	0.45	107.01
	Medium	36	2	100		5			
	Low	80	4	50		10			

^a See Section 10.2 for weight fraction (WF) sources and discussion.

^b See text in Section 10.2 for discussion on calculation of duration of use. Based on product use description from manufacturers.

^c CEM default.

^d Based on product use description from manufacturers and EPA' *Exposure Factors Handbook* ([U.S. EPA, 2011](#)) data sourced for frequency of use.

^e Intermediate frequency of use is not a parameter directly inputted into CEM. Acute results from CEM are scaled outside of CEM to account for intermediate frequency of use.

10.3.2 Propellants, Non-Motive (Blowing Agent) COU

CEM was not used to model inhalation exposure because there is no scenario or emission model that represents the polyurethane spray foam. IECCU is a previously peer-reviewed deterministic model that uses mass balance calculations and can consider both sources and sinks within the indoor environment to estimate concentrations in the indoor environment ([U.S. EPA, 2019c](#)). IECCU has over 60 different models available and thus can be used to evaluate a variety of release and exposure scenarios. IECCU is a higher tier model than EPA's Consumer Exposure Model (CEM) and has flexible equations that are more applicable to VOCs. Because EPA had test order data characterizing emission from spray foam products, IECCU was chosen to allow the emission equations to be fully tailored to the test order data.

For the Propellants, non-motive (Blowing agent) COU, inhalation exposures were estimated using Consumer Exposure Chamber Testing for *trans*-1,2 dichloroethylene prepared by members of the TDCE Consortium and using ASTM D5116-25.

Small-scale environmental chambers, as described in ASTM D5116-25,⁹ provide a controlled environment for measuring VOC emissions from building products and other indoor materials and products. This data may be used to derive accurate estimates of emission parameters for use in indoor air quality models for regulatory purposes.

This analysis aims to estimate emission parameters for *trans*-1,2 dichloroethylene using a double exponential emission model fitted to chamber testing data. The approach used is consistent with the methods in Section 9.4.1.4 of ASTM D5116-25 and is designed to support integration with in [IECCU](#) (accessed July 29, 2026).

EPA identified two products containing *trans*-1,2-dichloroethylene that were evaluated in this exposure assessment. One product is a smaller can for filling gaps, and the other product is a larger canister type propellant that is used for larger spaces like an attic. IECCU requires that all inputs be user-defined, such as environmental parameters (*e.g.*, building and room volumes, air flow, and ventilation rates) which are adjustable over time. IECCU can be configured with one, two, or three zones within a building. However, it does not distinguish between user and bystander or between near- and far-field as in CEM.

IECCU reports air concentrations in each zone for the entire modeling period. These values are then used to calculate an exposure concentration in air (C_{air}) for product users and bystanders (based on the average concentration in each zone over the exposure duration of interest and the amount of time spent in each zone).

10.3.2.1.1 IECCU Models

Table 10-5 presents a crosswalk between the COU subcategories and IECCU models used for each product scenario.

⁹ Available at: <https://store.astm.org/d5116-25.html> (accessed July 28, 2026), Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products.

Table 10-5. Crosswalk of COUs and Relevant IECCU Models Used for Consumer Modeling

Consumer COU Category	Consumer COU Subcategory	Product Modeled	Emission Model	Emission Parameters
Propellants, non-motive (Blowing agent)	Polyurethane foam building insulation	Gap filler and sealant (1 component cylinder)	Empirical Source; Dual first-order decay source (Model 5b in IECCU)	Derived from test order results
		Open cell non-structural sealant (2 component cylinder)		

10.3.2.2 Model Inputs and Parameterization

Emission Characterization

The dual-first order decay empirical emission model within IECCU contains two distinct time constants, a “fast” decay rate k_1 and a “slow” decay rate k_2 . This equation was chosen because it can best capture the actual concentration profile seen in the chamber test order data ([EPA-HQ-OPPT-2018-0465-0071](#); see analysis in Appendix H.3.2 for the chamber test order data, and Appendix H.3.3 for more information on the dual-first order decay emission model within IECCU.). The model is implemented using emission parameters derived from test order chamber study data and product specific inputs (described below). The simulation duration selected for the empirical emission rate model was 50 hours, and the number of data points selected was 5,000, resulting in a time series concentration profile of 36-second intervals.

Environmental Parameters

Room volume and ventilation rates were set to IECCU default values based on a two-zone building configuration with Zone 1 being all living space of the home and Zone 2 being the unconditioned attic (the room of use). IECCU also utilizes Zone 0, the outdoors. The air flows between the attic and living area were 15 m³/hour. Air flows from the outside to living area and attic were 150 and 300 m³/hour, respectively, and 15 m³/hour between Zones 1 and 2.

Room dimensions were also set to IECCU default parameters for the given building configuration: the living area had a volume of 300 m³ and the attic had a volume of 150 m³. Based on this attic volume, the wall dimensions were calculated to be 25.72 ft (7.84m) on each side, assuming an 8 ft (2.44 m) ceiling and a square room.

No chemical sinks were utilized in these scenarios.

Product-Specific Use Characteristics

Product-specific use scenarios differ in the area of wall that is covered and thus associated amount of product used and resulting mass of *trans*-1,2-dichloroethylene used (M); where M is needed to calculate the E1 and E2 factors in the emission equation (and the A is set to 1 m², as discussed above). The area or volume of coverage in the attic was first determined for each scenario; then, product application rates and yields were used to determine the mass of product needed to cover the area or volume in the attic for each use event. As described above, modeling assumed a single wall, and then model results were used to construct a profile assuming four walls as a post-processing step. Thus, the description below provides the mass and area associated with a single wall.

Gap-Filler Foam: The single component gap-filler product is assumed to be applied to the perimeter of each wall, where each wall has dimensions 25.72 ft (7.84 m) by 8 ft (2.44 m). Thus, a single wall requires coverage of 20.56 m (2 × 7.84 m + 2 × 2.44 m) of foam.

The expected application rate or yield was not provided in the documentation of the specific product being modeled and was therefore sourced from the technical data sheet of a similar, surrogate product with same weight fraction: DAP Touch N Seal Quick Cure Foam Sealant Low GWP 0.1. This product yield was 4,605 linear ft per 10-pound cylinder, resulting in an application rate of 3.23 g product/m. Based on single wall coverage of 20.56 m and a weight fraction of 0.05, the resulting mass of *trans*-1,2-dichloroethylene used (M) for 1 wall is 3.32×10^6 mg (approximately 1% of a 10-pound cylinder).

Open Cell Foam Insulation: The two-component open cell foam product is assumed to be applied to the entire surface area of each wall where one wall has dimensions of 25.72 ft (7.84 m) by 8 ft (2.44 m). Thus, a single wall requires coverage of 19.13 m^2 . For this product, the reported yield is in terms of volume (board feet or m^3 @ 25 mm thick). Therefore, assuming a single layer application at a depth of 25 mm, a single wall requires coverage of 0.48 m^3 product.

The mass of product per cylinder was not provided in the technical data sheet of the specific product being modeled, DAP® TOUCH 'n SEAL® Low Density, and was therefore sourced from the technical data sheet from a similar, surrogate product: DAP® TOUCH 'n SEAL® Low GWP 1.0 PCF Spray Foam – Cream. The mass of product per cylinder listed on the packaging is 18.11 kg (≈ 40 lb). To align with the reported mass of product, the expected yield used to calculate mass of *trans*-1,2-dichloroethylene applied was also taken from the surrogate product; the expected product yield per cylinder was reported as 90.5 m^2 at 25mm depth (2.26 m^3), resulting in an application rate of $8.00 \times 10^4 \text{ g/m}^3$. Based on single wall coverage of 0.48 m^3 and a weight fraction of 0.025 (high-end weight fraction of 0.05 in B-part component, diluted by 50% to account for 1:1 ratio mixing with the A-part component), the resulting mass of *trans*-1,2-dichloroethylene used (M) for 1 wall is 9.57×10^7 mg (21% of a 40-pound cylinder).

Product User and Activity Pattern

The user was assumed to be in the attic (Zone 1) for two hours, which included 40 minutes of product application (10 minutes per wall) followed by an additional 1 hour and 20 minutes to perform touch ups, clean-up, and other maintenance activities. After the 2 hours in Zone 1, the user was assumed to be in Zone 2 (living area) for the remainder of the simulation. The bystander was assumed to be in Zone 2 (living area) at all times and never entered the attic.

Frequency of Use

The use frequency was set to 1 event per day for acute exposure, the CEM default. For intermediate exposures, frequency of use was a varied input, set to 2, 3, and 4 days per month based on professional judgement of intended product usage. These assumptions correspond to applying insulation to two, three, and four 4 rooms—each on a different day. The 3 and 4 days per month scenarios are considered relatively unlikely for a consumer (as opposed to a professional) but are included to represent upper-bound scenarios.

Table 10-6. Summary of Key Parameters for Inhalation Exposure to *trans*-1,2-dichloroethylene for Cleaning Agent COU Modeled in IECCU Version 1.1

Product	Expos. Scenario Level	WF ^a (%)	Mass of Chem. ^b (mg)	E1 and E2 ^h (mg/m ² /h)	Duration of Use Per Wall ^c (mins)	Acute Freq. of Use ^d (day ⁻¹)	Int. Freq. of Use ^{d,e} (day ⁻¹)	Zone Config.:Room and Volume (m ³) ^{f,g}	Air Flow from Zone 0 ^f (m ³ /h)	Inter- zone Ventilation Rate (m ³ /h) ^f	Activity Pattern	
Gap filler and sealant (1 component cylinder)	Low	5	3.32E06	E1: 2.4E7 E2: 1.4E5	10	1	2	Zone 1: Attic; 150 m ³ Zone 2: Living Area; 300 m ³	Zone 1: 150	15	User: 2 hours in Attic (Zone 1) and the remainder of the time in the Living Area (Zone 2)	
	Medium						3					
	High						4					
Open cell non-structural sealant (2 component cylinder)	Low	2.5	9.57E07	E1: 7.0E08 E2: 4.1E06	10	1	2		Zone 2: 300	15		Bystander: All time spent in the Living Area (Zone 2)
	Medium						3					
	High						4					

^a See Section 10.2 for weight fraction (WF) sources and discussion.

^b Mass of product based on application to four walls (perimeter of wall for gap filler and entire wall for open-cell). Based on product use description from manufacturers.

^c Application of each wall was a 10-minute duration and assumed to occur back-to-back. Duration based on product use descriptions from manufacturers. See text in Section 10.3.2.2 for additional information.

^d Based on product use description from manufacturers.

^e Frequency of use is not a parameter directly inputted into IECCU. Results from IECCU are adjusted for frequency of use outside of IECCU.

^f IECCU defaults.

^g CEM default.

^h E1 is the initial emission factor for rapid emissions; E2 is the initial emission factor for slow emissions.

10.4 Modeling Dermal for Cleaning Agent and Propellant COUs

This section summarizes the available dermal absorption data related to *trans*-1,2-dichloroethylene, the interpretation of the dermal absorption data, dermal absorption modeling efforts, and uncertainties associated with dermal absorption estimation in Section 10.5.2. Test order data on percutaneous dermal absorption in human in vitro skin was used to inform the assessment ([EPA-HQ-OPPT-2018-0465-0069](#)). Dermal modeling was done using the approach described below. This approach is the same as implemented in CEM Model P_DER2a but is run in a spreadsheet in this draft assessment to allow the different inputs and equations to be fully demonstrated. Acute dermal exposures were not assessed because no POD was identified for acute dermal exposure (see *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026m](#)) for details).

10.4.1 Dermal Approach

To establish appropriate dermal input parameters, EPA used test order data that performed experiments under different conditions: (1) infinite dose experiments to determine the permeability coefficient appropriate for a flux-limited modeling approach, and (2) finite dose experiments to determine the fraction absorbed appropriate for delivery-limited modeling *U.S. EPA Indoor Exposure Product Testing, Version 2.0, Protocol 1 and 3* (([\[Company Withheld\], 2023](#)), [EPA-HQ-OPPT-2018-0465-0065](#)). The physical and chemical properties of *trans*-1,2-dichloroethylene (high molecular weight, large size, low solubility in water, and high volatility) allow mass to evaporate from the skin and impede its ability to cross the dermal barrier, suggesting a flux-limited approach may be appropriate. Because the product descriptions do not include instructions requiring deliberate contact, such as hand mixing prior to application, EPA expects that the amount available for absorption may be limited compared with the full quantity of the exposure. In the test order, the infinite dose experiments were occluded and evaporation was prevented, suggesting any steady state flux estimated from the experiments may overestimate the flux for those scenarios developed in this assessment.

Therefore, EPA used delivery-limited fractional absorption approach based on the test order experiments as the most appropriate choice for the consumer COUs.

10.4.2 Dermal Absorption Modeling

Based on expected use conditions of the identified products, a thin-film model based on a delivery-limited modeling approach was used to estimate the potential dermal dose of *trans*-1,2-dichloroethylene for each contact event assuming an unoccluded, finite-dose scenario as follows ([U.S. EPA, 2007](#)):

Equation 10-1. Dermal Dose from Liquid Products per Exposure Event

$$DA_{liq} = Q_u \times f_{abs} \times SA$$

Where:

DA_{liq}	=	Dermal event dose (mg/event)
Q_u	=	Dermal loading (mg/cm ² -event)
f_{abs}	=	Fractional absorption (set to 1 for all products)
SA	=	Area of contact (cm ²)

Equation 10-2. Dermal Loading on Skin for Liquid Products

$$Q_u = FT \times \rho \times WF \times CF_1$$

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Where:

Q_u	=	Dermal loading on skin (mg/cm ²)
FT	=	Film thickness on skin (cm)
ρ	=	Density of product (g/cm ³)
WF	=	Weight fraction of <i>trans</i> -1,2-dichloroethylene in product (g chemical/g product)
CF_1	=	Conversion factor (1,000 mg/g)

Dermal dose was estimated based on the lifestage of the product user. EPA made some adjustments to match CEM's lifestages to those listed in the Center for Disease Control and Prevention (CDC) guidelines ([CDC, 2021](#)) and EPA's *A Framework for Assessing Health Risks of Exposures to Children* ([U.S. EPA, 2006](#)). CEM lifestages are re-labeled from this point forward as follows:

- User: Adult (21+ years) → Adult
- User: Youth 2 (16–20 years) → Teenager and young adult
- User: Youth 1 (11–15 years) → Young teen
- Non-User (no exposure): Child 2 (6–10 years) → Middle childhood
- Non-User (no exposure): Child 1 (3–5 years) → Preschooler
- Non-User (no exposure): Infant 2 (1–2 years) → Toddler
- Non-User (no exposure): Infant 1 (<1 year) → Infant

10.4.3 Model Inputs and Parameterization

The dermal model inputs were used for the both Cleaning agent and Propellants, non-motive (Blowing agent) COUs. The parameters cited below apply to the dermal assessment of all consumer products.

Density

The density of the degreaser and flux remover were found to be 1.28 and 1.27 g/cm³, respectively, based on information in the product SDSs ([C. R. C. Industries Inc, 2022](#); [Techspray, 2021](#)).

The density of the gap filler was found to be 1.21 g/cm³ in the product SDS, whereas the density of the open cell non-structural sealant was provided as a range of 0.35 to 0.44 g/cm³ in the product SDS ([D. A. P. Global, 2022b](#)). For the latter product, the upper value of 0.44 g/cm³ was used for the modeling. These densities were assumed to correspond to the final foam after application, which is the appropriate value to use for the dermal modeling.

Weight Fraction

As discussed in Section 10.3.1.2 for inhalation for the cleaning agent COU, the weight fraction was varied using the minimum, mean, and maximum values for the low-, medium-, and high-intensity exposure scenarios, respectively as obtained from the identified SDSs (Section 10.2). Values of 3, 51, and 90% were used for aerosol spray/degreasers and values of 1, 36, and 80% were used for flux removers.

As discussed in Section 10.3.2.2 for inhalation for the Propellants, non-motive (Blowing agent) COUs, both the gap filler sealer and the open cell foam insulation had maximum weight fractions of 5%. This value was used for the gap filler; for open cell foam insulation, 5% was reduced to 2.5% to account for the 50% dilution that comes from this product requiring a 1:1 ratio mixing with an A-part component, which does not contain *trans*-1,2-dichloroethylene.

Film Thickness

Film thickness values were taken from the defaults from product in CEM 4.0. For the degreasers and flux removers, the “degreaser” default thickness of 6.55×10^{-3} cm was used. There are no spray foam products in CEM; instead, the “caulk” default thickness of 0.0159 cm was used.

Absorption Fraction

The absorption fractions were set to 0.6% (rounded from 0.59%), corresponding to the absorption fraction calculated from the mean absorption into receptor fluid of all formulations after 4 hours, and 1.2% (rounded from 1.22%), corresponding to the mean absorption fraction (adjusted for outliers) calculated after 24 hours in the test order experiments ([TDCE Consortium, 2023](#)). The 0.6% represents a more realistic estimate considering the reduced exposure duration for consumer scenarios, while the 1.2% was used to represent a reasonable upper bound in a scenario where the product remains on the skin for an extended period.

Skin Contact Area

To calculate acute and chronic doses, skin contact areas were selected based on professional judgment considering product use descriptions from manufacturers and each product’s typical use. Because the exposure is assumed to be inadvertent and the contact area under these scenarios are not known, three different values corresponding to a low-, medium-, and high-end scenario were used. This corresponded to “inside one hand (palms, fingers),” “inside of two hands (palms, fingers),” and “both hands (entire surface area).” Age-specific surface to volume ratios for the different user lifestyles corresponding to these surface area fractions are provided in the EPA’s CEM Version 4.0 Appendices ([U.S. EPA, 2023a](#)).

Frequency of Use

Frequency of use was determined based on professional judgment and for the degreaser scenario, EPA’s *Exposure Factors Handbook* ([U.S. EPA, 2011](#)) was referenced. The products in question relate to DIY (do-it-yourself) construction projects (spray foam), cleaning of circuit boards (flux remover), or cleaning of mechanical equipment/components. To account for the fact that use of these products by consumers could be in hobbyist activities, the intermediate frequencies of use were set equal to those discussed above for inhalation: 2, 5, and 10 times in a month for the degreaser scenarios and 2, 3, and 4 times in a month for the foam scenarios.

Values for all key parameters used to estimate dermal exposure are provided in Table 10-7. Calculations, data sources, input parameters, and results are also available in *Draft Consumer and Commercial Exposure and Risk Calculator Analysis for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026f](#)).

Table 10-7. Key Parameters Used to Model Dermal Uptake from Liquid Products

Product	Exposure Level	WF ^a %	Intermediate Frequency (days/month) ^b	Product Density ^a (g/cm ³)	Film Thickness ^c (cm)	Chemical Mass on Skin ^d (mg/cm ²)	Dermal Absorption Fraction ^e	Contact Area ^f
Degreasers for mechanical equipment and components	Low	0.03	2	1.28	0.00655	0.084	0.006	Inside of 1 hand (palms, fingers)
	Medium	0.51	5			3.0		Inside of 1 hand (palms, fingers)
	High	0.9	10			6.7	0.012	Both hands (entire surface area)
Flux remover and contact cleaners for electronics	Low	0.01	2	1.27	0.00655	0.25	0.006	Inside of 1 hand (palms, fingers)
	Medium	0.36	5			4.2		Inside of 1 hand (palms, fingers)
	High	0.8	10			7.5	0.012	Both hands (entire surface area)
Gap filler and sealant (1 component)	Low	0.01	2	1.21	0.0159	0.19	0.006	Inside of 1 hand (palms, fingers)
	Medium	0.025	3			0.58		Inside of 1 hand (palms, fingers)
	High	0.05	4			0.96	0.012	Both hands (entire surface area)
Open cell non-structural sealant (2 component)	Low	0.005	2	0.44	0.0159	0.035	0.006	Inside of 1 hand (palms, fingers)
	Medium	0.015	3			0.10		Inside of 1 hand (palms, fingers)
	High	0.025	4			0.17	0.012	Both hands (entire surface area)

^a See Section 10.2 for weight fraction (WF) and product density sources and discussion.

^b Based on manufacturer product use descriptions to support decision making.

^c Input obtained from [CEM Guide](#) (accessed July 29, 2026) and Table 7-24 in the *Exposure Factors Handbook* ([U.S. EPA, 2011b](#)).

^d Calculated parameter using Equation 12.

^e Dermal absorption fraction determined from Test Order Data ([TDCE Consortium, 2023](#)) and with adjustment .

^f Contact Area is implemented as a surface area to body weight ratio (cm²/kg). Refer to the [CEM guide](#) (accessed July 29, 2026) for values associated with the described contact area.

10.5 Exposure Modeling Results

10.5.1 Inhalation Modeling Results

As inhalation risk estimates for *trans*-1,2-dichloroethylene are based on a human equivalent concentration (HEC), the appropriate inhalation exposure metric is an exposure concentration. A 15-minute average exposure concentration was calculated for acute durations to correspond with the sensory irritation hazard effect, and a 24-hour average exposure concentration was selected for intermediate durations to correspond with the reduced immune function hazard effect observed (refer to the *Draft Human Health and Environmental Hazard Assessment for trans-1,2-dichloroethylene* ([U.S. EPA, 2026m](#)) for more information on hazard endpoint selection). The acute and intermediate exposure concentrations are presented in Table 10-8.

Table 10-8. Exposure Concentrations of *trans*-1,2-Dichloroethylene in Air Emitted from Consumer Products (mg/m³)

Product	Exposure Scenario Level	Acute Exposure		Intermediate Exposure	
		15-Minute TWA		24-Hour TWA	
		User ^a	Bystander ^b	User ^a	Bystander ^b
Degreasers for mechanical equipment and components	Low	19.2	1.5	0.10	0.001
	Medium	790	51	3.4	0.86
	High	3,000	180	25	6.1
Flux remover and contact cleaners for electronics	Low	15.03	0.62	0.018	0.0036
	Medium	1,200	45	3.4	0.65
	High	5,300	200	31	5.8
Gap filler and sealant (1 component)	Low	35	1.1	0.10	0.010
	Medium			0.15	0.016
	High			0.21	0.021
Open cell non-structural sealant (2 components)	Low	1,000	3.1	3.0	0.30
	Medium			4.5	0.45
	High			5.9	0.60
TWA = time-weighted average					
^a User includes adults and youths; adult population aged 21+ years and youth population aged 11 to 20 years.					
^b Bystander includes children. The child population is age 0-10.					

10.5.2 Dermal Modeling Results

As dermal risk estimates for *trans*-1,2-dichloroethylene are based on a human equivalent dose (HED), the appropriate dermal exposure metric is the age-specific exposure dose in grams per kilogram of body weight per day. EPA did not model dermal exposures for the acute scenarios, because there was no acute POD. For dermal, HEDs are available for intermediate exposure durations, so the estimated doses are based on the number of uses per 30 day month (refer to the *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026m](#)) for more information on hazard endpoint selection for more information on hazard endpoint selection). The intermediate dermal exposure doses per age group are shown in Table 10-9.

Table 10-9. Intermediate Dermal Exposure Doses of *trans*-1,2-Dichloroethylene from Exposure to Consumer Products

Product	Scenario	Dermal Dose (mg/kg/day)			
		Bystanders (Children 0–10 years)	User: Youths (11 to <15 years)	User: Youths (16–20 years)	User: Adults (21+ years)
Degreasers for mechanical equipment and components	Low	N/A	1.1E–04	9.7E–05	1.0E–04
	Medium	N/A	1.9E–02	1.7E–02	1.9E–02
	High	N/A	0.34	0.31	0.33
Flux remover and contact cleaners for electronics	Low	N/A	3.2E–04	2.9E–04	3.1E–04
	Medium	N/A	2.7E–02	2.4E–02	2.6E–02
	High	N/A	0.38	0.35	0.37
Gap filler and sealant (1 component)	Low	N/A	1.2E–03	1.1E–03	1.2E–03
	Medium	N/A	3.7E–03	3.3E–03	3.6E–03
	High	N/A	2.0E–02	1.8E–02	1.9E–02
Open cell non- structural sealant (2 components)	Low	N/A	2.2E–04	2.0E–04	2.2E–04
	Medium	N/A	6.7E–04	6.1E–04	6.5E–04
	High	N/A	3.5E–03	3.2E–03	3.5E–03

10.6 Consumer Exposure Analysis Weight of Scientific Evidence

Variability and uncertainty are two key elements in evaluating the weight of scientific evidence. Variability refers to the inherent heterogeneity or diversity of data in an assessment. It is a description of the range or spread of a set of values. Uncertainty refers to a lack of data or an incomplete understanding of the context of the risk evaluation decision. Variability cannot be reduced, but it can be better characterized while uncertainty can be reduced by collecting more or better data. Uncertainty also can be addressed qualitatively by including a discussion of factors such as data gaps and subjective decisions or instances where professional judgment was used. Uncertainties associated with approaches and data used in the evaluation of consumer exposures are described below.

The exposure assessment of chemicals from consumer products and articles has inherent challenges due to many sources of uncertainty in the analysis, including variations in product formulation, patterns of consumer use, frequency and duration of use, and product application methods. Variability in environmental conditions may also alter physical and/or chemical behavior of the product or article. Key sources of uncertainty for evaluating exposure to *trans*-1,2-dichloroethylene in consumer goods and strategies to address those uncertainties are described in this section.

Generally, designation of robust confidence suggests thorough understanding of the scientific evidence and uncertainties. The supporting weight of scientific evidence outweighs the uncertainties to the point where it is unlikely that the uncertainties could have a significant effect on the exposure estimate. The designation of moderate confidence suggests some understanding of the scientific evidence and uncertainties. More specifically, the supporting scientific evidence weighed against the uncertainties is reasonably adequate to characterize exposure estimates, but there are some unknowns. The designation of slight confidence is assigned when the weight of scientific evidence may not be adequate to characterize the scenario, and when the assessor is making the best scientific assessment possible in the absence of complete information and there are additional unknown uncertainties that may need to be

considered. Table 10-10 summarizes the overall uncertainty per COU, and a discussion of rationale used to assign the overall uncertainty. The following subsections ahead of the table describe sources of uncertainty for several parameters that apply across COUs and provide an in depth understanding of the sources of uncertainty, limitations, and strengths. The confidence to use the results for risk characterization ranges from slight to robust.

Product Formulation and Composition

Variability in the formulation of consumer products, including changes in ingredients, concentrations, and chemical forms can introduce uncertainty in exposure assessments. In this assessment, EPA has robust confidence in the weight fractions because they were obtained from SDSs. EPA used the high-end weight fractions for the propellant analysis to capture use of products with the highest trans-1,2-dichloroethylene content in order to ensure that the modeling was going to capture the highest exposure within the range identified in the SDS (1–5%). For the cleaning agent analysis, EPA varied the weight fractions across high, medium, and low scenarios to capture the range of trans-1,2-dichloroethylene content.

Product Use Patterns

Consumer use patterns such as frequency of use, duration of use, the size of the application area, and skin contact area are expected to differ across different users and scenarios. For the Cleaning agent COU, the CEM default values for the mass used for low, medium, and high use cases were used. The default values are within the degreaser saved analysis within CEM. For more information on the saved analysis see the [CEM Guide](#) (accessed July 28, 2026). The duration of use was varied based on marketing materials that gave a typical application rate of mass per second; the durations were varied according to that application rate and the mass applied in each scenario. For the frequency of use, EPA varied the frequency across low, medium, and high scenarios to represent use one weekend per month, five days per month, and every weekend day (10 days per month) based on professional judgement.

For the Propellants, non-motive (Blowing agent) COU, emission rates for trans-1,2-dichloroethylene were estimated based on a test order that estimated emission from a spray propellant foam product in a chamber with known air exchange rate and volume. After accounting for mass lost during the experiment, the profile of emission was well-captured by a dual exponential decay function. To adjust the emissions for specific use scenarios, both the area of application and the mass per use were needed. The areas were taken assuming certain fractions of the wall are covered, where the wall size was determined from the IECCU default attic room volume. The associated areas were determined by taking product yields and mass per product container and calculating the mass for the particular coverage area. The product yields and mass per product container were obtained from product manufacturer information.

Human Behavior

CEM Version 4.0 has three different activity patterns: stay-at-home, part-time out-of-the home (daycare, school, or work), and full-time out-of-the-home. The activity patterns were developed based on the Consolidated Human Activity Database. For all products modeled, the stay-at-home or part-time activity patterns were chosen and confidence is considered robust.

Inhalation and Dermal Modeling Tools

Confidence in the modeling tools considers whether the model has been peer-reviewed and whether they are being applied in a manner appropriate to its design and objective. The models used (CEM Version 4.0 and IECCU) have been peer-reviewed, are publicly available, and have been applied in their intended manner to estimate exposures associated with uses of household products. Default inputs such

as building and room volumes, interzonal ventilation rates, and air exchange rates were also used when appropriate. For the dermal modeling, the absorption fraction was taken from test order data in unoccluded settings and other inputs are set to their CEM defaults. Overall confidence in the proper use of CEM and IECCU for consumer exposure modeling is robust.

Table 10-10. Weight of Scientific Evidence Summary per Consumer COU

Consumer COU Category and Subcategory	Weight of Scientific Evidence	Overall Confidence
Cleaning agent: Aerosol spray/degreaser and flux remover	Low, medium, and high scenarios were assessed for 7 aerosol spray/degreaser products and 14 flux remover products using the same methods for each. Inhalation exposure was modeled using CEM. The confidence in the weight fraction for CEM modeling is robust because they were informed by SDS. Confidence in the surface area to be cleaned, and thus the mass of product used, is moderate, since product-specific values could not be determined. Instead, CEM defaults were used. Confidence in the associated event durations are considered moderate, since they are based on the mass used along with manufacturer-provided product spray volumes in mass per second. Confidence in the exposure frequencies were based on manufacturer product descriptions and the <i>Exposure Factors Handbook</i> (U.S. EPA, 2011). Confidence is moderate because consumer frequency use of products could be highly variable. Overall, the confidence in the inhalation estimate range (across low, medium, and high scenarios) is moderate. For dermal exposure, EPA implemented the mass-limited model equations in CEM with absorption fractions derived from test order data. EPA explored the difference in assuming flux-limited vs. mass-limited scenarios and determined the mass-limited method was appropriate. Overall, confidence in the dermal estimate range (across low, medium, and high scenarios) is moderate.	Inhalation – Moderate Dermal – Moderate
Propellants, non-motive (Blowing agent); Polymer foam building insulation	Low, medium, and high scenarios were assessed for two gap-filler propellant polyurethane foam insulation products and one open-cell polyurethane foam insulation product. The exponential form for the emission equation was determined based on test order data. The mass and area of application per event were determined based on the total area of an attic wall based on IECCU defaults, the fraction of the wall covered by each product, and the yield per container, mass per container, and weight fractions based on manufacturer specifications. The overall confidence in the inhalation estimate range (across low, medium, and high scenarios) is moderate. For dermal exposure, EPA implemented the mass-limited model equations in CEM with absorption fractions derived from test order data. EPA explored the difference in assuming flux-limited vs. mass-limited scenarios and determined the mass-limited method was appropriate. Overall, confidence in the dermal	Inhalation – Moderate Dermal – Moderate

Consumer COU Category and Subcategory	Weight of Scientific Evidence	Overall Confidence
	estimate range (across low, medium, and high scenarios) is moderate.	

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APPENDICES

Appendix A ENVIRONMENTAL RELEASES AND OCCUPATIONAL EXPOSURE MODEL APPROACHES AND PARAMETERS

This appendix presents the modeling approach and model equations used in estimating environmental releases and occupational exposures for each of the applicable OESs. The models were developed through review of the literature and consideration of existing EPA/OPPT models, ESDs, and/or GSs. An individual model input parameter could either have a discrete value or a distribution of values. The Agency assigned statistical distributions based on reasonably available literature data. A Monte Carlo simulation (a type of stochastic simulation) was conducted to capture variability in the model input parameters. The simulation was conducted using the Latin hypercube sampling method in @Risk Industrial Edition, Version 8.0.0. The Latin hypercube sampling method generates a sample of possible values from a multi-dimensional distribution and is considered a stratified method, meaning the generated samples are representative of the probability density function (variability) defined in the model. EPA performed the model at 100,000 iterations to capture a broad range of possible input values, including values with low probability of occurrence.

EPA used the 95th and 50th percentile Monte Carlo simulation model result values for assessment. The 95th percentile value represents the high-end release amount or exposure level, whereas the 50th percentile value represents the typical release amount or exposure level. The following subsections detail the model design equations and parameters for each of the OESs.

A.1 EPA/OPPT Standard Models

This section discusses the standard models used by EPA to estimate environmental releases and occupational exposure of chemicals. All the models presented in this section are models that were previously developed by the Agency and are not the result of any new model development work for this draft risk evaluation. Therefore, this appendix does not provide the details of the derivation of the model equations that have been provided in other documents such as the *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)), *Chemical Engineering Branch Manual for the Preparation of Engineering Assessments, Volume I* ([CEB, 1991](#)), Evaporation of pure liquids from open surfaces ([Arnold and Engel, 2001](#)), Evaluation of the Mass Balance Model Used by the References Environmental Protection Agency for Estimating Inhalation Exposure to New Chemical Substances ([Fehrenbacher and Hummel, 1996](#)) and Releases During Cleaning of Equipment ([PEI Associates, 1988](#)). The models address loss fraction as well as estimating chemical vapor generation rates used in subsequent model equations to estimate the volatile releases to air and occupational inhalation exposure concentrations. The parameters in the equations of this appendix section are specific to calculating environmental releases of *trans*-1,2-dichloroethylene.

The EPA/OPPT Penetration Model estimates releases to air from evaporation of a chemical from an open, exposed liquid surface. This model is appropriate for determining volatile releases from activities that are performed indoors or when air velocities are expected to be less than or equal to 100 feet per minute. The EPA/OPPT Penetration Model calculates the average vapor generation rate of the chemical from the exposed liquid surface using the following equation:

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Equation_Apx A-1.

$$G_{activity} = \frac{(8.24 \times 10^{-8}) \times (MW_{t-DCE}^{0.835}) \times F_{correction\_factor} \times VP \times \sqrt{Rate_{air\_speed}} \times (0.25\pi D_{opening}^2)^4 \sqrt{\frac{1}{29} + \frac{1}{MW_{t-DCE}}}}{T^{0.05} \times \sqrt{D_{opening}} \times \sqrt{P}}$$

Where:

$G_{activity}$	=	Vapor generation rate for activity (g/s)
MW_{t-DCE}	=	<i>trans</i> -1,2-Dichloroethylene molecular weight (g/mol)
$F_{correction\_factor}$	=	Vapor pressure correction factor (unitless)
VP	=	<i>trans</i> -1,2-Dichloroethylene vapor pressure (torr)
$Rate_{air\_speed}$	=	Air speed (cm/s)
$D_{opening}$	=	Diameter of opening (cm)
T	=	Temperature (K)
P	=	Pressure (torr)

The EPA/OPPT Mass Transfer Coefficient Model estimates releases to air from the evaporation of a chemical from an open, exposed liquid surface. This model is appropriate for determining this type of volatile release from activities that are performed outdoors or when air velocities are expected to be greater than 100 feet per minute. The EPA/OPPT Mass Transfer Coefficient Model calculates the average vapor generation rate of the chemical from the exposed liquid surface using the following equation:

Equation_Apx A-2.

$$G_{activity} = \frac{(1.93 \times 10^{-7}) \times (MW_{t-DCE}^{0.78}) \times F_{correction\_factor} \times VP \times Rate_{air\_speed}^{0.78} \times (0.25\pi D_{opening}^2)^3 \sqrt{\frac{1}{29} + \frac{1}{MW_{t-DCE}}}}{T^{0.4} D_{opening}^{0.11} (\sqrt{T} - 5.87)^{2/3}}$$

Where:

$G_{activity}$	=	Vapor generation rate for activity (g/s)
MW_{t-DCE}	=	<i>trans</i> -1,2-Dichloroethylene molecular weight (g/mol)
$F_{correction\_factor}$	=	Vapor pressure correction factor (unitless)
VP	=	<i>trans</i> -1,2-Dichloroethylene vapor pressure (torr)
$Rate_{air\_speed}$	=	Air speed (cm/s)
$D_{opening}$	=	Diameter of opening (cm)
T	=	Temperature (K)

The EPA's Office of Air Quality Planning and Standards (OAQPS) AP-42 Loading Model estimates releases to air from the displacement of air containing chemical vapor as a container/vessel is filled with a liquid. This model assumes that the rate of evaporation is negligible compared to the vapor loss from the displacement and is used as the default for estimating volatile air releases during both loading activities and unloading activities. It is used for unloading activities because it is assumed that, while one vessel is being unloaded, another is loaded. The EPA/OAQPS AP-42 Loading Model calculates the average vapor generation rate from loading or unloading using the following equation:

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Equation_Apx A-3.

$$G_{activity} = \frac{F_{saturation\_factor} \times MW_{t-DCE} \times V_{container} \times 3785.4 \frac{cm^3}{gal} \times F_{correction\_factor} \times VP \times \frac{RATE_{fill}}{3600 \frac{s}{hr}}}{R \times T}$$

Where:

$G_{activity}$	=	Vapor generation rate for activity (g/s)
$F_{saturation\_factor}$	=	Saturation factor (unitless)
MW_{t-DCE}	=	<i>trans</i> -1,2-Dichloroethylene molecular weight (g/mol)
$V_{container}$	=	Volume of container (gal/container)
$F_{correction\_factor}$	=	Vapor pressure correction factor (unitless)
VP	=	<i>trans</i> -1,2-Dichloroethylene vapor pressure (torr)
$RATE_{fill}$	=	Fill rate of container (containers/hour)
R	=	Universal gas constant (L•torr/mol–K)
T	=	Temperature (K)

For each of the vapor generation rate models, the vapor pressure correction factor ($F_{correction\_factor}$) can be estimated using Raoult's Law and the mole fraction of *trans*-1,2-dichloroethylene in the liquid of interest.

If calculating an environmental release, the vapor generation rate calculated from one of the above models (Equation_Apx A-1, Equation_Apx A-2, Equation_Apx A-3) is then used along with an operating time to calculate the release amount:

Equation_Apx A-4.

$$Release\_Year_{activity} = Time_{activity} \times G_{activity} \times 3600 \frac{s}{hr} \times 0.001 \frac{kg}{g}$$

Where:

$Release\_Year_{activity}$	=	<i>trans</i> -1,2-Dichloroethylene released for activity per site-year (kg/site-yr)
$Time_{activity}$	=	Operating time for activity (hour/site-yr)
$G_{activity}$	=	Vapor generation rate for activity (g/s)

In addition to the vapor generation rate models, EPA uses various loss fraction models to calculate environmental releases, including the following:

- EPA/OPPT Small Container Residual Model;
- EPA/OPPT Drum Residual Model;
- EPA/OPPT Bulk Transport Residual Model;
- EPA/OPPT Multiple Process Vessel Residual Model;
- EPA/OPPT Single Process Vessel Residual Model; and
- March 2023 Methodology for Estimating Environmental Releases from Sampling Waste.

The loss fraction models apply a given loss fraction to the overall throughput of *trans*-1,2-dichloroethylene for the given process. The loss fraction value or distribution of values differs for each model; however, the models each follow the same general equation:

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Equation_Apx A-5.

$$Release\_Year_{activity} = PV \times F_{activity\_loss}$$

Where:

$$\begin{aligned}
 Release\_Year_{activity} &= \text{trans-1,2-Dichloroethylene released for activity per site-year} \\
 &\quad (\text{kg/site-yr}) \\
 PV &= \text{Production volume throughput of trans-1,2-dichloroethylene} \\
 &\quad (\text{kg/site-yr}) \\
 F_{activity\_loss} &= \text{Loss fraction for activity (unitless)}
 \end{aligned}$$

The EPA/OPPT Mass Balance Inhalation Model estimates a worker inhalation exposure to an estimated concentration of chemical vapors within the worker's breathing zone using a one box model. The model estimates the amount of chemical inhaled by a worker during an activity in which the chemical has volatilized and the airborne concentration of the chemical vapor is estimated as a function of the source vapor generation rate or the saturation level of the chemical in air. First, the applicable vapor generation rate model (see Equation_Apx A-1, Equation_Apx A-2, Equation_Apx A-3) is used to calculate the vapor generation rate for the given activity. With this vapor generation rate, the EPA/OPPT Mass Balance Inhalation Model calculates the volumetric concentration of trans-1,2-dichloroethylene using the following equation:

Equation_Apx A-6.

$$Cv_{activity} = \text{Minimum:} \left\{ \frac{\left[\frac{170,000 \times T \times G_{activity}}{MW_{t-DCE} \times Q \times k} \right]}{\left[\frac{1,000,000 \text{ ppm} \times F_{correction\_factor} \times VP}{P} \right]} \right\}$$

Where:

$$\begin{aligned}
 Cv_{activity} &= \text{Exposure activity volumetric concentration (ppm)} \\
 G_{activity} &= \text{Exposure activity vapor generation rate (g/s)} \\
 MW_{t-DCE} &= \text{trans-1,2-Dichloroethylene molecular weight (g/mol)} \\
 Q &= \text{Ventilation rate (ft}^3\text{/min)} \\
 k &= \text{Mixing factor (unitless)} \\
 T &= \text{Temperature (K)} \\
 F_{correction\_factor} &= \text{Vapor pressure correction factor (unitless)} \\
 VP &= \text{trans-1,2-Dichloroethylene vapor pressure (torr)} \\
 P &= \text{Pressure (torr)}
 \end{aligned}$$

Mass concentration can be estimated by multiplying the volumetric concentration by the molecular weight of trans-1,2-dichloroethylene and dividing by molar volume at standard temperature and pressure.

A.2 Acute, Intermediate, and Chronic 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 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.

8480 **Table Apx A-1. Parameter Values for Calculating Inhalation Exposure Estimates**

Parameter Name	Symbol	Value	Unit
Full-shift exposure duration	ED_{FS}	8, 10, 12 ^a	hour/day
Breathing rate ratio	BR	2.04	m ³ /hour
Exposure frequency	EF	167, 200, 250 ^a	days/year
Working years	WY	31 (50th percentile) 40 (95th percentile)	year
Lifetime years	LT	78	year
Chronic averaging time	AT_c	683,280	hour
Intermediate averaging time	AT_{int}	720	hour
^a Discrete and uniform distribution			

8481 **A.2.1 Exposure Duration (ED)**

8482 EPA generally uses an exposure duration of eight, ten, or twelve hours per day to estimate full-shift
8483 exposure.

8484 **A.2.2 Breathing Rate Ratio (BR)**

8485 EPA uses a breathing rate ratio, which is the ratio between the worker breathing rate and resting
8486 breathing rate, to account for the amount of air a worker breathes during exposure. The typical worker
8487 breathes about 10 m³ of air in 8 hours, or 1.25 m³/hour (CEB, 1991) while the resting breathing rate is
8488 0.6125 m³/hour (CEB, 1991). The ratio of these two values is equivalent to 2.04.

8489 **A.2.3 Exposure Frequency (EF)**

8490 EPA generally uses a maximum exposure frequency of 250 days per year based on an assumed shift
8491 duration of 8-hours/day. Since the Repackaging OES assesses 8-, 10-, and 12-hour shift durations, the
8492 exposure frequency is adjusted to be consistent with an assumed 2,000 working hours per year. This
8493 works out to be exposure frequencies of 167, 200, and 250 days per year.

8494 **A.2.4 Working Years (WY)**

8495 EPA has developed a triangular distribution for working years. EPA has defined the parameters of the
8496 triangular distribution as follows:

- 8497 • Minimum value: BLS CPS tenure data with current employer as a low-end estimate of the
8498 number of lifetime working years: 10.4 years;
- 8499 • Mode value: The 50th percentile tenure data with all employers from the Survey of Income and
8500 Program Participation (SIPP) as a mode value for the number of lifetime working years: 36
8501 years; and
- 8502 • Maximum value: The maximum average tenure data with all employers from SIPP as a high-end
8503 estimate on the number of lifetime working years: 44 years.

8504 This triangular distribution has a 50th percentile value of 31 years and a 95th percentile value of 40
8505 years. EPA uses these values for central tendency and high-end ADC and LADC calculations,
8506 respectively.
8507

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The BLS ([U.S. BLS, 2014](#)) provides information on employee tenure with *current employer* obtained from the Current Population Survey (CPS). CPS 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](#)) 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](#)). EPA acknowledges the age of the data may not be reflective of the current workforce demographics. For this Panel, lifetime tenure data are available by Census Industry Codes, which can be crosswalked with NAICS codes.

SIPP data include fields for each individual surveyed: the industry in which the surveyed individual works (TJBIND1), worker age (TAGE), and years of work experience *with all employers* over the surveyed individual's lifetime.¹⁰ 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 age 50 and older; (2) workers age 60 and older; and (3) workers of all ages employed at time of survey. EPA 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 is less than five from the analysis.

Table_Apx A-2 summarizes the average tenure for workers age 50 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 50+ Years)

Industry Sectors	Working Years			
	Average	50th Percentile	95th Percentile	Maximum
All industry sectors relevant to the 10 chemicals undergoing 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 excluded from this analysis.				

¹⁰ 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). EPA then subtracted any intervening months when not working (ETIMEOFF).

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 uses the most recent (2014) CPS data for workers aged 55 to 64 years, which indicates 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	January 2008	January 2010	January 2012	January 2014
16 years and over	4.1	4.4	4.6	4.6
16 to 17 years	0.7	0.7	0.7	0.7
18 to 19 years	0.8	1.0	0.8	0.8
20 to 24 years	1.3	1.5	1.3	1.3
25 years and over	5.1	5.2	5.4	5.5
25 to 34 years	2.7	3.1	3.2	3.0
35 to 44 years	4.9	5.1	5.3	5.2
45 to 54 years	7.6	7.8	7.8	7.9
55 to 64 years	9.9	10.0	10.3	10.4
65 years and over	10.2	9.9	10.3	10.3
Source: (U.S. BLS, 2014)				

A.2.5 Lifetime Years (LT)

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

A.3 Repackaging Model Approaches and Parameters

This appendix presents the modeling approach and equations used to estimate environmental releases and occupational exposures for *trans*-1,2-dichloroethylene during the Repackaging OES. This approach utilizes the ESD for Transport and Storage of Chemicals ([OECD, 2009b](#)) combined with Monte Carlo simulation (a type of stochastic simulation).

Based on the ESD, EPA identified the following release sources from repackaging operations:

- Release source 1: Transfer operation losses to air from emptying drum;
- Release source 2: Releases during storage (not assessed);
- Release source 3: Transfer operation losses to air from filling small containers;
- Release source 4: Open surface losses to air during drum cleaning; and
- Release source 5: Drum cleaning releases to landfill or incineration.

Environmental releases and occupational exposures for *trans*-1,2-dichloroethylene during repackaging are a function of *trans*-1,2-dichloroethylene's physical properties, container size, mass fractions, and other model parameters. Although physical properties are fixed, some model parameters are expected to vary. EPA used a Monte Carlo simulation to capture variability in the following model input parameters for environmental releases: container loss fraction, saturation factor, container volume, and air speed.

For occupational exposure, additional model parameters were ventilation rate, mixing factor, air speed, saturation factor, loss factor, and container sizes. The Agency used the outputs from a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method in @Risk to calculate release amounts and exposure concentrations for this OES.

A.3.1 Model Equations

Table_Apx A-4 provides the models and associated variables used to calculate environmental releases for each release source within each iteration of the Monte Carlo simulation. EPA used these environmental releases to develop a distribution of release outputs for the Repackaging OES. The variables used to calculate each of the following values include deterministic or variable input parameters, known constants, physical properties, conversion factors, and other parameters. The values for these variables are provided in Appendix A.3.2. The Monte Carlo simulation calculated the total *trans*-1,2-dichloroethylene (by environmental media) across all release sources during each iteration of the simulation. EPA then selected 50th and 95th percentile values to estimate the central tendency and high-end releases, respectively.

Table_Apx A-4. Models and Variables Applied for Release Sources in the Repackaging OES

Release Source	Model(s) Applied	Variables Used
Release source 1: Transfer operation losses to air from emptying drum	EPA/OAQPS AP-42 Loading Model (Appendix A.1)	Vapor Generation Rate: F_{t-DCE} ; VP ; $F_{saturation\_unloading}$; MW_{t-DCE} ; V_{import_cont} ; R ; T ; $RATE_{fill\_drum}$ Operating Time: $RATE_{fill\_drum}$
Release source 2: Releases during Storage (not assessed)	Not assessed; release is not expected to lead to significant losses to the environment unless there is an accident.	Not applicable
Release source 3: Transfer operation losses to air from filling small containers	EPA/OAQPS AP-42 Loading Model (Appendix A.1)	Vapor Generation Rate: F_{t-DCE} ; VP ; $F_{saturation\_loading}$; MW_{t-DCE} ; V_{fill_cont} ; R ; T ; $RATE_{fill\_smallcont}$ Operating Time: $RATE_{fill\_smallcont}$
Release source 4: Open surface losses to air during drum cleaning	EPA/OPPT Penetration Model or EPA/OPPT Mass Transfer Coefficient Model, based on air speed (Appendix A.1)	Vapor Generation Rate: F_{t-DCE} ; MW_{t-DCE} ; VP ; $RATE_{air\_speed}$; $D_{opening\_cont-cleaning}$; T ; P Operating Time: $RATE_{fill\_drum}$
Release source 5: Drum cleaning releases to incineration or landfill	EPA/OPPT Drum Residual Model (Appendix A.1)	PV ; F_{loss_cont}
OAQPS = EPA Office of Air Quality Planning and Standards		

Appendix A.3.6 provides equations and discussion for release source operating times used to calculate releases to air.

A.3.2 Model Input Parameters

Table_Apx A-5 summarizes the model parameters and their values for the Repackaging Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for each parameter are provided following this table.

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Table_Apx A-5. Summary of Parameter Values and Distributions Used in the Repackaging Models

Input Parameter	Symbol	Unit	Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale/Basis
			Value	Lower Bound	Upper Bound	Mode	Distribution Type	
Air Speed	$RATE_{air\_speed}$	cm/s	10	1.3	202.2	–	Lognormal	See Section A.3.7
Container Loss Fraction	F_{loss_cont}	kg/kg	0.025	0.017	0.03	0.025	Triangular	See Section A.3.8
Saturation Factor Unloading	$F_{saturation\_unloading}$	unitless	0.5	0.5	1.45	0.5	Triangular	See Section A.3.9
Saturation Factor Loading	$F_{saturation\_loading}$	unitless	0.5	0.5	1.45	0.5	Triangular	See Section A.3.10
Import Container Volume	V_{import_cont}	gal/container	20,000	10,000	20,000	20,000	Triangular	See Section A.3.11
Small Container Volume	V_{prod_cont}	gal/container	5	5	20	5	Triangular	See Section A.3.11
Number of Sites	N_s	sites	1	–	–	–	–	“What-if” scenario input
Production Volume	PV	kg/year	11,340	–	–	–	Uniform	“What-if” scenario input
Import Concentration	$F_{t-DCE\ import}$	kg/kg	1.0	–	–	–	–	Assumed pure <i>trans</i> -1,2-dichloroethylene repackaged
Temperature	T	Kelvin	298	–	–	–	–	Process parameter
Pressure	P	torr	760	–	–	–	–	Process parameter
Gas Constant	R	L*torr/mol–K	62.36367	–	–	–	–	Universal constant
<i>trans</i> -1,2-Dichloroethylene Vapor Pressure	VP	torr	331	–	–	–	–	Physical property
<i>trans</i> -1,2-Dichloroethylene Density	ρ_{t-DCE}	kg/m ³	1,256.9	–	–	–	–	Physical property
<i>trans</i> -1,2-Dichloroethylene Molecular Weight	MW_{t-DCE}	g/mol	96.94	–	–	–	–	Physical property
Fill Rate of Rail Car	$RATE_{fill\_rail}$	containers/hour	1	–	–	–	–	See Section A.3.12
Fill Rate of Drum	$RATE_{fill\_drum}$	containers/hour	20	–	–	–	–	See Section A.3.12
Fill Rate of Small Container	$RATE_{fill\_small}$	containers/hour	60	–	–	–	–	See Section A.3.12
Diameter of Opening for Container Cleaning	$D_{opening\_cont-cleaning}$	cm	7.6	–	–	–	–	See Section A.3.9

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A.3.3 Throughput Parameters

The facility production rate is calculated as an input value to be used in the model equations during each iteration. The facility production rate is calculated using the following equation:

Equation_Apx A-7.

$$PV_{site} = \frac{PV}{N_s}$$

Where:

PV	=	Production volume (kg/year)
N_s	=	Number of sites (sites)
PV_{site}	=	Facility production rate (kg/site-year)

EPA assumed that one imported container was unloaded per day, thus the number of release days in a single year is also equivalent to the number of import containers unloaded for repackaging in a single year. The equation to calculate the number of import containers is in Appendix A.3.4.

A.3.4 Number of Containers per Year

EPA assumed that facilities unloaded one imported drum in a single day for repackaging. The Agency assumes *trans*-1,2-dichloroethylene is imported in its pure form at 100% concentration. The number of import containers of *trans*-1,2-dichloroethylene used by a site per year is calculated using the following equation:

Equation_Apx A-8.

$$N_{cont\_yr} = \frac{PV}{N_s \times \rho_{t-DCE} \times \left(0.00378541 \frac{m^3}{gal}\right) \times V_{import\_cont}}$$

Where:

PV	=	Production volume (kg/year)
ρ_{t-DCE}	=	<i>trans</i> -1,2-Dichloroethylene density (kg/m ³)
V_{import_cont}	=	Import container volume (gal/container)
N_s	=	Number of sites (sites)
N_{cont_yr}	=	Annual number of import containers (container/site-year)

A.3.5 Release Days per Year

EPA calculated the number of release days in a single year using the following equation:

Equation_Apx A-9.

$$RD = \frac{PV_{site}}{\rho_{t-DCE} \times \left(0.00378541 \frac{m^3}{gal}\right) \times V_{import\_cont}}$$

Where:

RD	=	Release days or Number of import containers (days/site-yr or containers/site-yr)
ρ_{t-DCE}	=	<i>trans</i> -1,2-Dichloroethylene density (kg/m ³)
V_{import_cont}	=	Import container volume (gal/container)

As described in Appendix A.3.4, EPA assumed that the number of import containers unloaded in a

single operating day was one. Therefore, the number of release days is equivalent to the number of import containers, with a range of 24 to 119.

A.3.6 Operating Hours and Exposure Durations

EPA estimated operating hours and exposure durations using calculations and parameters provided by the ESD on Transport and Storage of Chemicals ([OECD, 2009b](#)) and *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)). The operating time for release and exposure activities associated with unloading (release source 1 and 4; exposure points A and C) are calculated using the following equation:

Equation_Apx A-10.

$$Time_{RP1/RP4} = \frac{1}{RATE_{fill\_drum}}$$

Where:

$$\begin{aligned} Time_{RP1/RP4} &= \text{Operating time for release sources 1 and 4 (hour/container)} \\ RATE_{fill\_drum} &= \text{Fill rate of drum (containers/hour)} \end{aligned}$$

For the emptying of drums, the *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)) indicates a drum fill rate of 20 drums per hour based on the Chemical Engineering Branch Manual for the Preparation of Engineering Assessments, Volume 1 ([CEB, 1991](#)). EPA assumed that one drum is imported and repackaged in a single operating day; therefore, equating the number of import containers received in a single year to the number of release days per year. For the cleaning of drums, the *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)) uses the same drum fill rate as emptying drums to estimate an exposure duration. EPA did not identify any other information on drum fill rates; therefore, the Agency used a single deterministic value for fill rate.

The operating hours for both release source 3 and exposure point B is calculated using the following equation:

Equation_Apx A-11.

$$Time_{RP3} = \frac{V_{import\_cont}}{V_{fill\_cont} \times Rate_{fill\_smallcont} \times RD}$$

Where:

$$\begin{aligned} Time_{RP3} &= \text{Operating time for release source 3 (h/site-day)} \\ V_{import\_cont} &= \text{Import container volume (gal/container)} \\ V_{fill\_cont} &= \text{Small container volume (gal/container)} \\ RATE_{fill\_smallcont} &= \text{Fill rate of small container (containers/hour)} \\ RD &= \text{Release days or number of import containers (days/site-yr or containers/site-yr)} \end{aligned}$$

For filling small containers, see Appendix A.3.11 for details on the distribution of small container volume and Appendix A.3.12 for details on the small container fill rate. Generally, EPA calculated the duration of filling small containers using the container volume and fill rate from the *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)). The calculated small container fill duration was used for both the release source (operating hours rate for release source 3) and exposure point (exposure duration for exposure point B).

A.3.7 Air Speed

Baldwin and Maynard ([1998](#)) measured indoor air speeds across a variety of occupational settings in the

United Kingdom, specifically, 55 work areas were surveyed. EPA analyzed the air speed data from Baldwin and Maynard and categorized the air speed surveys into settings representative of industrial facilities and representative of commercial facilities. The Agency fit separate distributions for these industrial and commercial settings and used the industrial distribution for this OES.

EPA fit a lognormal distribution for the dataset as consistent with the authors' observations that the air speed measurements within a surveyed location were lognormally distributed and the population of the mean air speeds among all surveys were lognormally distributed ([Baldwin and Maynard, 1998](#)). Because lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the largest observed value among all of the survey mean air speeds.

EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model, the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard ([1998](#))) to prevent the model from sampling values that approach infinity or are otherwise unrealistically small or large ([Baldwin and Maynard, 1998](#)).

Baldwin and Maynard ([1998](#)) only presented the mean air speed of each survey. The authors did not present the individual measurements within each survey. Therefore, these distributions represent a distribution of mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting. However, a mean air speed (averaged over a work area) is the required input for the model. EPA converted the units to ft/min prior to use within the model equations.

A.3.8 Container Residue Loss Fraction

EPA previously contracted PEI Associates, Inc. (PEI) to conduct a study for providing estimates of potential chemical releases during cleaning of process equipment and shipping containers ([PEI Associates, 1988](#)). The study used both a literature review (analyzing cleaning practices and release data) and a pilot-scale experiment to determine the amount of residual material left in vessels. The data from literature and pilot-scale experiments addressed different conditions for the emptying of containers and tanks, including various bulk liquid materials, different container constructions (e.g., lined steel drums or plastic drums), and either a pump or pour/gravity-drain method for emptying. EPA reviewed the pilot-scale data from PEI and determined a range and average percentage of residual material remaining in vessels following emptying from drums by either pumping or pouring as well as tanks by gravity-drain ([PEI Associates, 1988](#)).

EPA previously used the study results to generate default central tendency and high-end loss fraction values for the residual models (e.g., EPA/OPPT Small Container Residual Model, EPA/OPPT Drum Residual Model) provided in the *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)). The Agency used a combination of the PEI study results and that user guide default loss fraction values to develop probability distributions for various container sizes.

Specifically, EPA paired the data from the PEI study such that the residuals data for emptying drums by pouring was aligned with the default central tendency and high-end values from the EPA/OPPT Small Container Residual Model, and the residuals data for emptying drums by pumping was aligned with the default central tendency and high-end values from the EPA/OPPT Drum Residual Model. The Agency applied the EPA/OPPT Small Container Residual Model to containers with capacities less than 20 gallons, and the EPA/OPPT Drum Residual Model to containers with capacities between 20 and 100 gallons ([U.S. EPA, 2015a](#)).

For unloading drums via pouring, the PEI study experiments showed average container residuals in the range of 0.03 to 0.79% with a total average of 0.32% (PEI Associates, 1988). The EPA/OPPT Small Container Residual Model recommends a default central tendency loss fraction of 0.3% and a high-end loss fraction of 0.6% (U.S. EPA, 2015a). For unloading drums by pumping, the PEI study experiments showed average container residuals with the dip pipe at the bottom in the range of 1.7% to 4.7% with a total average of 2.6% (PEI Associates, 1988).

The EPA/OPPT Drum Residual Model from the *ChemSTEER User Guide* recommends a default central tendency loss fraction of 2.5% and a high-end loss fraction of 3.0% (U.S. EPA, 2015a). The underlying distribution of the loss fraction parameter for small containers or drums is not known; therefore, the Agency assigned a triangular distribution defined by the estimated lower bound, upper bound, and mode of the parameter values. The Agency assigned the mode and upper-bound values for the loss fraction triangular distributions using the central tendency and high-end values from the respective *ChemSTEER User Guide* (U.S. EPA, 2015a). EPA assigned the lower-bound values for the triangular distributions using the minimum average percent residual measured in the PEI study for the respective drum emptying technique (pouring or pumping) (PEI Associates, 1988).

A.3.9 Diameters of Opening

The *ChemSTEER User Guide* indicates diameters for the openings for various vessels that may hold liquids in order to calculate vapor generation rates during different activities (U.S. EPA, 2015a). In the simulation developed for the Repackaging OES based on the ESD for Transport and Storage of Chemicals (OECD, 2009b), EPA used the default diameters of vessels from the *ChemSTEER User Guide* (U.S. EPA, 2015a) for container cleaning.

For container cleaning activities, the *ChemSTEER User Guide* indicates a single default value of 5.08 cm (U.S. EPA, 2015a). Therefore, EPA could not develop a distribution of values for this parameter and used the single value 5.08 cm from that user guide.

A.3.10 Saturation Factor

The Chemical Engineering Branch Manual for the Preparation of Engineering Assessments, Volume 1 ("CEB Manual") indicates that during splash filling (which occurs when liquid is poured into a container with splashing that induces volatilization depending on the saturation factor), the saturation concentration was reached or exceeded by misting with a maximum saturation factor of 1.45 (CEB, 1991). The CEB Manual indicates that saturation concentration for bottom filling was expected to be about 0.5 (CEB, 1991). The underlying distribution of this parameter is not known; therefore, the Agency assigned a triangular distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was not provided for this parameter, EPA also assigned a mode value of 0.5 for bottom filling as bottom filling minimizes volatilization (CEB, 1991). This value also corresponds to the typical value provided in the *ChemSTEER User Guide* for the EPA/OAQPS AP-42 Loading Model (U.S. EPA, 2015a).

A.3.11 Container Size

The *ChemSTEER User Guide* (U.S. EPA, 2015a) indicates a range of 20 to less than 100 gallons for the volume capacity of drums modeled in container-related activities, and the ESD for Transport and Storage of Chemicals (OECD, 2009b) suggests nearly 80% of all steel drums in the United States have a capacity of 55 gallons. The underlying distribution for import drum sizes is not known; therefore, the Agency assigned a lower bound of 20 gallons, an upper bound of 100 gallons, and a mode of 55 gallons for the import container volume distribution. The User Guide (U.S. EPA, 2015a) indicates a range of 5 to less than 20 gallons for the volume capacity of small containers modeled in container-related

activities with 5 gallons as the default volume size. Therefore, EPA assigned a lower bound of 5 gallons, an upper bound of 20 gallons, and a mode of 5 gallons for the small container volume distribution.

A.3.12 Container Fill Rates

The *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)) provides a typical fill rate of 20 containers per hour for containers with 20 to 100 gallons of liquid and a typical fill rate of 60 containers per hour for containers with less than 20 gallons of liquid.

A.4 Vapor Degreasing Model Approaches and Parameters

This appendix presents the modeling approach and equations used to estimate environmental releases and occupational exposures for *trans*-1,2-dichloroethylene during the Industrial and Commercial Non-Aerosol Cleaning/Degreasing OES. The release approach utilizes the ESD on the Use of Vapour Degreasers ([OECD, 2017](#)) combined with Monte Carlo simulation (a type of stochastic simulation).

Based on the ESD, EPA identified the following release sources from vapor degreasing operations:

- Release source 1: Transfer operation losses to fugitive or stack air from unloading transport containers;
- Release source 2: Container residue releases to wastewater treatment, incineration, or landfill;
- Release source 3: Vapor degreasing operations to fugitive or stack air;
- Release source 4: Equipment cleaning and waste solvent disposal to incineration; and
- Release source 5: Vapor degreasing wastewater to wastewater treatment.

An individual model input parameter could either have a discrete value or a distribution of values. EPA assigned statistical distributions based on available literature data. A Monte Carlo simulation (a type of stochastic simulation) was conducted to capture variability in the model input parameters. The simulation was conducted using the Latin hypercube sampling method in @Risk Industrial Edition, Version 7.0.0. The Latin hypercube sampling method is a statistical method for generating a sample of possible values from a multi-dimensional distribution. Latin hypercube sampling is a stratified method, meaning it guarantees that its generated samples are representative of the probability density function (variability) defined in the model. EPA performed the model at 100,000 iterations to capture the range of possible input values (*i.e.*, including values with low probability of occurrence).

Model results from the Monte Carlo simulation are presented as 95th and 50th percentile values. The statistics were calculated directly in @Risk. The 95th percentile value was selected to represent high-end release and exposure levels, whereas the 50th percentile value was selected to represent typical release and exposure levels. The following subsections detail the model design equations and parameters for the Vapor Degreasing OES.

A.4.1 Model Equations

Table_Apx A-6 provides the models and associated variables used to calculate environmental releases for each release source within each iteration of the Monte Carlo simulation. EPA used these environmental releases to develop a distribution of release outputs for the Vapor Degreasing OES. The variables used to calculate each of the following values include deterministic or variable input parameters. The values for these variables are provided in Appendix A.4.2. The Monte Carlo simulation calculated the total *trans*-1,2-dichloroethylene release (by environmental media) across all release sources during each iteration of the simulation. EPA then selected 50th and 95th percentile values to estimate the central tendency and high-end releases, respectively.

8815 **Table_Apx A-6. Models and Variables Applied for Release Sources in the Vapor Degreasing OES**

Release Source	Model(s) Applied	Variables Used
Release source 1: Transfer operation losses to air from unloading transport containers	EPA/OAQPS AP-42 Loading Model (Appendix A.1)	Vapor Generation Rate: F_{t-DCE} ; VP ; $F_{saturation\_unloading}$; MW_{t-DCE} ; Q_{cont} ; R ; T ; $RATE_{fill\_smallcont}$ Operating Time: $RATE_{fill\_smallcont}$; $N_{cont\_unload\_yr}$; OP_{days}
Release source 2: Container residue releases	EPA/OPPT Drum Residual Model (Appendix A.1)	V_{drum} ; F_{drum_disp}
Release source 3: Vapor degreasing operations	Equation_Apx A-12	$Q_{chem\_site\_day (recalc)}$; LF_{air}
Release source 4: Equipment cleaning and waste solvent disposal	Equation_Apx A-13	$Q_{chem\_site\_day (recalc)}$; $N_{container\_unload\_site\_yr}$; $FT_{changeout}$
Release source 5: Vapor degreasing wastewater	Equation_Apx A-14	WS_{chem} ; CF ; $V_{wastewater}$
OAQPS = EPA Office of Air Quality Planning and Standards		

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8817 **Equation_Apx A-12.**

$$Elocal_{evap} = Q_{chem\_site\_day} \times LF_{air} \times (1 - EF_{control})$$

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8820 Where:

8821 $Elocal_{evap}$	=	Daily release of chemical to air due to evaporative losses (kg/site-day)
8822 $Q_{chem\_site\_day}$	=	Daily use rate of chemical of interest (kg/site-day)
8823 LF_{air}	=	Fraction of chemical evaporated to air (unitless)
8824 $EF_{control}$	=	Engineering control efficiency (unitless)

8825
8826
8827 **Equation_Apx A-13.**

$$Elocal_{incin} = \frac{Q_{chem\_site\_yr} - \{(Elocal_{air} + Elocal_{container\_residue}) \times N_{container\_unload\_site\_yr}\} - \{(Elocal_{evap} + Elocal_{wastewater}) \times TIME_{operating\_days}\}}{FT_{changeout}}$$

8828
8829
8830 Where:

8831 $Elocal_{incin}$	=	Daily release of chemical to incineration (kg/site-day)
8832 $Q_{chem\_site\_yr}$	=	Annual use rate of chemical of interest (kg/site-yr)
8833 $Elocal_{air}$	=	Daily release of chemical to air from container unloading (kg/site-day)
8834 $Elocal_{container\_residue}$	=	Daily release of chemical to air from container residue (kg/site-day)
8835 $N_{container\_unload\_site\_yr}$	=	Number of transport containers unloaded at each site per year (containers/site-yr)
8836 $Elocal_{evap}$	=	Daily release of chemical to air due to evaporative losses during degreaser operation (kg/site-day)
8837 $Elocal_{wastewater}$	=	Daily release of chemical from wastewater (kg/site-day)
8838 $TIME_{operating\_days}$	=	Number of operating days (days/year)

$FT_{changeout}$ = Frequency of solvent changeout (days/year)

Equation_Apx A-14.

$$Elocal_{wastewater} = WS_{chem} \times CF \times V_{wastewater} \times \frac{3.785 L}{gal} \times \frac{kg}{1000 grams}$$

Where:

$Elocal_{wastewater}$ = Daily release of chemical from wastewater (kg/site-day)

WS_{chem} = Water solubility of the vapour degreasing chemical of interest (g/L)

CF = A factor to account for any variability, such as a known or estimated correction of the water solubility of the chemical or other corrections (unitless)

$V_{wastewater}$ = Daily volume of wastewater discharged (gal/day)

A.4.2 Model Input Parameters

Table_Apx A-7 summarizes the model parameters and their values for the vapor degreasing chemical Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for each parameter are provided following this table.

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Table_Apx A-7. Summary of Parameter Values and Distributions Used in the Vapor Degreasing Release Model

Input Parameter	Symbol	Unit	Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale/Basis
				Lower Bound	Upper Bound	Mode	Distribution Type	
Operating Days	$TIME_{operating\_days}$	days/yr	296	258	365	296	Triangular	See Appendix A.4.3
Concentration of <i>trans</i> -1,2-dichloroethylene	F_{chem}	unitless	1	Multiple distributions depending on product data			Uniform	See Appendix A.4.4
Solvent Annual Use Rate	$Q_{solv\_site\_yr}$	kg/site-yr	2,083	78	79,120	—	Beta	See Appendix A.4.5
Drum Volume	V_{drum}	gal	55	20	100	55	Triangular	See Appendix A.4.9
Fill Rate of Drums	$RATE_{fill\_drum}$	containers/hour	20	—	—	—	—	
Saturation Factor During Unloading	$F_{saturation\_unloading}$	unitless	0.5	0.5	1.45	0.5	Triangular	See Appendix A.4.12
Loss Fraction for Vapor Degreaser	LF_{air}	kg/kg	0.81	0.0084	1	0.81	Triangular	See Appendix A.4.13
Fraction of Solvent Residue in Drum	F_{drum_disp}	kg/kg	0.025	0.017	0.03	0.025	Triangular	See Appendix A.4.14
Wastewater Loss Fraction	$LF_{wastewater}$	kg/kg	0.057	0.0057	0.057	—	Uniform	See Appendix A.4.15
Production Volume	PV	kg/yr	182,640	—	—	—	Uniform	“What-if” scenario input
Temperature	T	K	298	—	—	—	—	Process parameter
Pressure (torr)	P_{torr}	torr	760	—	—	—	—	Process parameter
Pressure (atm)	P_{atm}	Atm	1	—	—	—	—	Process parameter
Gas Constant	R	L•torr/mol-K	62.36367	—	—	—	—	Universal constant
<i>trans</i> -1,2-dichloroethylene Vapor Pressure	VP	torr	331	—	—	—	—	Physical property
<i>trans</i> -1,2-dichloroethylene Molecular Weight	MW_{t-DCE}	g/mol	96.94	—	—	—	—	Physical property
Frequency of Solvent Changeout	$FT_{changeout}$	days/yr	26	—	—	—	—	See Appendix A.4.16
Correction Factor	CF	kg/kg	1	—	—	—	—	See Appendix A.4.17
Daily Volume of Wastewater Discharged	$V_{wastewater}$	Gal/day	2	—	—	—	—	See Appendix A.4.18
Water Solubility	WS_{chem}	g/L	5.3	—	—	—	—	Physical property

A.4.3 Operating Days

The ESD on the Use of Vapor Degreasers ([U.S. EPA, 2023c](#); [OECD, 2017](#)), estimates the number of operating days from employment data obtained through the 2017 NEI. The ESD suggests 259 to 364 days/year with a mode of 296 days/year. For the purpose of building the model distribution, 258 to 365 days/year were used, but they were assigned a probability of zero. The effective range in the simulation is 259 to 364 days/year.

A.4.4 Concentration of *trans*-1,2-Dichloroethylene

EPA used a two-dimensional sampling technique to model the *trans*-1,2-dichloroethylene weight fraction. A discrete distribution is used to model the frequency of occurrence of each product type. For each product, the concentration of *trans*-1,2-dichloroethylene was reported as a range. EPA used a uniform distribution to model the *trans*-1,2-dichloroethylene weight fraction within each product type. On each iteration of the simulation, the model executes each product's weight fraction distribution and the product frequency distribution. The model then reads the product selected from the product frequency distribution and selects the weight fraction that was generated from the corresponding product's weight fraction distribution. Table_Apx A-8 provides a summary of the reported *trans*-1,2-dichloroethylene content reported in the SDSs and the fractional probability of each product type.

Table_Apx A-8. Summary of *trans*-1,2-Dichloroethylene-Based Solvent Formulations

Product Name	<i>trans</i> -1,2-Dichloroethylene Concentration		Fractional Probability
	Low-End	High-End	
3M™ Novec™ 71DE Engineered Fluid	50%	50%	0.0135
3M™ Novec™ 71DA Engineered Fluid	44.6%	44.6%	0.0135
3M™ Novec™ 72DE Engineered Fluid	68%	72%	0.0135
3M™ Novec™ 72DA Engineered Fluid	68%	68%	0.0135
3M™ Novec™ 73DE Engineered Fluid	84%	86%	0.0135
3M™ Novec™ 72FL Engineered Fluid	≤20%	≤20%	0.0135
3M™ Novec™ 71D90 Engineered Fluid	90%	90%	0.0135
PWR-4 Flux Remover	90%	100%	0.0135
PWR-4 Industrial Maintenance Cleaner	90%	100%	0.0135
PWR-4 Solvent 3410	90%	100%	0.0135
Precision-V Solvent 371DA	25%	50%	0.0135
Precision-V Solvent 371DE	25%	50%	0.0135
Precision-V Solvent 3820	25%	50%	0.0135
Precision-V Solvent 372DA	50.0%	75.0%	0.0135
Precision-V Solvent 372DE	50.0%	75.0%	0.0135
Precision-V Solvent 373DE	84.0%	86.0%	0.0135
PWR-4 Solvent 3910	90%	100%	0.0135
Electro-Wash Tri-V Degreaser	90%	100%	0.0135
EnSolv Plus	75.0%	100.0%	0.0135
ETI 71DA	1.0%	43.0%	0.0135
ETI 71DE	45.0%	100.0%	0.0135
ETI 73DE	60.0%	100.0%	0.0135
NEXT HD Pro 43A	40.0%	40.0%	0.0135

Product Name	<i>trans</i> -1,2-Dichloroethylene Concentration		Fractional Probability
	Low-End	High-End	
NEXT HD Pro 43	40.0%	50.0%	0.0135
NEXT HD Pro 70A	1.0%	75.0%	0.0135
NEXT HD Pro 70	65.0%	100.0%	0.0135
NEXT HD Pro A	70.0%	90.0%	0.0135
NEXT HD Pro M	75.0%	100.0%	0.0135
NEXT HD Pro	70.0%	90.0%	0.0135
PROMOSOLVTM 70	70.0%	70.0%	0.0135
Fluosolv 5408	85.0%	99.0%	0.0135
FluoSolv 71DE	25.0%	50.0%	0.0135
FluoSolv HT-G20 (Non-PFAS)	65.0%	100.0%	0.0135
FluoSolv NPX	40.0%	65.0%	0.0135
Vertrel™ MCA specialty fluid	30.0%	60.0%	0.0135
Vertrel™ SDG specialty fluid	80.0%	100.0%	0.0135
Vertrel™ SFR specialty fluid	60.0%	80.0%	0.0135
Vertrel™ SMT specialty fluid	30.0%	60.0%	0.0135
Vertrel™ X-DF specialty fluid	30.0%	60.0%	0.0135
Opteon™ SF79 Specialty fluid	90.0%	100.0%	0.0135
Novec 71DA	42.0%	46.0%	0.0135
Novec 71DE	49.0%	51.0%	0.0135
Novec 72DA	66.0%	70.0%	0.0135
Novec 72DE	68.0%	72.0%	0.0135
Novec 73DE	60.0%	90.0%	0.0135
Vertrel MCA Plus	30.0%	60.0%	0.0135
Vertrel SDG Select	80.0%	100.0%	0.0135
Vertrel S-DF	80.0%	100.0%	0.0135
Vertrel XMS Plus	30.0%	60.0%	0.0135
Opteon Sion	80.0%	100.0%	0.0135
Opteon SF30	10.0%	30.0%	0.0135
Opteon SF80	80.0%	100.0%	0.0135
PROMOSOLVTM DE4	40.0%	70.0%	0.0135
PROMOSOLVTM NEO B1	50.0%	80.0%	0.0135
71DA Engineered Fluid	50.0%	100.0%	0.0135
71DE Engineered Fluid	50.0%	100.0%	0.0135
72DA Engineered Fluid	50.0%	100.0%	0.0135
72DE Engineered Fluid	50.0%	100.0%	0.0135
73DE Engineered Fluid	50.0%	100.0%	0.0135
Synthetic Grease Cleaner	60.0%	100.0%	0.0135
HDS Heavy Duty Degreasing Solvent	50.0%	100.0%	0.0135
SMT	25.0%	50.0%	0.0135
Tergo CCA Broad Range Degreasing Fluid	50.0%	100.0%	0.0135

Product Name	<i>trans</i> -1,2-Dichloroethylene Concentration		Fractional Probability
	Low-End	High-End	
Tergo High Performance Flux Remover – Rinse	25.0%	50.0%	0.0135
Tergo General Cleaning Fluid	50.0%	100.0%	0.0135
Tergo Heavy Degreasing Fluid	50.0%	100.0%	0.0135
Tergo Metal Cleaning Fluid Booster	25.0%	50.0%	0.0135
Tergo Metal Cleaning Fluid	50.0%	100.0%	0.0135
Tergo SFR	50.0%	100.0%	0.0135
Tergo XCF2	50.0%	100.0%	0.0135
Tergo XCF3	50.0%	100.0%	0.0135
Tergo HDF Booster Premix	25.0%	50.0%	0.0135
Tergo High Performance Flux Remover 2 – Additive	2.5%	5.0%	0.0135
Tergo High Performance Flux Remover 2	50.0%	100.0%	0.0135
Aerotron AV	85.0%	100.0%	0.0135

A.4.5 Solvent Annual Use Rate

The ESD on the Use of Vapor Degreasers ([U.S. EPA, 2023c](#); [OECD, 2017](#)) compiles data on annual machine-level solvent use rates ($Q_{\text{solvent\_site\_yr}}$). For the Post-MACT (Maximum Achievable Control Technology) scenario, the ESD estimates 78 to 79,120 kg solvent/year, with a 50th percentile value of 2,083 kg solvent/year. EPA fit a beta distribution with a minimum of 78 kg/site-yr to a maximum of 79,120 kg/site-yr (with $\alpha_1 = 0.49815$ and $\alpha_2 = 9.5451$).

A.4.6 *trans*-1,2-Dichloroethylene Annual Use Rate

Daily use rate of *trans*-1,2-dichloroethylene can be calculated using the annual solvent rate and the concentration of *trans*-1,2-dichloroethylene in the solvent, per Equation_Apx A-15:

Equation_Apx A-15.

$$Q_{\text{chem\_site\_yr}} = Q_{\text{solvent\_site\_yr}} \times F_{\text{chem}}$$

Where:

$Q_{\text{chem\_site\_yr}}$	=	Annual use rate of <i>trans</i> -1,2-dichloroethylene (kg/site-yr)
$Q_{\text{solvent\_site\_yr}}$	=	Annual machine-level solvent use rates (kg solvent/site-yr)
F_{chem}	=	Weight fraction of <i>trans</i> -1,2-dichloroethylene in the formulation as received (kg/kg)

A.4.7 Daily Use Rate of *trans*-1,2-Dichloroethylene

Daily use rate of *trans*-1,2-dichloroethylene can be calculated using the annual *trans*-1,2-dichloroethylene rate and the number of operating days per year:

Equation_Apx A-16.

$$Q_{\text{chem\_site\_day}} = \frac{Q_{\text{chem\_site\_yr}}}{\text{TIME}_{\text{operating\_days}}}$$

Where:

$Q_{\text{chem\_site\_day}}$	=	Daily use rate of <i>trans</i> -1,2-dichloroethylene (kg/site-day)
$Q_{\text{chem\_site\_yr}}$	=	Annual use rate of <i>trans</i> -1,2-dichloroethylene (kg/site-yr)
$\text{TIME}_{\text{operating\_days}}$	=	Number of operating days for the degreasing machine (days/yr)

A.4.8 Number of Sites

The ESD on the Use of Vapor Degreasers ([OECD, 2017](#)) provides a method of determining the number of sites based on the total annual production volume and annual throughput per site of the solvent. The number of facilities using the chemical of interest (N_{sites}) depends on the total annual production of the chemical of interest ($Q_{\text{solv\_site\_yr}}$), the daily use rate of the chemical of interest ($Q_{\text{solv\_site\_day}}$), and the annual operating days ($\text{TIME}_{\text{operating\_days}}$). Equation_Apx A-17 demonstrates how the number of facilities performing vapor degreasing operations using a chemical of interest could be determined.

Equation_Apx A-17.

$$N_{\text{sites}} = \frac{Q_{\text{solv\_site\_yr}}}{Q_{\text{solv\_site\_day}} \times \text{TIME}_{\text{operating\_days}}}$$

Where:

N_{sites}^{11}	=	Number of sites using the vapor degreasing chemical (sites)
$Q_{\text{solv\_site\_yr}}$	=	Annual production volume of vapor degreasing chemical (kg solvent/yr)
$Q_{\text{solv\_site\_day}}$	=	Daily use rate of vapor degreasing chemical (kg solvent/site-day)
$\text{TIME}_{\text{operating\_days}}$	=	Number of operating days for degreasing machines (days/site-yr)

A.4.9 Drum Volume

The ESD on the Use of Vapor Degreasers ([U.S. EPA, 2023c](#)) recommends assuming 55-gallon drums for transport of vapor degreasing solvent.

A.4.10 Number of Containers Unloaded Annually per Site

The number of containers unloaded at each site annually can be estimated using Equation_Apx A-18:

Equation_Apx A-18.

$$N_{\text{container\_unload\_site\_yr}} = \frac{Q_{\text{chem\_site\_day}} \times \text{TIME}_{\text{operating\_days}}}{F_{\text{chem}} \times V_{\text{container}} \times \rho_{\text{formulation}} \times 3.785 \frac{\text{L}}{\text{gal}}}$$

Where:

$N_{\text{container\_unload\_site\_yr}}$	=	Number of transport containers unloaded at each site per year (containers/site-yr)
$Q_{\text{chem\_site\_day}}$	=	Daily use rate of <i>trans</i> -1,2-dichloroethylene (kg/site-day)
$\text{TIME}_{\text{operating\_days}}$	=	Number of operating days (days/yr)

¹¹ The value for N_{sites} should be rounded up to the nearest integer value. $Q_{\text{chem\_site\_day}}$ should then be adjusted for the N_{sites} integer value (to avoid errors due to rounding) as follows:

$$Q_{\text{chem\_site\_day}} = \frac{Q_{\text{chem\_yr}}}{N_{\text{sites}} \times \text{TIME}_{\text{operating\_days}}}$$

F_{chem}	=	Weight fraction of <i>trans</i> -1,2-dichloroethylene in the formulation as received (kg/kg)
$V_{\text{container}}$	=	Volume of transport container (gal)
$\rho_{\text{formulation}}$	=	Density of chemical formulation (kg/L formulation)

A.4.11 Container Fill Rates

The *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)) provides a typical fill rate of 60 containers per hour for containers with less than 20 gallons of liquid.

A.4.12 Saturation Factor During Unloading

The CEB Manual indicates that during splash filling, the saturation concentration was reached or exceeded by misting with a maximum saturation factor of 1.45 ([CEB, 1991](#)). The Manual indicates that saturation concentration for bottom filling was expected to be about 0.5 ([CEB, 1991](#)). The underlying distribution of this parameter is not known; therefore, the Agency assigned a triangular distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was not provided for this parameter, the Agency assigned a mode value of 0.5 for bottom filling as bottom filling minimizes volatilization ([CEB, 1991](#)). This value also corresponds to the typical value provided in the *ChemSTEER User Guide* for the EPA/OAQPS AP-42 Loading Model ([U.S. EPA, 2015a](#)).

A.4.13 Loss Fraction for Vapor Degreaser

The ESD on the Use of Vapor Degreasers ([U.S. EPA, 2023c](#)) estimates solvent loss fractions of 0.0084 to 1.0, with a default central tendency of 0.81.

A.4.14 Fraction of Residue in Drum

EPA previously contracted for a study for providing estimates of potential chemical releases during cleaning of process equipment and shipping containers ([PEI Associates, 1988](#)). The study used both a literature review (analyzing cleaning practices and release data) and a pilot-scale experiment to determine the amount of residual material left in vessels. The data from literature and pilot-scale experiments addressed different conditions for the emptying of containers and tanks, including various bulk liquid materials, different container constructions (e.g., lined steel drums or plastic drums), and either a pump or pour/gravity-drain method for emptying. EPA reviewed the pilot-scale data from PEI and determined a range and average percentage of residual material remaining in vessels following emptying from drums by either pumping or pouring as well as tanks by gravity-drain ([PEI Associates, 1988](#)).

EPA previously used the study results to generate default central tendency and high-end loss fraction values for the residual models (e.g., EPA/OPPT Small Container Residual Model, EPA/OPPT Drum Residual Model) provided in the *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)). The Agency used a combination of the PEI study results and the User Guide default loss fraction values to develop probability distributions for various container sizes.

Specifically, EPA paired the data from the PEI study such that the residuals data for emptying drums by pouring was aligned with the default central tendency and high-end values from the EPA/OPPT Small Container Residual Model, and the residuals data for emptying drums by pumping was aligned with the default central tendency and high-end values from the EPA/OPPT Drum Residual Model. The Agency applied the EPA/OPPT Small Container Residual Model to containers with capacities less than 20 gallons, and the EPA/OPPT Drum Residual Model to containers with capacities between 20 and 100 gallons ([U.S. EPA, 2015a](#)).

For unloading drums via pouring, the PEI study experiments showed average container residuals in the range of 0.03 to 0.79% with a total average of 0.32% (PEI Associates, 1988). The EPA/OPPT Small Container Residual Model recommends a default central tendency loss fraction of 0.3% and a high-end loss fraction of 0.6% (U.S. EPA, 2015a). For unloading drums by pumping, the PEI study experiments showed average container residuals in the range of 1.7 to 4.7% with a total average of 2.6% and indicated that the dip pipe was on the bottom (PEI Associates, 1988).

The EPA/OPPT Drum Residual Model from the *ChemSTEER User Guide* recommends a default central tendency loss fraction of 2.5% and a high-end loss fraction of 3.0% (U.S. EPA, 2015a). The underlying distribution of the loss fraction parameter for small containers or drums is not known; therefore, the Agency assigned a triangular distribution defined by the estimated lower bound, upper bound, and mode of the parameter values. The Agency assigned the mode and upper bound values for the loss fraction triangular distributions using the central tendency and high-end values from the respective *ChemSTEER User Guide* model (U.S. EPA, 2015a). EPA assigned the lower bound values for the triangular distributions using the minimum average percent residual measured in the PEI study for the respective drum emptying technique (pouring or pumping) (PEI Associates, 1988).

A.4.15 Wastewater Loss Fraction

The ESD on the Use of Vapor Degreasers (U.S. EPA, 2023c) states that the default daily throughput of vapor degreasing chemicals is 7.04 kg/site-day. Using the range of 2 to 20 gallons of wastewater discharged per day, and the water solubility of *trans*-1,2-dichloroethylene, the daily release would be 0.04 to 0.4 kg *trans*-1,2-dichloroethylene/site day. This results in a loss fraction of 5.7×10^{-3} to 5.7×10^{-2} kg *trans*-1,2-dichloroethylene lost/kg *trans*-1,2-dichloroethylene used.

A.4.16 Frequency of Solvent Changeout

The ESD on the Use of Vapor Degreasers (U.S. EPA, 2023c) estimates that dirty solvent will be changed out once every 2 weeks, or 26 times per year.

A.4.17 Correction Factor

The ESD on the Use of Vapor Degreasers (U.S. EPA, 2023c) applies a correction factor (CF) to account for any variability, such as a known or estimated correction of the water solubility of the chemical or other corrections. The default correction factor is 1.

A.4.18 Daily Volume of Wastewater Discharged

The ESD on the Use of Vapor Degreasers (U.S. EPA, 2023c) estimates that the range of wastewater discharged is 2 to 20 gallons per day.

A.5 Aerosol Degreasing Model Approaches and Parameters

This appendix presents the modeling approach and model equations used in the Aerosol Degreasing release Model. The release model uses data from CARB to estimate 1,2-dichloroethane use rates; 100% of the sprayed *trans*-1,2-dichloroethylene is expected to be released to air.

The model uses the following parameters to estimate degreaser use rates:

- Concentration of *trans*-1,2-dichloroethylene in the aerosol formulation;
- Amount of degreaser used per brake job;
- Number of degreaser applications per brake job;
- Time duration of brake job;
- Operating hours per week; and

- Number of jobs per work shift.

An individual model input parameter could either have a discrete value or a distribution of values. EPA assigned statistical distributions based on available literature data. A Monte Carlo simulation (a type of stochastic simulation) was conducted to capture variability in the model input parameters. The simulation was conducted using the Latin hypercube sampling method in [@Risk](#) Industrial Edition, Version 7.0.0. The Latin hypercube sampling method is a statistical method for generating a sample of possible values from a multi-dimensional distribution. Latin hypercube sampling is a stratified method, meaning it guarantees that its generated samples are representative of the probability density function (variability) defined in the model. EPA performed the model at 100,000 iterations to capture the range of possible input values (*i.e.*, including values with low probability of occurrence).

Model results from the Monte Carlo simulation are presented as 95th and 50th percentile values. The statistics were calculated directly in [@Risk](#). The 95th percentile value was selected to represent high-end exposure level, whereas the 50th percentile value was selected to represent central tendency exposure level. The following subsections detail the model design equations and parameters for the brake servicing model.

A.5.1 Model Design Equations

In brake servicing, the vehicle is raised on an automobile lift to a comfortable working height to allow the worker (mechanic) to remove the wheel and access the brake system. Brake servicing can include inspections, adjustments, brake pad replacements, and rotor resurfacing. These service types often involve disassembly, replacement or repair, and reassembly of the brake system. Automotive brake cleaners are used to remove oil, grease, brake fluid, brake pad dust, or dirt. Mechanics may occasionally use brake cleaners, engine degreasers, carburetor cleaners, and general purpose degreasers interchangeably ([CARB, 2000](#)). Automotive brake cleaners can come in aerosol or liquid form ([CARB, 2000](#)): this model estimates exposures from aerosol brake cleaners (degreasers).

Based on data from CARB ([2000](#)), EPA assumes each brake job requires one 14.4-ounce can of aerosol brake cleaner as described in further detail below. The model determines the application rate of *trans*-1,2-dichloroethylene using the weight fraction of *trans*-1,2-dichloroethylene in the aerosol product. EPA uses a uniform distribution of weight fractions for *trans*-1,2-dichloroethylene based on facility data for the aerosol products in use ([CARB, 2000](#)).

A.5.2 Model Parameters

Table_Apx A-9 summarizes the model parameters and their values for the aerosol degreasing release model. Each parameter is discussed in detail in the following subsections.

The specificity of more complex distributions (*e.g.*, triangular, lognormal) to characterize a model parameter value requires adequate data to demonstrate the distribution; if only an overall range is known, then a uniform distribution is the only possible distribution to use. There may be cases where a uniform distribution is appropriate if data indicate it as such, but generally, uniform distributions were used because no data were found to demonstrate a more sophisticated distribution.

Model parameters kept as constants were generally cases where data to describe variability or uncertainty of the parameter value were unknown. Additionally, some model parameters were kept as constants by choice (*i.e.*, temperature and pressure are constant as the model is isothermal and isobaric), and some were kept as constants appropriately (*i.e.*, molecular weight kept appropriately constant).

Table_Apx A-9. Summary of Parameter Values and Distributions Used in the Brake Servicing Near-Field/Far-Field Inhalation Exposure Model

Input Parameter	Symbol	Unit	Constant Model Parameter Values		Variable Model Parameter Values				Comments
			Value	Basis	Lower Bound	Upper Bound	Mode	Distribution Type	
<i>trans</i> -1,2-Dichloroethylene Weight Fraction	wtfrac	unitless	—	—	0.01	1	—	Discrete	Discrete distribution of <i>trans</i> -1,2-dichloroethylene-based aerosol product formulations based on products identified in SDS. Where the weight fraction of <i>trans</i> -1,2-dichloroethylene in the formulation was given as a range, EPA assumed a uniform distribution within the reported range for the <i>trans</i> -1,2-dichloroethylene concentration in the product. See Appendix A.5.3 for further discussion.
Degreaser Used per Brake Job	W _d	oz/ job	14.4	—	—	—	—	Constant Value	Based on data from CARB (2000).
Number of Applications per Job	N _A	Applications/ job	11	—	—	—	—	Constant Value	Calculated from the average of the number of applications per brake and number of brakes per job.
Amount Used per Application	Amt	g <i>trans</i> -1,2-Dichloroethylene/application	—	—	33.4	37.1	—	Calculated	Calculated from wtfrac, W _d , and N _A .
Number of Brake Jobs per Year	Jobs _{site-yr}	jobs/site-yr	936	—	—	—	—	Constant Value	Based on data from CARB (2000).

A.5.3 *trans*-1,2-Dichloroethylene Weight Fraction

EPA used a two-dimensional sampling technique to model the *trans*-1,2-dichloroethylene weight fraction. A discrete distribution is used to model the frequency of occurrence of each product type. For each product, the concentration of *trans*-1,2-dichloroethylene was reported as a range. The Agency used a uniform distribution to model the *trans*-1,2-dichloroethylene weight fraction within each product type. On each iteration of the simulation, the model executes each product's weight fraction distribution and the product frequency distribution. The model then reads the product selected from the product frequency distribution and selects the weight fraction that was generated from the corresponding product's weight fraction distribution. Table_Apx A-10 provides a summary of the reported *trans*-1,2-dichloroethylene content reported in the SDSs and the fractional probability of each product type.

Table_Apx A-10. Summary of *trans*-1,2-Dichloroethylene-Based Solvent Formulations

Product Name	<i>trans</i> -1,2-Dichloroethylene Concentration		Fractional Probability
	Low-End	High-End	
Novec Electronic Degreaser	65%	75%	0.010
Novec Contact Cleaner Plus	15%	24%	0.010
Novec Contact Cleaner Lubricant	15%	25%	0.010
Novec Flux Remover	55%	70%	0.010
PF Precision Cleaner	3%	5%	0.010
Aviation T Force	40%	50%	0.010
Aviation XT 2000 Precision Cleaner	20%	30%	0.010
Contact Cleaner 2000 VC Precision Cleaner	30%	40%	0.010
Contact Cleaner 2000 Precision Cleaner	60%	70%	0.010
Heavy Duty Degreaser MUO	5%	10%	0.010
Lectra Force	40%	50%	0.010
T Force Degreaser MUO Non Flammable	80%	90%	0.010
T Force Next Generation Degreaser	40%	50%	0.010
XT 2000 Precision Cleaner	20%	30%	0.010
LPS Instant Super Degreaser 2.0	60%	70%	0.010
Ultra Cut 2 Cutting Tool Coolant	5%	10%	0.010
Heavy Duty Degreaser	80%	90%	0.010
T-Force® Degreaser	80%	100%	0.010
Non Flammable Mold Cleaner (A497)	5%	20%	0.010
Pow-R-Wash CZ	10%	15%	0.010
Pow-R-Wash Delta	45%	55%	0.010
A4 All Purpose Flux Remover and Cleaner	25%	50%	0.010
Blue Shower® G3®	50%	75%	0.010
G3 Contact Cleaner	25%	50%	0.010
G3 Flux Remover	25%	50%	0.010
G3 No-Clean Flux Remover	50%	75%	0.010
G3 Industrial Maintenance Cleaner	10%	23%	0.010
Precision-V Flux Remover	1%	13%	0.010
Aviation Degreaser II	25%	50%	0.010

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Product Name	<i>trans</i> -1,2-Dichloroethylene Concentration		Fractional Probability
	Low-End	High-End	
PWR-4 Transit Equipment Degreaser	60%	70%	0.010
Mold Release cold release PTFE liquid	25%	50%	0.010
Flux-Off Delta	25%	50%	0.010
Electro-Wash NXO Degreaser	25%	50%	0.010
Flux-off Heavy Duty	15%	30%	0.010
Electro-Wash VZ Degreaser	25%	50%	0.010
Flux-Off VZ	10%	25%	0.010
Pow-R-Wash VZ	10%	50%	0.010
Electro-Wash CZ Degreaser	1%	10%	0.010
Flux-Off CZ	50%	75%	0.010
Max-Kleen Tri-V	60%	70%	0.010
Super Degreaser MUO	40%	50%	0.010
Super Degreaser Plus Degreaser	60%	70%	0.010
Electrical CRC Electronic Component Cleaner	60%	70%	0.010
NT Precision Cleaner	10%	20%	0.010
CE Precision Cleaner	60%	70%	0.010
Cable Clean Degreaser	1%	5%	0.010
Cable Clean RD High Voltage Cleaner (Rapid Dry)	80%	90%	0.010
Cable Clean High Voltage Splice and Termination Cleaner	60%	70%	0.010
LPS MAX Instant Super Degreaser 2.0	35%	45%	0.010
LPS MAX NoFlash 2.0	7%	13%	0.010
Circuit-Safe	30%	40%	0.010
DYLEK II AEROSOL	50%	60%	0.010
Drummond™ 3-2-1 Electronic Cleaner	58%	58%	0.010
Flux Remover and Cleaner	7%	13%	0.010
Whitmore Manufacturing LLC	35%	45%	0.010
LPS NoFlash 2.0	35%	45%	0.010
LPS Electra X 2.0	5%	10%	0.010
LPS® Electro Contact Cleaner	38%	52%	0.010
MS-122SE	53%	56%	0.010
DPMS H0805A LGW Heavy Duty Solvent & Flux Remover	68%	74%	0.010
MS-124H	20%	40%	0.010
MS-255 M-255M Surface PrepClean	38%	42%	0.010
MS-381H MS-381HM MS-381HSP	42%	52%	0.010
MS-530N	65%	70%	0.010
MS-555	42%	48%	0.010
MS-560	50%	60%	0.010
MS-580N DPMS-N0627A-1	30%	35%	0.010
MS-460 H	33%	37%	0.010

Product Name	<i>trans</i> -1,2-Dichloroethylene Concentration		Fractional Probability
	Low-End	High-End	
MS-725 MS-725M	40%	60%	0.010
LIGHTNING PLUS III	30%	40%	0.010
Clean & Lube	70%	80%	0.010
Circuit Wash	83%	95%	0.010
Force 200 (Aerosol)	55%	65%	0.010
QC Lube	88%	92%	0.010
Novec 71D90	1%	45%	0.010
AG-1D-RH Flaw Finder Cleaner, Aerosol	1%	45%	0.010
Oxygen Fitting Cleaner AG-OFC	1%	45%	0.010
Hi Performance Synthetic Lubricant	1%	40%	0.010
Acid/Base Colormetric Developer	1%	60%	0.010
Pinpoint Colormetric Developer for Ammonia	1%	60%	0.010
Pinpoint Ammonia Detecting Spray	29%	29%	0.010
Flaw-Finder AG-2D-DH Penetrant Developer (Aerosol)	1%	50%	0.010
Color Change Developer for Hydro 2 (Aerosol)	1%	50%	0.010
ODP-210 Pinpoint Colormetric Hydrocarbon Detection Paint (Aerosol)	1%	50%	0.010
Pinpoint Colormetric Developer for Water (Aerosol)	60%	80%	0.010
Vertrel C-HD	20%	30%	0.010
TORQ CB III	50%	75%	0.010
Circ-Kleen Ultra High Performance Contact Cleaner	25%	50%	0.010
General Purpose Flux Remover	25%	50%	0.010
Flux Remover C	50%	100%	0.010
Heavy Duty Degreaser, Aerosol	50%	100%	0.010
Lead-Free Flux Remover – Powerclean, Aerosol and Bulk	50%	100%	0.010
SPR – Heavy Duty Flux Remover – Suprclean, Aerosol	35%	41%	0.010
MS-143HN	15%	40%	0.010
Electrical Contact Cleaner	80%	90%	0.010
Pow High Voltage Cable Cleaner and Electric Motor Degreaser	70%	70%	0.010
Power Cable & Contact Cleaner	40%	60%	0.010
Nix Stix Mold Release	90%	100%	0.010
CSM-3	10%	30%	0.010

A.5.4 Volume of Degreaser Used per Brake Job

CARB (2000) assumed that brake jobs require 14.4 oz of aerosol product. EPA did not identify other information to estimate the volume of aerosol product per job; therefore, the Agency used a constant volume of 14.4 oz per brake job based on CARB (2000).

A.5.5 Number of Applications per Brake Job

Workers typically apply the brake cleaner before, during, and after brake disassembly. Workers may also apply the brake cleaner after brake reassembly as a final cleaning process (CARB, 2000). Therefore, EPA assumed a worker applies a brake cleaner three or four times per wheel. Because a

brake job can be performed on either one or two axles (CARB, 2000), EPA also assumed a brake job may involve either two or four wheels. Therefore, the number of brake cleaner (aerosol degreaser) applications per brake job can range from 6 (3 applications/brake × 2 brakes) to 16 (4 applications/brake × 4 brakes). The Agency assumed a constant number of applications per brake job based on the midpoint of this range of 11 applications per brake job.

A.5.6 Amount of *trans*-1,2-Dichloroethylene Used per Application

EPA calculated the amount of *trans*-1,2-dichloroethylene used per application using Equation_Apx A-19. The calculated mass of *trans*-1,2-dichloroethylene used per application ranges from 3.7 to 29.7 grams.

Equation_Apx A-19.

$$Amt = \frac{W_d \times wtfrac \times 28.3495 \frac{g}{oz}}{N_A}$$

Where:

<i>Amt</i>	=	Amount of <i>trans</i> -1,2-dichloroethylene used per application (g/application);
<i>W_d</i>	=	Weight of degreaser used per brake job (oz/job);
<i>Wtfrac</i>	=	Weight fraction of <i>trans</i> -1,2-dichloroethylene in aerosol degreaser (unitless)
<i>N_A</i>	=	Number of degreaser applications per brake job (applications/job).

This value was used as the daily amount released to the atmosphere.

A.5.7 Number of Brake Jobs per Year

CARB (2000) visited 137 automotive maintenance and repair shops and collected data on the number of brake jobs performed annually at each facility. CARB calculated an average of 936 brake jobs performed at each facility per year.

A.6 Use of Adhesives Model Approaches and Parameters

This appendix presents the modeling approach and equations used to estimate environmental releases for *trans*-1,2-dichloroethylene during the use of adhesives and sealants OES. This approach utilizes the Emission Scenario Document on Use of Adhesives (OECD, 2015) combined with Monte Carlo simulation (a type of stochastic simulation).

Based on the ESD, EPA identified the following release sources from the application of adhesives and sealants:

- Release source 1: Container Cleaning Wastes;
- Release source 2: Open Surface Losses to Air During Container Cleaning (not assessed);
- Release source 3: Transfer Operation Losses from Unloading Adhesive Formulation;
- Release source 4: Equipment Cleaning Wastes;
- Release source 5: Open Surface Losses to Air During Equipment Cleaning;
- Release source 6: Process Releases During Adhesive Application (not assessed);
- Release source 7: Open Surface Losses to Air During Curing/Drying; and
- Release source 8: Trimming Wastes (not assessed).

Environmental releases for *trans*-1,2-dichloroethylene during use of adhesives and sealants are a function of the chemical's physical properties, container size, mass fractions, and other model parameters. While physical properties are fixed, some model parameters are expected to vary. EPA used

a Monte Carlo simulation to capture variability in the following model input parameters: production volume, product throughput, *trans*-1,2-dichloroethylene concentrations, air speed, saturation factor, container size, loss fractions, and operating days. EPA used the outputs from a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method in @Risk to calculate release amounts for this OES.

A.6.1 Model Equations

Table_Apx A-11 provides the models and associated variables used to calculate environmental releases for each release source within each iteration of the Monte Carlo simulation. EPA used these environmental releases to develop a distribution of release outputs for the use of adhesives and sealants OES. The variables used to calculate each of the following values include deterministic or variable input parameters, known constants, physical properties, conversion factors, and other parameters. The values for these variables are provided in Section A.6.2. The Monte Carlo simulation calculated the total *trans*-1,2-dichloroethylene release (by environmental media) across all release sources during each iteration of the simulation. EPA then selected 50th percentile and 95th percentile values to estimate the central tendency and high-end releases, respectively.

Table_Apx A-11. Models and Variables Applied for Release Sources in the Use of Adhesives and Sealants OES

Release Source	Model(s) Applied	Variables Used
Release source 1: Container Cleaning Wastes.	EPA/OPPT Small Container Residual Model (Appendix A.1)	$PV_{site}; LF_{RS1}; OP_{days}$
Release source 2: Open Surface Losses to Air During Container Cleaning.	Not assessed; release is not expected as <i>trans</i> -1,2-dichloroethylene -containing adhesives and sealants are expected to be received in syringes which are disposed of following use.	Not applicable
Release source 3: Transfer Operation Losses from Unloading Adhesive Formulation.	EPA/OAQPS AP-42 Loading Model (Appendix A.1)	Vapor Generation Rate: $F_{chem\_product}; VP_{t-DCE}; f_{sat}; MW_{t-DCE}; T_K$; $RATE_{prod\_cont}; V_{prod\_cont}$ Operating Time: $RATE_{prod\_cont}; N_{cont\_unload\_site\_day}$
Release source 4: Equipment Cleaning Wastes.	EPA/OPPT Multiple Process Vessel Residual Model (Appendix A.1)	$PV_{site}; LF_{RS4}$
Release source 5: Open Surface Losses to Air During Equipment Cleaning.	EPA/OPPT Penetration Model or EPA/OPPT Mass Transfer Coefficient Model, based on air speed (Appendix A.1)	Vapor Generation Rate: $F_{chem\_product}; MW_{t-DCE}; VP_{t-DCE}; RATE_{air\_speed}; D_{RS5}; T_K; P_{Torr}$ Operating Time: $N_{batch\_site\_day}; OH_{batch}$
Release source 6: Process Releases During Adhesive Application.	Not assessed; volatile releases are assumed to occur to completion during curing/drying.	Not applicable

Release Source	Model(s) Applied	Variables Used
Release source 7: Open Surface Losses to Air During Curing/Drying.	No model applicable; remaining chemical not released from the previous release sources is released here.	Not applicable
Release source 8: Trimming Wastes.	Not assessed; it is assumed that all <i>trans</i> -1,2-dichloroethylene evaporated during adhesive curing/drying so releases from trimming wastes are not assessed.	Not applicable

A.6.2 Model Input Parameters

Table_Apx A-12 summarizes the model parameters and their values for the Application of Adhesives and Sealants Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for each parameter are provided after this table.

9158 **Table_Apx A-12. Summary of Parameter Values and Distributions Used in the Use of Adhesives and Sealants Model**

Input Parameter	Symbol	Unit	Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale / Basis
			Value	Lower Bound	Upper Bound	Mode	Distribution Type	
Adhesive/ Sealant <i>trans</i> -1,2-Dichloroethylene Concentration	F_{chem_prod}	kg/kg	3E-02	1E-02	5E-02	–	Uniform	See Section A.6.7
Container Residual Loss Fraction	LF_{RS1}	kg/kg	3.0E-03	3.0E-04	6.0E-03	3.0E-03	Triangular	See Section A.6.11
Equipment Cleaning Loss Fraction	LF_{RS4}	kg/kg	2.0E-03	7E-04	1E-02	2E-03	Triangular	See Section A.6.14
Diameter of Equipment Cleaning Opening	D_{RS5}	cm	2.5	2.5	10	2.5	Triangular	See Section A.6.13
Air Speed	$RATE_{air\_speed}$	ft/min	19.7	2.56	398	–	Lognormal	See Section A.6.9
Saturation Factor	f_{sat}	unitless	0.5	0.5	1.45	0.5	Triangular	See Section A.6.10
Container Volume	V_{prod_cont}	gal	55	–	–	–	–	Generic Scenario
Density of Adhesive/Sealant	RHO_{prod}	kg/m ³	1,256.5	–	–	–	–	See Section A.6.7
Production Volume	PV	kg/year	34,019	–	–	–	–	See Section A.6.4
Molecular Weight	MW_{t-DCE}	g/mol	96.94	–	–	–	–	Physical property
Temperature	T_K	K	298	–	–	–	–	Process parameter
Density of <i>trans</i> -1,2-Dichloroethylene	RHO_{t-DCE}	kg/m ³	1,256.5	–	–	–	–	Physical property
Vapor Pressure at 25 °C	VP_{t-DCE}	torr	331	–	–	–	–	Physical property
Pressure	P_{Torr}	torr	760	–	–	–	–	Process parameter
Container Fill Rate	$RATE_{cont}$	containers/hour	20	–	–	–	–	Generic Scenario

Input Parameter	Symbol	Unit	Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale / Basis
			Value	Lower Bound	Upper Bound	Mode	Distribution Type	
Number of Adhesive Batches used per Site-Day	$N_{batch\_site-day}$	Batches/site-day	1	–	–	–	–	See Section A.6.4
Annual Facility Throughput of Adhesive/ Sealant	$Q_{app\_use\_rate}$	kg/year	13,500	1,000	1E06	1.4E05	Triangular	See Section A.6.4
Operating Days	OP_{days}	days/year	260	–	–	–	–	See Section A.6.8
Operating Hours for Equipment Cleaning per Batch	OH_{batch}	hour/day	1	–	–	–	–	See Section A.6.6

9159

A.6.3 Number of Sites

The number of sites is calculated using the following equation.:

Equation_Apx A-20.

$$N_{sites} = \frac{PV}{Q_{app\_use\_rate} \times F_{chem\_product}}$$

Where:

N_{sites}	=	Number of sites (sites)
PV	=	Production volume (kg/year)
$Q_{app\_use\_rate}$	=	Facility annual throughput of adhesive (kg/site-yr)
$F_{chem\_product}$	=	<i>trans</i> -1,2-Dichloroethylene concentration in adhesive/sealant(kg/site-yr)

A.6.4 Throughput Parameters

EPA estimates 1,000 to 1,000,000 kg/site-year for site adhesive use rate. EPA assigned a mode of 141,498 kg/site-year to the triangular distribution, based upon information reported in new chemical pre-manufacture notice submissions for chemicals indicating use in adhesives. This is based on the Emission Scenario Document on Use of Adhesives ([OECD, 2015](#)).

The annual throughput of *trans*-1,2-dichloroethylene in adhesives/sealants is calculated using Equation_Apx A-21 by multiplying the annual throughput of all adhesives and sealants by the concentration of *trans*-1,2-dichloroethylene in the adhesives/sealants.

Equation_Apx A-21.

$$PV_{site} = Q_{app\_use\_rate} \times F_{chem\_product}$$

Where:

PV_{site}	=	Facility annual throughput of <i>trans</i> -1,2-dichloroethylene (kg/site-yr)
$Q_{app\_use\_rate}$	=	Facility annual throughput of all adhesives/ sealants (kg/site-yr)
$F_{chem\_product}$	=	Concentration of <i>trans</i> -1,2-dichloroethylene in adhesive/ sealant (kg/kg)

The daily throughput of *trans*-1,2-dichloroethylene is calculated using Equation_Apx A-22 by dividing the annual production volume by the number of operating days. The number of operating days is determined according to Section 9.2.10.

Equation_Apx A-22.

$$PV_{site\_daily} = \frac{PV_{site}}{OP_{days}}$$

Where:

PV_{site_daily}	=	Facility daily throughput of <i>trans</i> -1,2-dichloroethylene (kg/site-day)
PV_{site}	=	Facility annual throughput of <i>trans</i> -1,2-dichloroethylene (kg/site-yr)
OP_{days}	=	Operating days (days/yr)

A.6.5 Number of Containers Per Year

The number of *trans*-1,2-dichloroethylene raw material containers received and unloaded by a site per year is calculated using the following equation:

Equation_Apx A-23.

$$N_{cont\_unload\_site\_yr} = \frac{PV_{site}}{V_{prod\_cont} \times RHO_{prod} \times \left(0.00379 \frac{m^3}{gal}\right)}$$

Where:

$N_{cont\_unload\_site\_yr}$	=	Annual number of containers unloaded (container/site-year)
PV_{site}	=	Facility annual throughput of <i>trans</i> -1,2-dichloroethylene (kg/site-yr)
V_{prod_cont}	=	Product container volume (gal/container)
RHO_{prod}	=	Product density (kg/L)

A.6.6 Operating Hours

EPA estimated operating hours or hours of duration using data provided from the Emission Scenario Document on Use of Adhesives ([OECD, 2015](#)), *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)), and/or through calculation from other parameters. Release points with operating hours provided from these sources include container cleaning, container unloading, and equipment cleaning.

For container unloading (release point 3), the operating hours are calculated based on the number of containers unloaded at the site and the unloading rate using the following equation:

Equation_Apx A-24.

$$OH_{RP3} = \frac{N_{cont\_unload\_site\_day}}{RATE_{fill}}$$

Where:

OH_{RP3}	=	Operating time for release point 3 (hour/site-day)
$N_{cont\_unload\_site\_day}$	=	Daily number of containers unloaded (container/site-year)
$RATE_{fill}$	=	Container fill rate (containers/hour)

For equipment cleaning (release point 5), the Emission Scenario Document on Use of Adhesives ([OECD, 2015](#)) states that the default operating hours for equipment cleaning is one hour/batch multiplied by the number of batches per day for multiple vessels. Per the Emission Scenario Document on Use of Adhesives ([OECD, 2015](#)), the default number of batches per day is one. Therefore, EPA assumes that equipment cleaning occurs for one hour/day.

A.6.7 Adhesive/Sealant *trans*-1,2-Dichloroethylene Concentration and Product Density

EPA used a two-dimensional sampling technique to model the *trans*-1,2-dichloroethylene weight fraction. A discrete distribution is used to model the frequency of occurrence of each product type. For each product, the concentration of *trans*-1,2-dichloroethylene was reported as a range. The Agency used a uniform distribution to model the *trans*-1,2-dichloroethylene weight fraction within each product type. On each iteration of the simulation, the model executes each product's weight fraction distribution and the product frequency distribution. The model then reads the product selected from the product frequency distribution, product density, and selects the product weight fraction that was generated from the corresponding product's weight fraction distribution. Table_Apx A-13 provides a summary of the reported *trans*-1,2-dichloroethylene content reported in the SDSs and the fractional probability of each product type.

9240 **Table Apx A-13. Summary of *trans*-1,2-Dichloroethylene Based Adhesive Formulations**

Product Name	<i>trans</i> -1,2-Dichloroethylene Concentration		Product Density (kg/m ³)	Fractional Probability
	Low-End	High-End		
Touch N Seal Storm Bond 1K PU Roof Tile Adhesive	1%	5%	1,256.5	0.33
ASC 10 Adhesive Accelerator	5%	10%	1,256.5	0.33
WA NF742/NF743 Canister Adhesive	40%	70%	1,256.5	0.33

9241 **A.6.8 Operating Days**

9242 EPA used the default operating days per year for the Motor and Non-Motor Vehicle, Vehicle Parts, and
9243 Tire Manufacturing (Except Retreading) sector from the Emission Scenario Document on Use of
9244 Adhesives ([OECD, 2015](#)). The emission scenario document provides the default operating days for this
9245 sector to be 260 days per year.

9246 **A.6.9 Air Speed**

9247 Baldwin and Maynard ([1998](#)) measured indoor air speeds across a variety of occupational settings in the
9248 United Kingdom. Fifty-five work areas were surveyed across a variety of workplaces. EPA analyzed the
9249 air speed data from Baldwin and Maynard ([1998](#)) and categorized the air speed surveys into settings
9250 representative of industrial facilities and representative of commercial facilities. EPA fit separate
9251 distributions for these industrial and commercial settings and used the industrial distribution for this
9252 OES.

9253
9254 EPA fit a lognormal distribution for the data set as consistent with the authors' observations that the air
9255 speed measurements within a surveyed location were lognormally distributed and the population of the
9256 mean air speeds among all surveys were lognormally distributed ([Baldwin and Maynard, 1998](#)). Since
9257 lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the
9258 largest observed value in the survey mean air speeds.

9259
9260 EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the
9261 following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model,
9262 the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed
9263 value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard ([1998](#)) to
9264 prevent the model from sampling values that approach infinity or are otherwise unrealistically small or
9265 large ([Baldwin and Maynard, 1998](#)).

9266
9267 Baldwin and Maynard ([1998](#)) only presented the mean air speed of each survey. The authors did not
9268 present the individual measurements within each survey. Therefore, these distributions represent a
9269 distribution of mean air speeds and not a distribution of spatially variable air speeds within a single
9270 workplace setting. However, a mean air speed (averaged over a work area) is the required input for the
9271 model. EPA converted the units to ft/min prior to use within the model equations.

9272 **A.6.10 Saturation Factor**

9273 The CEB Manual indicates that during splash filling, the saturation concentration was reached or
9274 exceeded by misting with a maximum saturation factor of 1.45 ([CEB, 1991](#)). The CEB Manual indicates
9275 that saturation concentration for bottom filling was expected to be about 0.5 ([CEB, 1991](#)). The
9276 underlying distribution of this parameter is not known; therefore, the Agency assigned a triangular
9277 distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was

not provided for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling minimizes volatilization ([CEB, 1991](#)). This value also corresponds to the typical value provided in the *ChemSTEER User Guide* for the EPA/OAQPS AP-42 Loading Model ([U.S. EPA, 2015a](#)).

A.6.11 Container Residue Loss Fraction

EPA used data from the PEI Associates Inc. study ([PEI Associates, 1988](#)) and the EPA/OPPT Small Container Residual Model. For unloading drums by pouring in the PEI Associates Inc. study ([PEI Associates, 1988](#)), EPA found that the average percent residual from the pilot-scale experiments showed a range of 0.03 to 0.79% with an average of 0.32%. The EPA/OPPT Small Container Residual Model from the *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)) recommends a default central tendency loss fraction of 0.3% and a high-end loss fraction of 0.6%.

The underlying distribution of the loss fraction parameter for small containers is not known; therefore, the Agency assigned a triangular distribution, since triangular distributions require least assumptions and are completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for the loss fraction probability distribution using the central tendency and high-end values, respectively, prescribed by the EPA/OPPT Small Container Residual Model in the *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)). EPA assigned the minimum value for the triangular distribution using the minimum average percent residual measured in the PEI study ([PEI Associates, 1988](#)) for emptying drums by pouring.

A.6.12 Container Unloading Rates

The *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)) provides a typical fill rate of 20 containers per hour for containers with 55 gallons of liquid.

A.6.13 Diameters of Opening

The *ChemSTEER User Guide* indicates diameters for the openings for various vessels that may hold liquids in order to calculate vapor generation rates during different activities ([U.S. EPA, 2015a](#)). For equipment cleaning operations, the *ChemSTEER User Guide* indicates a single default value of 92 cm ([U.S. EPA, 2015a](#)).

A.6.14 Equipment Cleaning Loss Fraction

EPA used the EPA/OPPT Single Process Vessel Residual Model to estimate the releases from equipment cleaning. The EPA/OPPT Single Process Vessel Residual Model, as detailed in the *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)), recommends a central tendency loss fraction of 0.0007, a conservative loss fraction of 0.01, and a default loss fraction of 0.002. The underlying distribution of this parameter is not known; therefore, the Agency assigned a triangular distribution based on the lower bound, upper bound, and mode of the parameter. EPA utilized a triangular distribution with 0.0007 as the low-end, 0.01 as the high-end, and 0.002 as the mode for the equipment cleaning loss fraction.

A.7 Blowing Agent in Spray Foam Model Approaches and Parameters

This appendix presents the modeling approach and model equations used estimate environmental releases for *trans*-1,2-dichloroethylene during its use as a blowing agent in spray foam OES. This approach utilizes the *Application of Spray Polyurethane Foam Insulation Generic Scenario* ([U.S. EPA, 2021b](#)) combined with Monte Carlo simulation (a type of stochastic simulation).

Spray polyurethane foam (SPF) insulation is commonly used in renovation or new building construction and is made by mixing fast-reacting chemicals that expand on contact to create a continuous stream of

foam. This foam is applied to walls, ceilings, roofs and other building structures to provide highly effective insulation from heat, air, and/or moisture.

SPF application generally occurs at residential and commercial building sites by commercial applicators. Once these sites are prepared for SPF application, the SPF is applied, checked to ensure the appropriate thickness was applied to walls, ceilings, roofs and other building structures to provide highly effective insulation from heat, air, and/or moisture.

SPF application generally occurs at residential and commercial building sites by commercial applicators. Once these sites, EPA identified the following release sources from the application of spray foam:

1. Release to air from transfer operation losses during unloading;
2. Release to water, landfill, or incineration from container residue losses;
3. Release to air from evaporative losses during container cleaning;
4. Release to landfill, or incineration from equipment cleaning residue;
5. Release to air from losses during application; and
6. Release to landfill from trimming wastes.

Environmental releases for *trans*-1,2-dichloroethylene during use of blowing agents in spray are a function of the chemical's physical properties, container size, mass fractions, and other model parameters. While physical properties are fixed, some model parameters are expected to vary. EPA used a Monte Carlo simulation to capture variability in the following model input parameters: production volume, product throughput, *trans*-1,2-dichloroethylene concentrations, air speed, saturation factor, container size, loss fractions, and operating days. EPA used the outputs from a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method in @Risk to calculate release amounts for this OES.

A.7.1 Model Equations

Table_Apx A-14 provides the models and associated variables used to calculate environmental releases for each release source within each iteration of the Monte Carlo simulation. EPA used these environmental releases to develop a distribution of release outputs for the Blowing Agent in Spray Foam OES. The variables used to calculate each of the following values include deterministic or variable input parameters, known constants, physical properties, conversion factors, and other parameters. The values for these variables are provided in Appendix A.3.2. The Monte Carlo simulation calculated the total *trans*-1,2-dichloroethylene (by environmental media) across all release sources during each iteration of the simulation. EPA then selected 50th and 95th percentile values to estimate the central tendency and high-end releases, respectively.

Table_Apx A-14. Models and Variables Applied for Release Sources in the Blowing Agent in Spray Foam OES

Release Source	Model(s) Applied	Variables Used
Release source 1: transfer operation losses during unloading	EPA/OAQPS AP-42 Loading Model (Equation_Apx A-3)	Vapor Generation Rate: F_{t-DCE} ; VP ; $F_{saturation\_unloading}$; MW_{t-DCE} ; V_{cont} ; R ; T ; $RATE_{fill\_drum}$ Operating Time: $RATE_{unload}$
Release source 2: Container residue losses to water,	EPA/OPPT Drum Residual Model (Equation_Apx A-5)	PV ; F_{loss_cont}

Release Source	Model(s) Applied	Variables Used
incineration, or landfill		
Release source 3: Open Surface Losses to Air During Container Cleaning	EPA/OPPT Penetration Model (if air speed ≤ 100 ft/min) (Equation_Apx A-1)	Vapor Generation Rate: F_{t-DCE} ; VP ; MW_{t-DCE} ; T ; $D_{container}$; P Operating Time: $RATE_{fill\_smallcont}$
Release source 4: Equipment cleaning and waste solvent disposal	EPA/OPPT Single Process Vessel Residual Model (Equation_Apx A-5)	$Q_{chem\ site\ day}$; $F_{equipment\ cleaning}$
Release source 5: Fugitive Emissions to Air During Application	Equation_Apx A-5	$Q_{chem\ site\ day}$; $F_{Spray\ release}$
Release source 6: Trimming Waste to Landfill	Equation_Apx A-5	$Q_{chem\ site\ day}$; $F_{Trimming}$

A.7.2 Model Parameters

Table_Apx A-15 summarizes the model parameters and their values for the blowing agent in spray foam OES release model. Each parameter is discussed in detail in the following subsections.

The specificity of more complex distributions (*e.g.*, triangular, lognormal) to characterize a model parameter value requires adequate data to demonstrate the distribution; if only an overall range is known, then a uniform distribution is the only possible distribution to use. There may be cases where a uniform distribution is appropriate if the data indicate it is appropriate, but generally, uniform distributions were used because no data were found to demonstrate a more sophisticated distribution.

Model parameters kept as point estimates or constant values were generally cases where data to describe variability or uncertainty of the parameter value were unknown. Additionally, some model parameters were kept as constants by choice (*i.e.*, temperature and pressure are constant as the model is isothermal and isobaric), and some were kept as constants appropriately (*i.e.*, molecular weight kept appropriately constant).

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Table Apx A-15. Summary of Parameter Values and Distributions Used for Blowing Agent in Spray Foam Release Model

Input Parameter	Symbol	Unit	Constant Model Parameter Values		Variable Model Parameter Values				Comments
			Value	Basis	Lower Bound	Upper Bound	Mode	Distribution Type	
<i>trans</i> -Dichloroethylene weight percent in SPF	$F_{chem\ side}$	kg/year	—	—	1	5	—	Discrete	Discrete distribution of <i>trans</i> -1,2-dichloroethylene-based spray foam product formulations based on products identified in SDS. Where the weight fraction of <i>trans</i> -1,2-dichloroethylene in the formulation was given as a range, EPA assumed a uniform distribution within the reported range for the <i>trans</i> -1,2-dichloroethylene concentration in the product. See Appendix A.5.3 for further discussion.
Density of formulation	$RHO_{formulation}$	kg/L	1.2565	—	—	—	—	Discrete	Discrete distribution of <i>trans</i> -1,2-dichloroethylene-based spray foam product densities based on products identified in SDS. See Appendix A.5.3 for further discussion.
Application Area per Job Site	$A_{app\ site}$	ft ²	1,560	—	—	—	—	Constant Value	Based on data from U.S. EPA (2021b).
Foam Density	RHO_{spf}	lb/ft ³	2	—	—	—	—	Constant Value	Based on data from U.S. EPA (2021b).
Foam Maximum Thickness	T_{spf}	ft	0.33	—	—	—	—	Constant Value	Based on data from U.S. EPA (2021b).
Mass Fraction of A or B-Side in SPF	F_{side_SPF}	kg formulation/kg SPF	0.5	—	—	—	—	Constant Value	Based on data from U.S. EPA (2021b).
Volume of Transport Container	$V_{container}$	gal	55	—	—	—	—	Constant Value	Based on data from U.S. EPA (2021b).
Fraction of Chemical Remaining in Container as Residue	$F_{container\ disp}$	kg container residue/kg formulation supplied in drums	0.03	—	—	—	—	Constant Value	Based on data from U.S. EPA (2021b).
Diameter of Opening	$D_{opening}$	cm	5.08	—	—	—	—	Constant Value	Based on data from U.S. EPA (2021b).

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Input Parameter	Symbol	Unit	Constant Model Parameter Values		Variable Model Parameter Values				Comments
			Value	Basis	Lower Bound	Upper Bound	Mode	Distribution Type	
Surface Area of Pool Opening	$Area_{opening}$	cm ²	20.3	—	—	—	—	Constant Value	Based on data from U.S. EPA (2021b).
Vapor Pressure Correction Factor	$F_{vapor\ pressure}$	unitless	1	—	—	—	—	Constant Value	Based on data from U.S. EPA (2021b).
Container Unload Rate	$RATE_{unload}$	containers/hour	20	—	—	—	—	Constant Value	Based on data from U.S. EPA (2021b).
Fraction of Formulation Containing the Chemical of Interest Released as Residual in Process Equipment	$F_{equipment\ cleaning}$	kg product released/kg holding capacity	0.02	—	—	—	—	Constant Value	Based on data from U.S. EPA (2021b).
Fraction of Chemical of Interest Lost During Trimming Operations	$F_{trimming}$	kg chemical released/kg trimmed	0.08	—	—	—	—	Constant Value	Based on data from U.S. EPA (2021b).
Fraction of Formulation Containing the Chemical of Interest Released During Spray Application	$F_{spray\ release}$	kg product released/kg sprayed	—	—	0.02	0.1	—	Uniform	Based on data from U.S. EPA (2021b).

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A.7.3 *trans*-1,2-Dichloroethylene Weight Fraction

EPA used a two-dimensional sampling technique to model the *trans*-1,2-dichloroethylene weight fraction. A discrete distribution is used to model the frequency of occurrence of each product type. For each product, the concentration of *trans*-1,2-dichloroethylene was reported as a range. The Agency used a uniform distribution to model the *trans*-1,2-dichloroethylene weight fraction within each product type. On each iteration of the simulation, the model executes each product's weight fraction distribution and the product frequency distribution. The model then reads the product selected from the product frequency distribution and selects the weight fraction that was generated from the corresponding product's weight fraction distribution. Table_Apx A-16 provides a summary of the reported *trans*-1,2-dichloroethylene content reported in the SDSs and the fractional probability of each product type.

Table_Apx A-16. Summary of *trans*-1,2-Dichloroethylene-Based Solvent Formulations

Product	<i>trans</i> -1,2-Dichloroethylene Weight (%)	Density of Formulation (kg/L)	Fractional Probability
Heatlok® XT B-side	1.0–5.0	1.2565	0.125
JM CORBOND IV Closed-cell Spray Polyurethane Foam	1.0–5.0	1.2565	0.125
Touch N Seal Quick Cure Cylinder High Yield PU Foam Sealant	1.0–5.0	1.2565	0.125
Heatlok® XT High Lift B-side	1.0–5.0	1.2565	0.125
PIPFoam 250A-CO B-Side	2.75–3.25	1.2565	0.125
PIPFoam 250A-DC B-Side	2.75–3.25	1.2565	0.125
PIPFoam 250A-FR B-Side	2.75–3.25	1.2565	0.125
R-10-011	1.0–3.0	1.2565	0.125
Total			1.00

A.7.4 Use Rate of *trans*-1,2-Dichloroethylene per Site

EPA calculated the use rate of *trans*-1,2-dichloroethylene in spray foam insulation per site using Equation_Apx A-25.

Equation_Apx A-25.

$$Q_{chem\_site} = F_{chem\_side} \times F_{side\_SPF} \times A_{app\_site} \times RHO_{SPF} \times T_{SPF} \times kg/lb$$

Where:

Q_{chem_site}	=	Use rate of <i>trans</i> -1,2-dichloroethylene per site (kg _{chem} /site)
F_{chem_side}	=	Mass fraction of <i>trans</i> -1,2-dichloroethylene listed on SDS (kg _{chem} /kg _{spf})
F_{side_SPF}	=	Mass Fraction of A or B-Side in SPF (kg _{side} /kg _{spf})
A_{app_site}	=	Application area per job site (ft ²)
RHO_{SPF}	=	Foam density (lb/ft ³)
T_{SPF}	=	Foam maximum thickness (ft)
kg/lb	=	Unit conversion (kg/lb)

A.7.5 Number of Transport Containers Unloaded

The number of spray foam insulation containers unloaded per site following equation:

Equation_Apx A-26.

$$N_{cont\_unload\_site} = \frac{Q_{chem\_site}}{F_{chem\_side} \times V_{container} \times RHO_{formulation} \times L/gal}$$

Where:

Q_{chem_site}	=	Site throughput of <i>trans</i> -1,2-dichloroethylene (kg)
F_{chem_side}	=	Mass fraction of <i>trans</i> -1,2-dichloroethylene listed on SDS (kg _{chem} /kg _{spf})
$V_{container}$	=	Volume of transport container (gal)
RHO_{formul}	=	Density of formulation (kg/L)
L/gal	=	Unit conversion (L/gal)

A.8 Use of Laboratory Chemicals Model Approaches and Parameters

This appendix presents the modeling approach and equations used to estimate environmental releases for *trans*-1,2-dichloroethylene during the use of laboratory chemicals OES. This approach utilizes the *Generic Scenario on Use of Laboratory Chemicals* ([U.S. EPA, 2023b](#)) and CDR data ([U.S. EPA, 2020a](#)) combined with Monte Carlo simulation (a type of stochastic simulation).

Based on the GS, EPA identified the following release sources from use of laboratory chemicals:

- Release source 1: Transfer Operation Losses to Air from Unloading Laboratory Chemicals;
- Release source 2: Dust Emissions from Transferring Powders (not assessed);
- Release source 3: Container Cleaning Wastes;
- Release source 4: Open Surface Losses to Air During Container Cleaning;
- Release source 5: Equipment Cleaning Wastes;
- Release source 6: Open Surface Losses to Air During Equipment Cleaning;
- Release source 7: Releases During Laboratory Analysis; and
- Release source 8: Laboratory Waste Disposal.

Environmental releases for *trans*-1,2-dichloroethylene during the use of laboratory chemicals are a function of *trans*-1,2-dichloroethylene's physical properties, container size, mass fractions, and other model parameters. Although physical properties are fixed, some model parameters are expected to vary. EPA used a Monte Carlo simulation to capture variability in the following model input parameters: facility throughput, operating days, *trans*-1,2-dichloroethylene concentrations, air speed, saturation factor, container size, loss fractions, and diameters of openings. EPA used the outputs from a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method in @Risk to calculate release amounts for this OES.

A.8.1 Model Equations

Table_Apx A-17 provides the models and associated variables used to calculate environmental releases for each release source within each iteration of the Monte Carlo simulation. EPA used these environmental releases to develop a distribution of release outputs for the use of laboratory chemicals OES. The variables used to calculate each of the following values include deterministic or variable input parameters, known constants, physical properties, conversion factors, and other parameters. The values for these variables are provided in Table_Apx A-18. The Monte Carlo simulation calculated the total *trans*-1,2-dichloroethylene release (by environmental media) across all release sources during each iteration of the simulation. EPA then selected 50th percentile and 95th percentile values to estimate the central tendency and high-end releases, respectively.

Table_Apx A-17. Models and Variables Applied for Release Sources in the Use of Laboratory Chemicals OES

Release source	Model(s) Applied	Variables Used
Release source 1: Transfer Operation Losses to Air from Unloading Laboratory Chemicals.	EPA/OAQPS AP-42 Loading Model (Appendix A.1)	Vapor Generation Rate: $F_{chem\_product}$; VP ; f_{sat} ; MW_{t-DCE} ; T_K ; V_{cont} ; $RATE_{fill}$ Operating Time: $N_{cont\_unload\_yr}$; $RATE_{fill}$; OD
Release source 2: Dust Emissions from Transferring Powders.	Not assessed; release is not expected since <i>trans</i> -dichloroethylene is assumed to be managed as a liquid	Not applicable
Release source 3: Container Cleaning Wastes.	EPA/OAQPS AP-42 Small Container Residual Model (Appendix A.1)	$Q_{chem\_site\_day}$; $F_{container\_residue}$
Release source 4: Open Surface Losses to Air During Container Cleaning.	EPA/OPPT Penetration Model or EPA/OPPT Mass Transfer Coefficient Model, based on air speed (Appendix A.1)	Vapor Generation Rate: $F_{chem\_product}$; MW_{t-DCE} ; VP_{t-DCE} ; $RATE_{air\_speed}$; $D_{cleaning}$; T_K ; P_{Torr} Operating Time: $N_{cont\_unload\_yr}$; $RATE_{fill}$; OD
Release source 5: Equipment Cleaning Wastes.	EPA/OPPT Multiple Process Vessel Residual Model (Appendix A.1)	$Q_{chem\_site\_day}$; $F_{lab\_residue}$
Release source 6: Open Surface Losses to Air During Equipment Cleaning.	EPA/OPPT Penetration Model or EPA/OPPT Mass Transfer Coefficient Model, based on air speed (Appendix A.1)	Vapor Generation Rate: $F_{chem\_product}$; MW_{t-DCE} ; VP_{t-DCE} ; $RATE_{air\_speed}$; $D_{cleaning}$; T_K ; P_{Torr} Operating Time: $OH_{equip\_cleaning}$; OD
Release source 7: Releases During Laboratory Analysis.	EPA/OPPT Penetration Model or EPA/OPPT Mass Transfer Coefficient Model, based on air speed (Appendix A.1)	Vapor Generation Rate: $F_{chem\_product}$; MW_{t-DCE} ; VP_{t-DCE} ; $RATE_{air\_speed}$; $D_{cleaning}$; T_K ; P_{Torr} Operating Time: $OH_{testing}$
Release source 8: Laboratory Waste Disposal.	No model applicable; all chemicals used in the laboratory are expected to be disposed at the end of each working day. Remaining chemical not released from the previous release sources is released here	Not applicable

A.8.2 Model Input Parameters

Table_Apx A-18 summarizes the model parameters and their values for the Use of Laboratory Chemicals Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for each parameter are provided after this table.

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Table_Apx A-18. Summary of Parameter Values and Distributions Used in the Use of Laboratory Chemicals Model

Input Parameter	Symbol	Unit	Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale / Basis
			Value	Lower Bound	Upper Bound	Mode	Distribution Type	
Total Production Volume of <i>trans</i> -Dichloroethylene	PV	kg/yr	34,019.40	—	—	—	—	See Section A.8.3
Daily Facility Throughput of <i>trans</i> -Dichloroethylene	$Q_{stock\_site\_day}$	mL/site-day	2,000	0.50	4000	2000	Triangular	See Section A.8.3
<i>trans</i> -Dichloroethylene Concentration	$F_{t-DCE\_product}$	kg/kg	—	0.001	1.0	—	Discrete	See Section A.8.7
Operating Days	OD	days/yr	260	174	260	260	Discrete	See Section A.8.8
Air Speed	$RATE_{air\_speed}$	ft/min	19.7	2.56	398.03	—	Lognormal	See Section A.8.9
Saturation Factor	f_{sat}	unitless	0.5	0.5	1.45	0.5	Triangular	See Section A.8.10
Container Size	V_{cont}	gal	0.066	0.00026	0.66	0.066	Triangular	See Section A.8.11
Container Loss Fraction	$F_{container\_residue}$	kg/kg	0.003	0.003	0.006	0.003	Triangular	See Section A.8.12
Vapor Pressure at 25 °C	VP	torr	331	—	—	—	—	Physical property
Molecular Weight	MW	g/mol	96.94	—	—	—	—	Physical property
Gas Constant	R	atm-cm ³ /g•mol-L	82.05	—	—	—	—	Universal constant
Density of Products	RHO	kg/L	1.256	—	—	—	Discrete	See Section A.8.7
Temperature	T	K	298	—	—	—	—	Process parameter
Pressure	P	atm	1	—	—	—	—	Process parameter
Small Container Fill Rate	$RATE_{fill}$	containers/hour	60	—	—	—	—	See Section A.8.13
Diameter of Opening – Container Cleaning	$D_{cleaning}$	cm	5.08	—	—	—	—	See Section A.8.14
Lab Testing Duration	$OH_{sampling}$	hour/day	1	—	—	—	—	See Section A.8.8
Equipment Cleaning Duration	OH_{equip}	hour/day	4	—	—	—	—	See Section A.8.8
Equipment Cleaning Loss Fraction	$F_{lab\_residue}$	kg/kg	0.02	—	—	—	—	See Section A.8.12

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A.8.3 Throughput Parameters

The *Use of Laboratory Chemicals – Generic Scenario for Estimating Occupational Exposures and Environmental Releases* ([U.S. EPA, 2023b](#)) provides daily throughput of *trans*-1,2-dichloroethylene required for laboratory stock solutions. According to the GS, laboratory liquid use rates range from 0.5 mL up to 4 L per day with a midpoint of 2 L/day. Laboratory stock solutions are used for multiple analyses and eventually need to be replaced. The expiration or replacement times range from daily to 6 months ([U.S. EPA, 2023b](#)). For this scenario, EPA assumes stock solutions are prepared daily. Therefore, the Agency initially assigned a triangular distribution for the daily throughput of laboratory stock solutions with upper and lower bounds corresponding to the high and low use rates, and the midpoint as the mode.

The daily throughput of *trans*-1,2-dichloroethylene in laboratory chemicals is calculated using Equation_Apx A-27 by multiplying the daily throughput of all laboratory solutions by the concentration of *trans*-1,2-dichloroethylene in the solutions and converting volume to mass.

Equation_Apx A-27.

$$Q_{chem\_site\_day} = Q_{stock\_site\_day} \times F_{112TCA} \times RHO \times \frac{0.001L}{mL}$$

Where:

$Q_{chem\_site\_day}$	=	Facility throughput of <i>trans</i> -1,2-dichloroethylene (kg/site-day)
$Q_{stock\_site\_day}$	=	Facility annual throughput of liquid laboratory chemicals (mL/site-day)
F_{t-DCE}	=	Concentration of <i>trans</i> -1,2-dichloroethylene in liquid laboratory chemicals (see Section A.8.7) (kg/kg)
RHO	=	Density of <i>trans</i> -1,2-dichloroethylene (kg/L)

A.8.4 Number of Sites

Per 2020 U.S. Census Bureau data for the NAICS codes identified in the *Use of Laboratory Chemicals – Generic Scenario for Estimating Occupational Exposures and Environmental Releases* ([U.S. EPA, 2023b](#)) there are 36,873 laboratory use sites ([U.S. BLS, 2016](#)). Therefore, this value is used as a bounding limit, not to be exceeded by the calculation. Number of sites is calculated using the following equation.:

Equation_Apx A-28.

$$N_s = \frac{PV}{Q_{chem\_site\_day} \times OD}$$

Where:

N_s	=	Number of sites (sites)
PV	=	Production volume (kg/year)
$Q_{chem\_site\_day}$	=	Facility daily throughput of <i>trans</i> -1,2-dichloroethylene (see Section A.8.3) (kg/site-yr)
OD	=	Operating days (days/yr)

A.8.5 Number of Containers Per Year

The number of *trans*-1,2-dichloroethylene laboratory containers unloaded by a site per year is calculated using the following equation:

Equation_Apx A-29.

$$N_{cont\_unload\_yr} = \frac{Q_{chem\_site\_day} \times OD}{F_{chem\_product} \times Q_{cont}}$$

Where:

$Q_{chem\_site\_day}$	=	Facility daily throughput of <i>trans</i> -1,2-dichloroethylene (see Section A.8.3) (kg/site-yr)
OD	=	Operating days (days/yr)
$F_{chem\_product}$	=	Mass fraction of <i>trans</i> -1,2-dichloroethylene in product (see Section A.8.7) (kg/kg)
Q_{cont}	=	Mass of <i>trans</i> -1,2-dichloroethylene in container (kg/container)

A.8.6 Operating Hours

EPA estimated operating hours or hours of duration using data provided from the Generic Scenario on Use of Laboratory Chemicals ([U.S. EPA, 2023b](#)), *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)), and/or through calculation from other parameters. Release points with operating hours provided from these sources include unloading, container cleaning, equipment cleaning, and product sampling.

For unloading and container cleaning (release points 1 and 4), the operating hours are calculated based on the number of containers unloaded at the site and the unloading rate using the following equation:

Equation_Apx A-30.

$$OH_{RP1/RP4} = \frac{N_{cont\_unload\_yr}}{RATE_{fill} \times OD}$$

Where:

$OH_{RP1/RP4}$	=	Operating time for release points 1 and 4 (hour/site-day)
$N_{cont\_unload\_yr}$	=	Annual number of containers unloaded (see Section A.8.5) (container/site-year)
$RATE_{fill}$	=	Container fill rate (see Section A.8.13) (containers/hour)
OD	=	Operating days (see Section A.8.6) (days/site-year)

For equipment cleaning (release point 6), the *ChemSTEER User Guide* provides an estimate of four hours per day for cleaning multiple vessels ([U.S. EPA, 2015a](#)). For product sampling (release point 7), the User Guide ([U.S. EPA, 2015a](#)) indicates a single value of 1 hour/day.

A.8.7 *trans*-1,2-Dichloroethylene Concentration in Laboratory Chemicals and Product Density

EPA used a two-dimensional sampling technique to model the *trans*-1,2-dichloroethylene weight fraction. A discrete distribution is used to model the frequency of occurrence of each product type. For each product, the concentration of *trans*-1,2-dichloroethylene was reported as a range. The Agency used a uniform distribution to model the *trans*-1,2-dichloroethylene weight fraction within each product type. On each iteration of the simulation, the model executes each product's weight fraction distribution and the product frequency distribution. The model then reads the product selected from the product frequency distribution, product density, and selects the product weight fraction that was generated from the corresponding product's weight fraction distribution. Table_Apx A-19 provides a summary of the reported *trans*-1,2-dichloroethylene content reported in the SDSs and the fractional probability of each product type.

Table Apx A-19. Summary of *trans*-1,2-Dichloroethylene Based Laboratory Formulations

Product Name	<i>trans</i> -1,2-Dichloroethylene Concentration		Product Density (kg/m ³)	Fractional Probability
	Low-End	High-End		
30043 / 502.2 Calibration Mix #2	20	20	1,256.5	0.25
30006 / VOA Calibration Mix #1	20	20	1,256.5	0.25
30601 / Drinking Water VOA MegaMix™, 524.2 Rev 4.1	20	20	1,256.5	0.25
Aerotron AE	55	100	1,256.5	0.25

A.8.8 Operating Days

EPA modeled the operating days per year using a discrete distribution with a low end of 174 days/year and a high end of 260 days/year. These values were based on U.S. BLS Occupational Employment Statistics ([U.S. BLS, 2016](#)). Per the BLS website, operating duration for each NAICS code is assumed as a “year-round, full-time” hours figure of 2,080 hours ([U.S. BLS, 2016](#)). Therefore, dividing this time by an assumed working duration of 8 or 12 hours/day yields 174 or 260 days/year. To ensure that only integer values of this parameter were selected, EPA modeled a discrete distribution that listed each integer between (and including) 174 and 260 days/year.

A.8.9 Air Speed

Baldwin and Maynard measured indoor air speeds across a variety of occupational settings in the United Kingdom ([Baldwin and Maynard, 1998](#)). Fifty-five work areas were surveyed across a variety of workplaces. EPA analyzed the air speed data from that study and categorized the air speed surveys into settings representative of industrial facilities and representative of commercial facilities. EPA fit separate distributions for these industrial and commercial settings and used the industrial distribution for this OES.

EPA fit a lognormal distribution for the data set as consistent with the authors’ observations that the air speed measurements within a surveyed location were lognormally distributed and the population of the mean air speeds among all surveys were lognormally distributed ([Baldwin and Maynard, 1998](#)). Because lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the largest observed value among the survey mean air speeds.

EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model, the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard) to prevent the model from sampling values that approach infinity or are otherwise unrealistically small or large ([Baldwin and Maynard, 1998](#)).

Baldwin and Maynard only presented the mean air speed of each survey. The authors did not present the individual measurements within each survey. Therefore, these distributions represent a distribution of mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting. However, a mean air speed (averaged over a work area) is the required input for the model. EPA converted the units to ft/min prior to use within the model equations.

A.8.10 Saturation Factor

The CEB Manual indicates that during splash filling, the saturation concentration was reached or exceeded by misting with a maximum saturation factor of 1.45 ([CEB, 1991](#)). The CEB Manual indicates that saturation concentration for bottom filling was expected to be about 0.5 ([CEB, 1991](#)). The underlying distribution of this parameter is not known; therefore, the Agency assigned a triangular distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was not provided for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling minimizes volatilization ([CEB, 1991](#)). This value also corresponds to the typical value provided in the *ChemSTEER User Guide* for the EPA/OAQPS AP-42 Loading Model ([U.S. EPA, 2015a](#)).

A.8.11 Container Size

The Generic Scenario on Use of Laboratory Chemicals ([U.S. EPA, 2023b](#)) states that laboratory chemicals are packaged in bottles, typically one gallon in size (liquids). According to the *ChemSTEER User Guide*, bottles are defined as containing between one and five gallons of liquid ([U.S. EPA, 2015a](#)). EPA identified laboratory products containing *trans*-1,2-dichloroethylene as having available container sizes as small as 1 mL (liquids). EPA built a triangular distribution for liquid volumes with a lower bound of 0.00026 gallons (1 mL), an upper bound of 0.66 gallons (250mL), and median of 0.066 gallons (25 mL) based on the identified products.

A.8.12 Container Loss Fraction

EPA used data from the PEI Associates Inc. study ([PEI Associates, 1988](#)) and the EPA/OPPT Small Container Residual Model. For unloading drums by pouring in the PEI Associates Inc. study ([PEI Associates, 1988](#)), EPA found that the average percent residual from the pilot-scale experiments showed a range of 0.03% to 0.79% with an average of 0.32%. The EPA/OPPT Small Container Residual Model from the *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)) recommends a default central tendency loss fraction of 0.3% and a high-end loss fraction of 0.6%.

The underlying distribution of the loss fraction parameter for small containers is not known; therefore, the Agency assigned a triangular distribution, since triangular distributions require least assumptions and are completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for the loss fraction probability distribution using the central tendency and high-end values, respectively, prescribed by the EPA/OPPT Small Container Residual Model in the *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)). EPA assigned the minimum value for the triangular distribution using the minimum average percent residual measured in the PEI Associates, Inc. study ([PEI Associates, 1988](#)) for emptying drums by pouring.

A.8.13 Small Container Fill Rate

The *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)) provides a typical fill rate of 60 containers per hour for containers with less than 20 gallons of liquid.

A.8.14 Diameters of Opening

For container cleaning activities, the *ChemSTEER User Guide* indicates a single default value of 5.08 cm for containers less than 5,000 gallons ([U.S. EPA, 2015a](#)).

A.8.15 Equipment Cleaning Loss Fraction

For liquids, EPA used the EPA/OPPT Multiple Process Residual Model to estimate the releases from equipment cleaning. As detailed in the *ChemSTEER User Guide* ([U.S. EPA, 2015a](#)), it provides an overall loss fraction of 2% from equipment cleaning.

A.9 Occupational Dermal Exposure Modeling Method

This appendix presents the modeling approach and equations to estimate occupational dermal exposures. This method was developed through review of relevant literature and consideration of existing exposure models, such as EPA/OPPT models.

A.9.1 Dermal Dose Equation

EPA used the following equation to estimate the acute potential dose rate (APDR) from occupational dermal exposures:

Equation_Apx A-31.

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

Where:

S	=	Is the surface area of skin in contact with the chemical formulation (cm ²)
Q_u	=	Is the dermal load (<i>i.e.</i> , the quantity of the chemical formulation on the skin after the dermal contact event, mg/cm ² -event)
f_{abs}	=	Is the fractional absorption of the chemical formulation into the stratum corneum, accounting for evaporation of the chemical from the dermal load, Q_u (unitless, $0 \leq f_{abs} \leq 1$)
Y_{derm}	=	Is the weight fraction of the chemical of interest in the liquid (unitless, $0 \leq Y_{derm} \leq 1$); and
FT	=	Frequency of events (integer number/day).

The inputs to the dermal dose equation are described in Appendix A.9.2.

A.9.2 Model Input Parameters

Table_Apx A-20 summarizes the model parameters and their values for estimating dermal exposures. Additional explanations of EPA's selection of the inputs for each parameter are provided in the subsections after the following table.

9643 **Table_Apx A-20. Summary of Dermal Model Input Values**

Input Parameter	Symbol	Unit	Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale
			Value	Lower Bound	Upper Bound	Mode	Distribution Type	
Surface Area	S	cm ²	1,070	0	1,070	–	Uniform	See Appendix A.9.2.1
Dermal Load	Q _u	mg/cm ² -event	2.1	0.7	2.1	–	Uniform	See Appendix A.9.2.2
Frequency of Events	FT	events/day	1	–	–	–	–	See Appendix A.9.2.5
Fraction Absorbed	F _{abs}	unitless	0.015	0.007	0.017	–	Uniform	See Appendix A.9.2.3
Chemical Weight Fraction	Y _{derm}	unitless	OES-dependent	–	–	–	–	See Appendix A.9.2.4
Exposure Days	EF	days/yr	OES-dependent	–	–	–	–	See Appendix A.9.2.5

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A.9.2.1 Surface Area

EPA used an exposed skin surface area (S) for workers of 1,070 cm² for the upper bound based on the mean two-hand surface area for adult males ages 21 years or older from Chapter 7 of EPA's *Exposure Factors Handbook* ([U.S. EPA, 2011](#)). For the lower bound, EPA assumed the exposure surface area was zero. The uniform distribution of surface areas used in the Monte Carlo analysis results with a median equivalent to a single hand (or 1 side 2 hands) *i.e.*, 535 cm² for workers.

It should be noted that while 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 the Agency assume that the entirety of the hands is exposed for all activities. Rather, EPA assumed that dermal exposures occur to some portion of the hands plus some portion of other body parts (*e.g.*, arms).

A.9.2.2 Dermal Load

The dermal load (Q_u) is the quantity of chemical on the skin after the dermal contact event. This value represents the quantity remaining after the bulk chemical formulation has fallen from the hand that cannot be removed by wiping the skin (*e.g.*, the film that remains on the skin). To estimate the dermal load from each activity, EPA used data from references cited by EPA's September 2013 engineering policy memorandum: *Updating CEB's Method for Screening-Level Assessments of Dermal Exposure* ([U.S. EPA, 2013](#)). That memorandum provides for the following dermal exposure scenarios:

- Routine and incidental contact with liquids (*e.g.*, maintenance activities, manual cleaning of equipment, filling drums, connecting transfer lines, sampling, and bench-scale liquid transfers);
- Routine immersion in liquids (*e.g.*, handling of wet surfaces and spray painting);
- Routine contact with container surfaces (*e.g.*, handling closed or empty bags of solid materials); and
- Routine, direct handling of solids (*e.g.*, filling/dumping containers of powders/flakes/granules, weighing powder/scooping/mixing, handling wet or dried material in a filtration and drying process).

For liquids, the memorandum uses values of 0.7 to 2.1 mg/cm²-event for routine or incidental contact with liquids and 1.3 to 10.3 mg/cm²-event for routine immersion in liquids ([U.S. EPA, 2013](#)). EPA used the maximum from each range to estimate high-end dermal loads. The memorandum does not provide recommended values for a central tendency dermal loading estimate. Therefore, the Agency analyzed data from EPA's *A Laboratory Method to Determine the Retention of Liquids on the Surface of the Hands* ([U.S. EPA, 1992b](#)) that served as the basis for the liquid dermal loads provided in the 2013 memorandum. To estimate central tendency liquid dermal loading values, EPA used the 50th percentile of the dermal loading results from the study for each type of activity (*i.e.*, routine/incidental contact and immersion). The 50th percentile was 1.7 mg/cm²-event for routine/incidental contact with liquids and 3.8 mg/cm²-event for routine immersion in liquids.

For *trans*-1,2-dichloroethylene, EPA applied a uniform distribution of 0.7 to 2.1 mg/cm²-event, respectively, for each OES.

A.9.2.3 Fractional Absorption

The Dermal Exposure to Volatile Liquids Model accounts for evaporation through the fraction absorbed parameter which is a measure of the fraction absorbed to the skin with the remainder lost to evaporation. Values for *trans*-1,2-dichloroethylene were obtained via test order (Docket: [EPA-HQ-2018-0465-0045](#)). In the study ([TDCE Consortium, 2023](#)), finite doses were applied to human skin samples as a neat material, 10% solution, 1% solution, and 0.1% solution. Solutions were prepared with both IPM and

toluene to compare the effect of mixture components on absorption of *trans*-1,2-dichloroethylene. For occupational exposure scenarios, all COUs involve handling *trans*-1,2-dichloroethylene in a concentration greater than 10%. The results of the 10% test preparation in IPM (when statistically adjusted, see ([U.S. EPA, 2026i](#))) showed mean absorption of 1.2%, and after the application of the EFSA upper confidence adjustment, percent absorbed ranged from 0.7 to 1.7%. Therefore, EPA employed a Monte Carlo model of occupational dermal exposure with a uniform distribution for percent absorbed ranging from 0.7 to 1.7%.

A.9.2.4 Chemical Weight Fraction

Table Apx A-21 summarizes the chemical weight fraction parameters for each OES and the associated distribution type.

Table Apx A-21. Chemical Weight Fraction Model Input Parameters

OES	Lower Bound	Upper Bound	Distribution Type	Rationale / Basis
Manufacture	0.9	1.0	Uniform	Based on 2020 and 2024 CDR data.
Manufacture as a Byproduct	0.0125	0.0125	Static	About 1.25 lb of mixed chlorinated organic liquids are unintentionally produced per 100 lb of ethylene dichloride manufactured (VI, 2020).
Repackaging	1.0	1.0	Static	Assumed repackaged at 100% concentration
Processing as a Reactant	1.0	1.0	Static	Assumed processed at 100% concentration
Incorporation into Formulation, Mixture, or Reaction Product	0.01	1.0	Uniform	Range of formulated products. Assumed to arrive at formulation sites at 100% concentration, then formulated into lower product concentrations.
Vapor Degreasing	0.01	1.0	Discrete	Discrete distribution based on product data
Miscellaneous Non-Aerosol Industrial and Commercial Uses	0.01	1.0	Discrete	Discrete distribution based on product data
Commercial Aerosol Products	0.01	1.0	Discrete	Discrete distribution based on product data
Application of Paints and Coatings	0.01	0.85	Discrete	Discrete distribution based on product data
Use of Adhesives and Sealants	0.01	0.70	Discrete	Discrete distribution based on product data
Blowing Agent in Spray Foam	0.01	0.05	Discrete	Discrete distribution based on product data
Use as a Laboratory Chemical	0.2	1.0	Discrete	Discrete distribution based on product data
Refrigerant and Refrigerant Flush	0.25	0.90	Discrete	Discrete distribution based on product data
Waste Handling, Disposal, Treatment, and Recycling	0.01	1.0	Uniform	Based on range of upstream concentrations.

A.9.2.5 Frequency of Events and Number of Exposure Days

The frequency of events, FT, refers to the number of dermal exposure events/day. Depending on the OES, workers may perform multiple activities throughout their shift that could potentially result in dermal exposures. Equation_Apx A-31 shows a linear relationship between FT and APDR; however, this fails to account for time between contact events. Because the chemical simultaneously evaporates from and absorbs into the skin, dermal exposure is a function of both the number of contact events/day and the time between contact events. Subsequent dermal exposure events may only meaningfully increase the dermal dose if there is sufficient time between the contact events to allow for significant evaporation/absorption of the previous exposure event. EPA did not identify information on how many contact events may occur and the time between contact events. Therefore, the Agency assumes a single contact event/day for estimating dermal exposures for all OES. EPA estimates the number of exposure days per year for each OES according to Table_Apx A-22.

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Table_Apx A-22. Exposure Days by OES

OES	Lower Bound	Upper Bound	Distribution Type	Notes/Comments
Manufacture	250	250	Static	Assumed 250 days/yr based on typical worker schedule
Manufacture as a Byproduct	250	250	Static	Assumed 250 days/yr based on typical worker schedule
Repackaging	167	250	Discrete	Provided by the Chemical Repackaging Generic Scenario. Obtained by multiplying the number of operating days (174-260 days/year) by the fraction of operating days with worker exposure (0.962 exposure days/operating days).
Processing as a Reactant	250	250	Static	Assumed 250 days/yr based on typical worker schedule
Incorporation into Formulation, Mixture, or Reaction Product	250	250	Static	Assumed 250 days/yr based on typical worker schedule
Vapor Degreasing	250	250	Static	Provided by the ESD on the Use of Vapour Degreasers
Miscellaneous Non-Aerosol Industrial and Commercial Uses	250	250	Static	Assumed 250 days/yr based on typical worker schedule
Commercial Aerosol Products	250	250	Static	Provided by ESD on Spray Coating in Automotive Industry
Application of Paints and Coatings	250	250	Static	Assumed 250 days/yr based on typical worker schedule
Use of Adhesives and Sealants	250	250	Static	Assumed 250 days/yr based on typical worker schedule
Blowing Agent in Spray Foam	250	250	Static	Assumed 250 days/yr based on typical worker schedule
Commercial Laboratory Use	167	250	Discrete	Provided by the Use of Laboratory Chemicals Generic Scenario. Obtained by multiplying the number of operating days (174-260 days/year) by the fraction of operating days with worker exposure (0.962 exposure days/operating days).
Refrigerant and Refrigerant Flush	250	250	Static	Assumed 250 days/yr based on typical worker schedule
Waste Handling, Treatment, Disposal, and Recycling	250	250	Static	Assumed 250 days/yr based on typical worker schedule

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Appendix B PROCEDURES FOR MAPPING FACILITIES FROM STANDARD ENGINEERING SOURCES TO OCCUPATIONAL EXPOSURE SCENARIOS AND CONDITIONS OF USE

B.1 Conditions of Use and Occupational Exposure Scenarios

Condition of Use (COU)

TSCA section 3(4) defines COUs as “the circumstances, as determined by the Administrator, under which a chemical substance is intended, known, or reasonably foreseen to be manufactured, processed, distributed in commerce, used, or disposed of.” COUs included in the scope of EPA’s risk evaluations are typically tabulated in scope documents and risk evaluation documents as summaries of life cycle stages, categories, and subcategories of use, as shown in Table_Apx B-1. Therefore, a COU is defined as a combination of life cycle stage, category, and subcategory. The Agency identifies COUs for chemicals during the scoping phase; however, this process is not discussed in this draft TSD.

Occupational Exposure Scenario (OES)

Thus far, EPA has not adopted a standardized definition for OES. The purpose of an OES is to group or segment COUs for assessment of releases and exposures based on similarity of the operations and data availability for each COU. For example, EPA may assess a group of multiple COUs together as one OES due to similarities in release and exposure potential (*e.g.*, the COUs for formulation of paints, formulation of cleaning solutions, and formulation of other products may be assessed together as a single OES). Alternatively, EPA may assess multiple OES for one COU because there are different release and exposure potentials for a given COU (*e.g.*, the COU for batch vapor degreasing may be assessed as separate OES for open-top vapor degreasing and closed-loop vapor degreasing). OES determinations are also largely driven by the availability of data and modeling approaches to assess occupational releases and exposures. For example, even if there are similarities between multiple COUs, if there is sufficient data to separately assess releases and exposures for each COU, and evidence that the exposure scenarios are distinct enough that it would be appropriate to assess them separately, EPA would not group them into the same OES. This is depicted in Figure_Apx B-1.

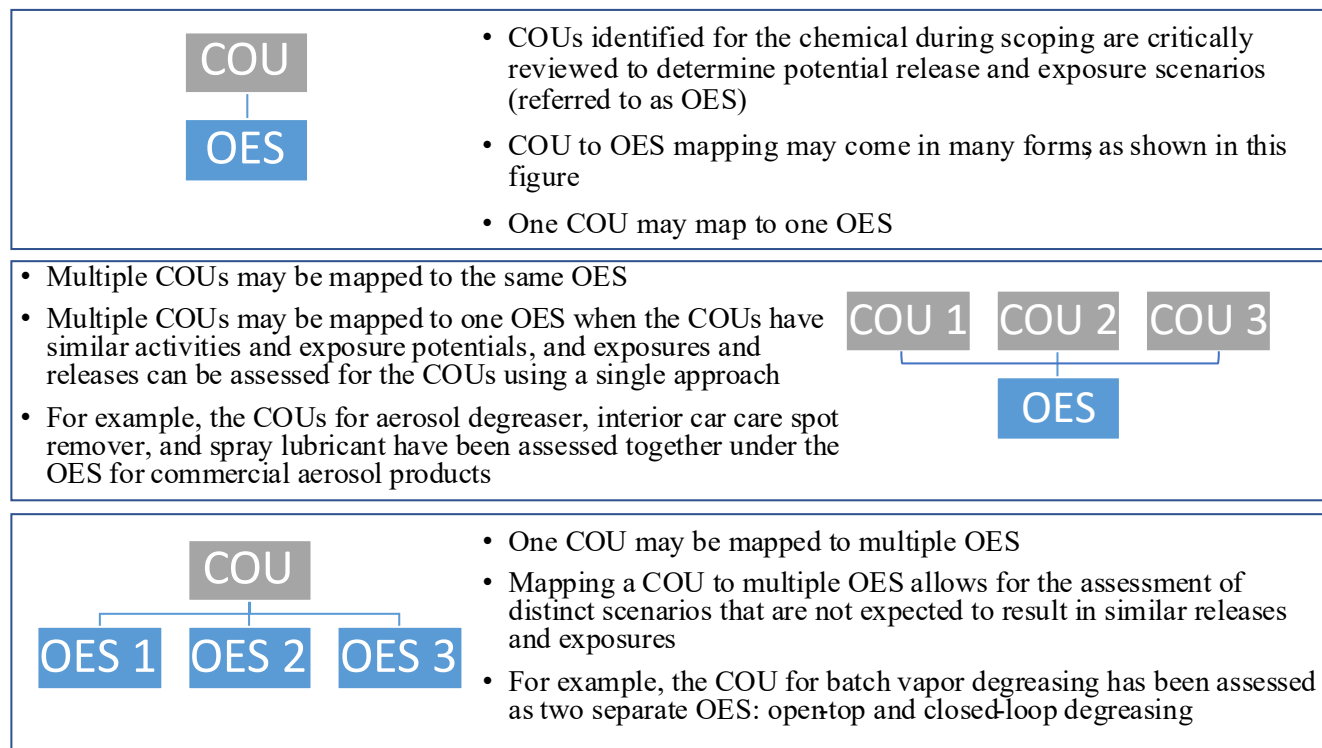
For chemicals undergoing risk evaluation, EPA maps each industrial and commercial COU to one or more OESs based on reasonably available data and information (*e.g.*, CDR, use reports, process information, public and stakeholder comments), assumptions, and inferences that describe how release and exposure take place within a COU. The Agency identify OESs for COUs—not vice-versa (*i.e.*, COUs are not altered during OES mapping). The mapping of COUs to OES is separate from and occurs after the identification of COUs. Both the identification of COUs and subsequent mapping of COUs to OESs occur early in the risk evaluation process and are described in this document in Section 4. This section is intended to just provide background context on COUs and OESs.

9749 **Table_Apx B-1. Example Condition of Use Table with Mapped Occupational Exposure Scenarios**

COU			OES
Life Cycle Stage	Category ^a	Subcategory ^b	
Manufacturing	Domestic manufacturing	Domestic manufacturing	Manufacturing
	Import	Import	Repackaging
Processing	As a reactant	Intermediate in all other basic organic chemical manufacturing	Processing as a Reactant
	Processing – Incorporation into formulation, mixture, or reaction product	Solvents (for cleaning or degreasing)	Formulation
		Adhesives and sealant chemicals	
	Repackaging	Solvents (for cleaning or degreasing)	Repackaging
	Etc.		

^a Categories reflect Chemical Data Reporting (CDR) codes and broadly represent the industrial and/or commercial settings of the condition of use (COU).
^b The subcategories reflect more specific COUs.

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Figure_Apx B-1. Condition of Use to Occupational Exposure Scenario Mapping Options

B.2 Standard Sources Requiring Facility Mapping

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The Agency utilizes release data from EPA programmatic databases and exposure data from standard sources to complete occupational exposure and environmental release assessments, which are described below:

- [Chemical Data Reporting \(CDR\)](#) (accessed July 29, 2026), to which import and manufacturing sites producing the chemical at or above a specified threshold must report. EPA uses CDR to identify COUs, OES, sites that import or manufacture the chemical, and for information on physical form and concentration of the chemical. In addition, EPA is currently developing the Tiered Data Reporting (TDR) rule, which would establish reporting requirements, including changes to CDR, to collect information that better meets data needs for the TSCA existing chemical program. The rule is expected to have reporting requirements tiered to specific stages of existing chemical assessments (*e.g.*, prioritization, risk evaluation) and harmonized to the Organization for Economic Co-operation and Development (OECD) risk assessment framework, which would help to better inform uses of chemicals and improve upon the OES mapping procedures in this document.
- [Toxics Release Inventory \(TRI\)](#) (accessed July 29, 2026), to which facilities handling a chemical covered by the TRI program at or above a specified threshold must report. EPA uses TRI data to quantify air, water, and land releases of the chemical undergoing risk evaluation.
- [Discharge Monitoring Report \(DMR\)](#) (accessed July 29, 2026), a periodic report required of National Pollutant Discharge Elimination System (NPDES) permitted facilities discharging to surface waters. EPA uses NEI data to quantify surface water discharges of the chemical undergoing risk evaluation.
- Occupational Safety and Health Administration (OSHA): [Chemical Exposure Health Data \(CEHD\)](#) (accessed July 29, 2026), a compilation of industrial hygiene samples taken when OSHA monitors worker exposures to chemical hazards. EPA uses OSHA CEHD to quantify occupational inhalation exposures to the chemical undergoing risk evaluation.
- National Institute of Occupational Safety and Health (NIOSH): [Health Hazard Evaluations \(HHEs\)](#) (accessed July 29, 2026), a compilation of voluntary employee, union, or employer requested evaluations of health hazards present at given workplace. EPA uses NIOSH HHE data to quantify occupational inhalation exposures to the chemical undergoing risk evaluation.

To utilize the data from these sources, the facilities that report to each must first be mapped to an OES. Other sources of data for specific facilities may require mapping the facilities to an OES; however, this document covers the most common data sources. Additionally, EPA often uses data from sources such as public and stakeholder comments, GSs, and process data that are usually not specific to an individual site; therefore, unlike the above sources, they do not involve mapping specific sites to an OES.

Mapping procedures for the above sources are discussed in detail in the subsequent sections; however, Table_Apx B-2 includes a summary of the type of information reported by companies in each database that helps to inform OES and COU mapping. This includes industrial classification codes such as those associated with the [NAICS](#) and [Standard Industrial Classification](#) (SIC) system (both URLs accessed July 29, 2026). Note that the U.S. government replaced SIC codes with NAICS codes in 1997; however, SIC codes are still used in DMR and are applicable for data from all listed sources for years prior to 1997. Additionally, some of the sources in Table_Apx B-2 have specific reporting requirements that include flags for the type of processes that occur at the site.

Assessors should be sure that a facility that reports to multiple databases/sources is consistently mapped to the same OES, as applicable. This is not applicable if the facility reports separately for different areas/processes of their facility (*e.g.*, a large chemical plant may report 1 block of unit operations separate from another such that they have different OESs).

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Table Apx B-2. EPA Programmatic Database Information That Aids OES/COU Mapping

Source	Reported Information Useful for Mapping OES/COU	Reporting Frequency	Notes
CDR	- Indication if the chemical is imported or domestically manufactured - Indication if the chemical is imported but never at the site, used on-site, or exported	- Facilities must report to CDR every 4 years - New datasets take years to become publicly available - Latest reporting year with available data: 2024	- While CDR also includes information on downstream processing and use, it does not include site identities for these operations; thus, it does not inform reporting site OES/COU mapping. - Claims of confidential business information (CBI) can limit data transparency in risk evaluations.
TRI	- NAICS codes - Flags for uses and sub-uses of the chemical - Release media information	- Facilities must report to TRI annually - New datasets become publicly available in October for the previous year - Latest reporting year with available data: 2023	- Reporters must select from specific uses (<i>e.g.</i>, manufacture, import, processing) and sub-uses (<i>e.g.</i>, formulation additive, degreaser, lubricant). - Sub-use information is only available in datasets starting in 2018. - Facilities may report with a Form A under certain circumstances; Form A's do not require use/sub-use reporting^a.
DMR	- SIC codes - NPDES) permit numbers	- Facilities must report to DMR at the frequency specified in their NPDES permit, which is typically monthly - Data typically flows through the State DMR reporting platform to EPA's ECHO database continuously	- Sites that only report non-detection of the chemical for the year are generally excluded from mapping. - NPDES permit numbers can sometimes indicate the type of general permit, which can inform mapping (<i>e.g.</i>, remediation general permit).
OSHA	- NAICS or SIC codes	- OSHA conducts monitoring as-needed for site investigations - Monitoring data is available in CEHD when the investigation and any subsequent litigation cases are closed - Latest year in CEHD with data: 2025	- CEHD includes data from 1984 and forward.
NIOSH HHE	- Facility process information - Worker activities	- NIOSH conducts HHEs upon request - HHEs are published online when NIOSH is completed with the evaluation - Latest year with a published HHE: 2025	- NIOSH HHEs generally include narrative descriptions of facility processes and worker activities, with specific information on how the chemical being monitored for is used.

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Source	Reported Information Useful for Mapping OES/COU	Reporting Frequency	Notes
CDR = Chemical Data Reporting; CEHD = Chemical Exposure Health Data; DMR = Discharge Monitoring Report; ECHO = Enforcement and Compliance History Online; HHE = Health Hazard Evaluation; NAICS = North American Industry Classification System; NIOSH = National Institute for Occupational Safety and Health; NPDES = National Pollutant Discharge Elimination System; OSHA = Occupational Safety and Health Administration; SIC = Standard Industrial Classification; TRI = Toxics Release Inventory ^a Facilities may report using a Form A if the annual reportable release amount of the chemical did not exceed 500 lb for the reporting year, and the amounts manufactured, or processed, or otherwise used did not exceed 1 million lb for that year.			

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B.3 OES Mapping Procedures

This section contains procedures for mapping facilities to OES for each source discussed in Section B.2.

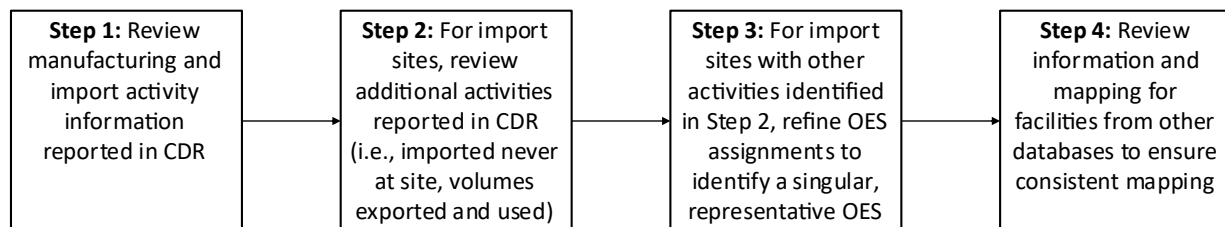
B.3.1 Chemical Data Reporting (CDR)

The only facilities required to report to CDR are those that manufacture or import specific chemicals at or above a specified threshold.¹² Therefore, sites that report for the chemical of interest in CDR will generally be mapped to either the Manufacturing or Import/repackaging OES. These sites must also report the processing and uses of the chemical; however, these procedures are specific to mapping of the reporting site and not downstream processing or use sites.

CDR, under TSCA, requires manufacturers (including importers) to provide EPA with information on the production and use of chemicals in commerce. These facilities must report to CDR every 4 years. For risk evaluations conducted under the amended TSCA, EPA has primarily used 2016, 2020, and 2024 CDR. The procedures in this document are applicable to CDR data; however, there are some data elements that are only applicable to 2020 or 2024 CDR, which are called out in the procedures where applicable. These procedures should be applicable to future CDR reporting, depending on changes to reporting requirements. If the Tiered Data Reporting (TDR) rule is promulgated, these procedures will be updated accordingly.

Chemical data reported under CDR is classified using Industrial Function Category (IFC) codes and/or commercial/consumer use product categories (PCs). CDR IFC codes describe the “intended physical or chemical characteristics for which a chemical substance or mixture is consumed as a reactant; incorporated into a formulation, mixture, reaction product, or article, repackaged; or used.” Alternatively, PCs describe the consumer and commercial products in which each reportable chemical is used. EPA typically uses these CDR codes to identify the COUs for the chemical in scope documents.

Figure_Apx B-2 depicts the steps that should be followed to map CDR reporting sites to OES. Each step is explained in the text below the figure. Additionally, Section B.5.1 shows step-by-step examples for using the mapping procedures to determine the OES for three example CDR reporting facilities.



Figure_Apx B-2. OES Mapping Procedures for CDR

¹² See [2024 CDR reporting instructions](#) (accessed July 29, 2026) for further information, including descriptions on the information required to be reported.

To map sites reporting to CDR, the following procedures should be used with the non-CBI CDR:

1. ***Review Manufacturing and Import Activity Information:*** The first step in the process is to review the reported activity information to identify if the facility imports or manufactures the chemical.
 - a. If the facility reports domestic manufacturing, the manufacturing OES should be assigned, even if the facility also reports importation or the facility may conduct other operations with the chemical. This is because manufacturing of the chemical is expected to be the primary operation, with any other processing or uses being ancillary operations.
 - b. If the chemical is being manufactured as a byproduct (this is a voluntary reporting element starting in 2020 CDR), this may need to be considered separately from non-byproduct manufacturing depending on assessment needs for the chemical.
 - c. If the facility does not manufacture the chemical and only imports the chemical, check if additional processes occur at the site as described in the subsequent steps.
2. ***For Importation Sites, Review Fields for “Imported Never at Site,” “Volume Exported,” and “Volume Used”:*** The next step is to review these additional fields to determine if the reporting facility conducts more than just importation activities.
 - a. If the facility imports the chemical, they must report if it is imported but never physically at the reporting site. If the facility indicates the chemical is imported and never at site, the facility does not handle the chemical and the only applicable OES is importation. In such cases, the assessor should proceed to Step 4. If the facility does not indicate the chemical is imported and never at site, proceed to Step 2b.
 - b. If the facility reports a quantity for “volume exported” and this quantity is the same as that imported, no additional OES occurs at the site beyond importation. In such cases, the assessor should proceed to Step 4. If the exported quantity is not equal to volume imported, assessors should check if any of the chemical is used at the reporting site per Step 2c.
 - c. If the facility reports a quantity for “volume used”, additional OES may be applicable to the facility beyond manufacturing or importation. Proceed to Step 3 to identify and refine additional OES.
3. ***Refine OES Assignments:*** If multiple OES were identified from the previous steps, a single primary OES must be selected using additional facility information. OES determinations should be made with the following considerations:
 - a. 6-digit NAICS code reported by the facility in CDR – note that this is only a requirement starting in 2020 CDR (*e.g.*, for a facility that reported NAICS code was 325520, Adhesive Manufacturing, the incorporation into a formulation, mixture, or reaction product OES may be appropriate; for a facility reporting a NAICS code starting in 424690, Other Chemical and Allied Products Merchant Wholesalers, only the repackaging OES is likely applicable).
 - b. Downstream processing and use information reported in CDR. The reporting site must provide information on downstream processing and use of the chemical for all sites, meaning it cannot be distinguished which processing and use information includes the reporting site operations vs. downstream site operations. However, this information may still help inform the operations at the reporting site and should be reviewed. Specifically,

for a given processing/use activity, if the submitter reports “Fewer than 10 sites” for the “number of sites” field (which is the lowest number of sites that can be reported), there is a likelihood that the facility’s operations may be included in this processing/use activity. In such cases, review the corresponding fields for “type of processing or use operation,” “industrial sector,” and “function category” to help identify the OES. The greater number of sites that are reported, the more likely that the associated processing and use information includes information from downstream sites and the less reliable the information is for mapping OES to the reporting site.

- c. Internet research of the types of products made at the facility (*e.g.*, if a facility’s website indicates the facility manufactures plastic products, the chemical may be used as a processing aid or component in the plastic products, depending on the known uses of the chemical within the plastics industry).
- d. Information from other reporting databases as described in Step 2c.
- e. An evaluation of the OES that is most likely to result in a release (*e.g.*, for facilities that reported importation and may also conduct formulation per the reported NAICS code, the formulation OES may be assigned, because, in most cases, importation would have a lower likelihood of a release).
- f. Grouped OES for similar uses (*e.g.*, multiple facilities that may conduct formulation operations based on the reported NAICS code may be assigned a grouped formulation OES that covers all types of formulation [*e.g.*, adhesives, paints, cleaning products])).

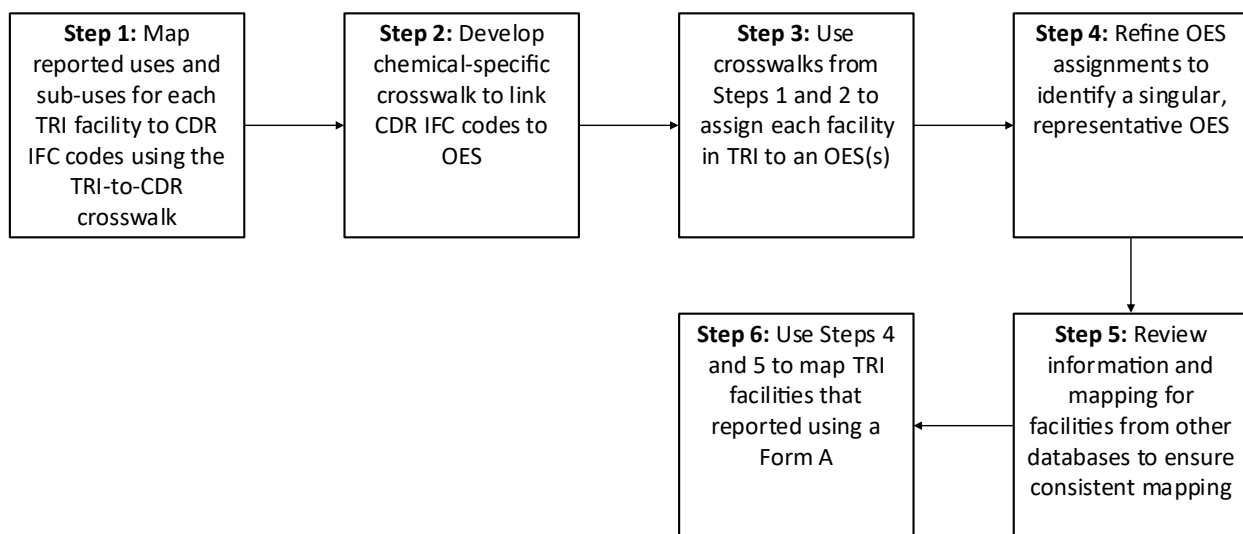
4. ***Review Information from Other Databases:*** Other databases/sources (such as TRI and DMR) should be checked to see if the facility has reported to these. If so, the OES determined from the mapping procedures for those databases (discussed in other sections of this document) should also be used. It is important that the same facility is mapped consistently across multiple databases/sources. The facility’s TRI identification number (TRFID) and Facility Registry Services identification number (FRS ID) can be used to identify sites that report to TRI and DMR. If the facility does not report to these databases, but additional OES are possible per Step 2, the assessor should search available facility information on the internet.

Given the information available in CDR, EPA expects that, for most chemicals, 100% of the sites reporting to CDR can feasibly be mapped to an OES.

B.3.2 Toxics Release Inventory (TRI)

TRI reporting is required for facilities that manufacture (including import), process, or otherwise use any TRI-listed chemical in quantities greater than the established threshold in the calendar year AND have 10 or more full-time employee equivalents (*i.e.*, a total of 20,000+ hours) and are included in a covered NAICS code. Therefore, unlike CDR reporters that are primarily manufacturers and importers, TRI reporters can be mapped to a variety of different OES.

Figure_Apx B-3 depicts the steps that should be followed to map TRI reporting sites to OES. Each step is explained in the text below the figure. Additionally, Section B.5.2 shows step-by-step examples for using the mapping procedures to determine the OES for three example TRI reporting facilities.



Figure_Apx B-3. OES Mapping Procedures for TRI

To map sites reporting to TRI, the following procedures should be used:

1. **Assign Chemical Data Reporting Codes Using TRI-to-CDR Crosswalk:** The first step in the TRI mapping process is to map the uses and sub-uses reported by each facility to one or more 2016 CDR IFC codes. To do this, first compile all TRI uses/sub-uses for the reporting facility into a single column, then map them to CDR IFC codes using the TRI-to-CDR Use Mapping crosswalk. This is a universal crosswalk that applies to all chemicals.
2. **Develop Chemical-Specific Crosswalk to Link CDR Codes to OES:** The next step is to develop a separate CDR IFC code-to-OES crosswalk that links CDR IFC codes to OES for the chemical. To create this crosswalk, match the COU categories and subcategories from the COU table in the published scope documents to the list of 2016 CDR IFC codes in the CDR reporting instructions.¹³ The categories and subcategories of COUs typically match the IFC code category. Recent examples of already completed CDR IFC code-to-OES crosswalk can be found for the fenceline chemicals (1-bromopropane, methylene chloride, n-Methylpyrrolidone, carbon tetrachloride, perchloroethylene, trichloroethylene, and 1,4-dioxane).
3. **Assign OESs:** Each TRI facility is then mapped to one or more OES using the CDR IFC codes assigned to each facility in Step 1 and the CDR IFC code-to-OES crosswalk developed in Step 2.
4. **Refine OES Assignments:** If a facility maps to more than one OES in Step 3, a single primary OES must be selected using additional facility information. OES determinations should be made with the following considerations:
 - a. 6-digit NAICS codes reported by the facility in TRI (e.g., for a facility that reported TRI uses for both formulation and use as cleaner, EPA assigned the Formulation OES if the NAICS code was 325199, All Other Basic Organic Chemical Manufacturing; another example is NAICS codes 562211, Hazardous Waste Treatment and Disposal, and 327310, Cement Manufacturing, almost always correspond to the disposal OES, regardless of the reported TRI uses and sub-uses).

¹³ Function Category (FC) codes (previously called IFC) and their definitions can be found in Table 4-15 of the [2024 CDR reporting instructions](#) (accessed July 29, 2026).

- b. Internet research of the types of products made at the facility (*e.g.*, if a facility's website indicates the facility manufactures metal parts, the facility is likely to use chemicals for degreasing or in a metalworking fluid) and information from sources cited in the COU table and scoping document, such as public and stakeholder comments (*i.e.*, EPA will review sources cited in the COU table and scoping document to see if there is any information specific to the reporting site that can be used to inform the mapping).
- c. Information from other reporting databases as described in Step 5.
- d. An evaluation of the OES that is most likely to result in a release (*e.g.*, facilities that reported both importation and formulation may be assigned a formulation OES, because, in most cases, importation would have a lower likelihood of a release).
- e. Grouped OES for similar uses/sub-uses (*e.g.*, facilities that reported cleaner and degreaser sub-uses may be assigned a grouped OES that covers both cleaning and degreasing because the specific cleaning/degreasing operation cannot be determined from the TRI data).

5. **Review Information from Other Databases:** Other databases/sources (including CDR, NEI, and DMR) should be checked to see whether the facility has reported to these. If so, the OES determined from the mapping procedures for those databases (discussed in other sections of this document) should also be used. It is important that the same facility is mapped consistently across multiple databases/sources. The facility's TRFID and FRS ID can be used to identify sites that report to TRI and DMR.

6. Note that facilities that submit using a TRI Form A do *not* report TRI uses/sub-uses. To determine the OES for these facilities, EPA will use information from Steps 4 and 5 above.

Given the information available in TRI, EPA expects that, for most chemicals, 100% of the sites reporting to TRI can feasibly be mapped to an OES.

B.3.3 EPA Discharge Monitoring Report (DMR)

Facilities must submit DMRs for chemicals when the following two conditions are met: (1) the facility has an NPDES permit for direct discharges to surface water, and (2) the NPDES permit contains monitoring requirements for the chemical of interest. Indirect discharges (*e.g.*, those sent to an off-site WWT plant or POTW) are not covered under the NPDES program.

If a facility has discharge monitoring requirements for the chemical of interest, these requirements are either technology-based or water-quality based. Typically, a facility has NPDES monitoring requirements for a chemical because the facility somehow manufactures, processes, or uses the chemical. However, it is possible for a facility to have monitoring requirements for a chemical they do not handle if the facility falls within a guideline containing requirements for that chemical, as described below.

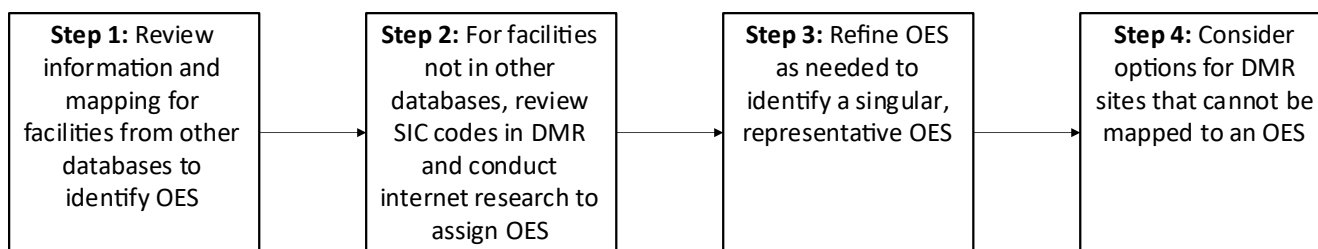
- **Technology-Based Guidelines:** If the facility falls within a certain industrial sector, it may be covered by a national effluent guideline. Effluent guidelines are industry-specific and contain treatment technology-based guidelines for discharges of specified pollutants (chemicals) commonly found within that industry.¹⁴ A common effluent guideline containing requirements for chemicals that have or are currently undergoing risk evaluation is the Organic Chemicals, Plastics & Synthetic Fibers (OCPSF) effluent guideline. Alternatively, if there is no applicable

¹⁴ A list of the industries for which EPA has promulgated effluent guidelines is available at: <https://www.epa.gov/eg/industrial-effluent-guidelines#existing> (accessed July 29, 2026).

effluent guideline for the facility, the permitting authority may establish technology-based guidelines using best professional judgment. If a facility falls within an existing effluent guideline, the permitting authority will generally include monitoring requirements in the facility's NPDES permit that are consistent with the effluent guideline, even if the facility does not handle all the chemicals for which there are monitoring requirements. Therefore, under this reasoning, it is possible that a facility reporting for the chemical of interest in DMRs does not actually handle the chemical.¹⁵

- **Water Quality-Based Guidelines:** The receiving water for the facility's discharges is impaired such that the permitting authority sets general water-quality based effluent limits and monitoring requirements for chemicals that may further impair the water quality. It is possible that the permitting authority uses these same general water-quality based requirements for all facilities that discharge to the water body. Therefore, under this reasoning, it is possible that a facility reporting for the chemical of interest in DMRs does not actually handle the chemical.⁵

Figure_Apx B-4 depicts the steps that should be followed to map DMR reporting sites to OESs. Each step is explained in the text below the figure. Additionally, Section B.5.3 shows step-by-step examples for using the mapping procedures to determine the OES for two example DMR reporting facilities.



Figure_Apx B-4. OES Mapping Procedures for DMR

To map sites reporting to DMR, the following procedures should be used:

1. **Review Information from Other Databases:** Given the limited facility information reported in DMRs, the first step for mapping facilities reporting to DMR should be to check other databases/sources (including CDR and TRI). If so, the OES determined from the mapping procedures for those databases (discussed in other sections of this document) should be used. It is important that the same facility is mapped consistently across multiple databases/sources. The facility's TRFID and FRS ID can be used to identify sites that report to TRI and DMR.
2. **Assign OESs:** If the facility does not report to other databases, the following information should be used to assign an OES.
 - a. 4-digit SIC codes reported by the facility in DMR (e.g., a facility that reported SIC code 2891, Adhesives and Sealants, likely formulates these products; a facility that reported SIC code 4952, Sewerage Systems, likely treats wastewater). Note that SIC codes can be crosswalked to NAICS codes, which are often more useful for mapping OES because they are more descriptive than SIC codes.
 - b. Internet research of the types of products made at the facility (e.g., if a facility's website indicates the facility manufactures metal parts, the facility is likely to use chemicals for

¹⁵ Note that a facility may request to have monitoring requirements reduced or removed from the permit where historical sampling demonstrates that these chemicals are consistently measured below the effluent limits. Thus, it is possible for a facility to cease monitoring for the chemical of interest upon approval by the permitting authority.

degreasing or in a metalworking fluid) and information from sources cited in the COU table and scoping document, such as public and stakeholder comments (*i.e.*, EPA will review sources cited in the COU table and scoping document to see if there is any information specific to the reporting site that can be used to inform the mapping).

3. **Refine OES:** If the specific OES still cannot be determined using the information in Step 2, the following should be considered.

- a. NPDES permit numbers reported in DMR. The permit number generally indicates if the permit is an individual permit or a general permit.¹⁶ If the permit is a general permit, the permit number can often indicate the type of general permit, which can provide information on the operations at the facility.
 - Individual NPDES permits are numbered in the format of the state abbreviation followed by a seven-digit number (*e.g.*, VA0123456). General permits are usually numbered in the format of state abbreviation followed by one letter then a six-digit number (*e.g.*, VAG112345 or MAG912345).
 - Since each state is slightly different in their general permit numbering, the general permit number should be searched on the internet to determine the type of general permit. For the general permit number examples provided above, a permit number beginning in “VAG11” signifies Virginia’s general permit for concrete products facilities and a permit number beginning with “MAG91” signifies Massachusetts’ general permit for groundwater remediation. Other common general permit types include those for construction sites, mining operations, sites that only discharge non-contact cooling water, and vehicle washes.
- b. Searching for the permit online. If the specific NPDES permit for the facility can be found online, it may contain some general process information for the facility that can help inform the OES mapping. However, NPDES permits may be difficult to find online and do not generally contain much information on process operations.
- c. An evaluation of the OES that is most likely to result in a water release (*e.g.*, for facilities that report an SIC code for the production of metal products, both vapor degreasing and metalworking fluid OES are applicable; in such cases, the metalworking fluid OES may be assigned because it is more likely to result in water releases than vapor degreasing).
- d. Grouped OES for similar uses (*e.g.*, multiple facilities that may conduct formulation operations based on the reported SIC code may be assigned a grouped formulation OES that covers all types of formulation [*e.g.*, adhesives, paints, cleaning products]).

4. **Consider Options for DMR Sites That Cannot be Mapped to an OES:** Given the limited information available in DMR, it may not always be feasible to achieve mapping of 100% of the sites reporting to DMR to an OES. In such cases, multiple options may be appropriate depending on assessment needs, such as:

- a. Assigning the sites as having an unknown OES with 250 release days/year. This allows for subsequent exposure modeling and the assessment of risk. For sites with identified risk, the OES can then be mapped using the below resources.
- b. Contacting the state government for the NPDES permit, permit applications, past inspection reports, and any available information on facility operations. Note that

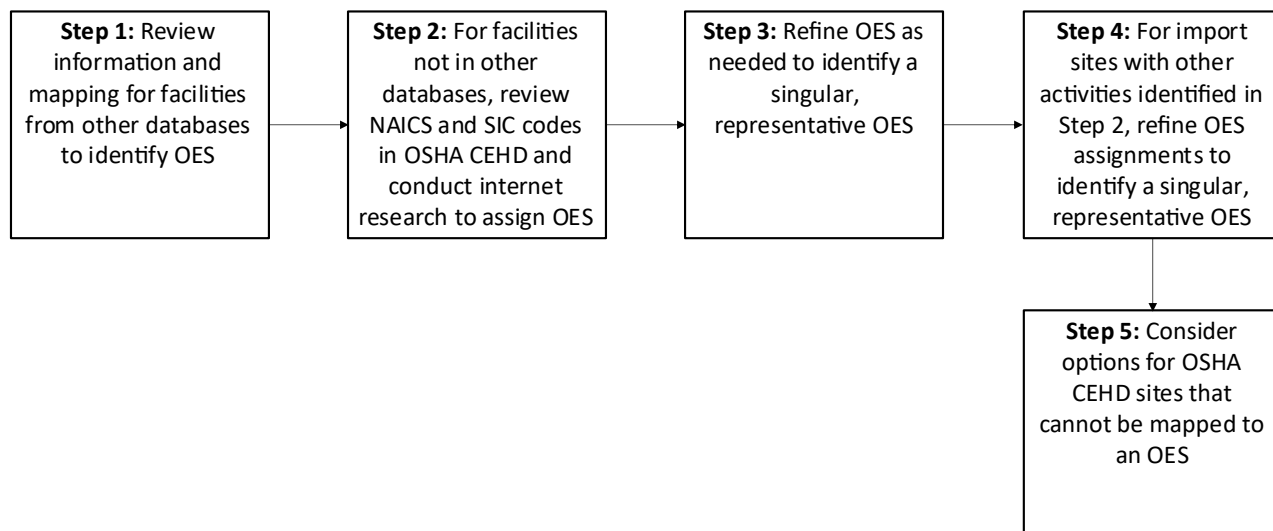
¹⁶ Information on individual and general NPDES permits can be found at: <https://www.epa.gov/npdes/npdes-permit-basics> (accessed July 29, 2026).

- information requests such as these may require an ICR if 10 or more entities are contacted.
- c. Contacting the facility for clarification on the use of the chemical. ICR requirements also apply when contacting 10 or more facilities.

B.3.4 Occupational Safety and Health Administration CEHD Data

OSHA CEHD is a compilation of industrial hygiene samples (*i.e.*, occupational exposure data) taken when OSHA monitors worker exposures to chemical hazards. OSHA will conduct monitoring at facilities that fall within targeted industries based on national and regional emphasis programs.¹⁷ OSHA conducts monitoring to compare against occupational health standards. Therefore, unlike CDR, TRI, and DMR, facilities are not required to report data to OSHA CEHD. Also, OSHA only visits selected facilities, so the amount of OSHA data available for each OES is often limited.

Figure_Apx B-5 depicts the steps that should be followed to map OSHA CEHD sites to OES. Each step is explained in the text below the figure. Additionally, Section B.5.4 shows step-by-step examples for using the mapping procedures to determine the OES for two example OSHA CEHD facilities.



Figure_Apx B-5. OES Mapping Procedures for OSHA CEHD

Within the OSHA CEHD data, there may be sites for which all air sampling data are non-detect (below the limit of detection) for the chemical. In these cases, if there is also no bulk sampling data indicating the presence of the chemical, there is no evidence that the chemical is present at the site. OSHA may have sampled for the chemical based on a suspicion or pre-determined sampling plan, and not because the chemical was actually present at the site. Therefore, these sites do not need to be mapped to OES. To map sites for which there is OSHA CEHD data that are not all non-detect for the chemical, the following procedures should be used:

1. **Review Information from Other Databases:** Given the limited facility information reported in OSHA CEHD, the first step for mapping facilities should be to check other databases/sources (including CDR, TRI, and TRI). If so, the OES determined from the mapping procedures for those databases (discussed in other sections of this document) should be used. It is important that the same facility is mapped consistently across multiple databases/sources. Because facility

¹⁷ More information on OSHA CEHD can be found at: <https://www.osha.gov/opengov/health-samples> (accessed July 29, 2026).

identifiers such as TRFID and FRS ID are not available in the CEHD, the name of the facility in the CEHD will need to be compared to the facility names in other databases to identify if the facility is present in multiple databases/sources.

2. **Assign OES:** If the facility does not report to other databases, the following information should be used to assign an OES.
 - a. 4-digit SIC and 6-digit NAICS codes reported in the CEHD (*e.g.*, a facility that reported SIC code 2891, Adhesives and Sealants, likely formulates these products; a facility that reported NAICS code 313320, Fabric Coating Mills, likely uses the chemical in fabric coating).
 - b. Internet research of the types of products made at the facility (*e.g.*, if a facility's website indicates the facility manufactures metal parts, the facility is likely to use chemicals for degreasing or in a metalworking fluid) and information from sources cited in the COU table and scoping document, such as public and stakeholder comments (*i.e.*, EPA will review sources cited in the COU table and scoping document to see if there is any information specific to the reporting site that can be used to inform the mapping).
3. **Refine OES:** If the specific OES still cannot be determined using the information in Step 2, the following should be considered.
 - a. An evaluation of the OES that is most likely to result in occupational exposures (*e.g.*, for facilities that report an SIC code for janitorial services, multiple OES may be applicable, such as cleaning, painting (*e.g.*, touch-ups), other maintenance activities; in such cases, the cleaning OES may be assigned for volatile chemicals because it has the highest exposure potential).
 - b. Grouped OES for similar uses (*e.g.*, multiple facilities that may conduct formulation operations based on the reported NAICS or SIC code may be assigned a grouped formulation OES that covers all types of formulation [*e.g.*, adhesives, paints, cleaning products]).
4. **Consider Options for OSHA CEHD Sites That Cannot be Mapped to an OES:** Given the limited information available in OSHA CEHD, it may not always be feasible to achieve mapping of 100% of the sites in the database to an OES. In such cases, multiple options may be appropriate depending on assessment needs, such as:
 - a. Assigning the sites as having an unknown OES with 250 exposure days/year. This allows for subsequent health modeling and the assessment of risk. For workers with identified risk, the OES can then be mapped using the below resources.
 - b. Contacting OSHA for additional information on the facility from the OSHA inspection/monitoring.
 - c. Contacting the facility for clarification on the use of the chemical. Note that information requests such as these may require an ICR if 10 or more entities are contacted.
 - d. As discussed previously, sites for which all air monitoring data is non-detect for the chemical and for which there is no bulk data indicating the presence of the chemical do not need to be mapped to an OES. This is because the data do not provide evidence that the chemical is present at the site.

B.3.5 National Institute of Occupational Safety and Health Health Hazard Evaluation (HHE)

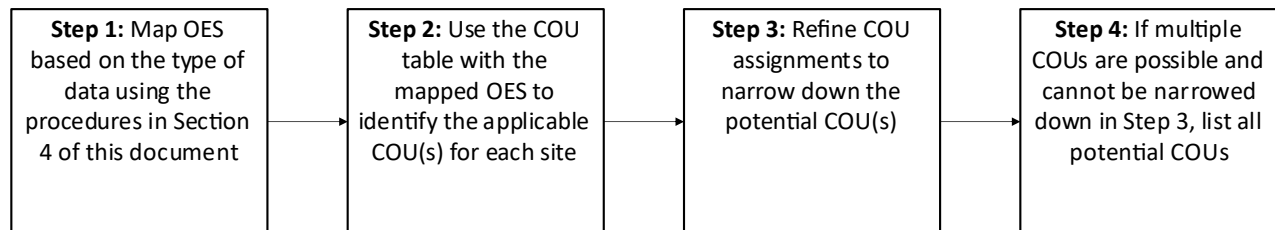
NIOSH conducts HHEs at facilities to evaluate current workplace conditions and to make recommendations to reduce or eliminate the identified hazards.¹⁸ NIOSH conducts HHEs at the request of employers, unions, or employees in workplaces where employee health and wellbeing is affected by the workplace. Therefore, unlike CDR, TRI, and DMR, facilities are not required to report data to NIOSH under the HHE program. Also, NIOSH only visits selected facilities where an HHE was requested, so the number of NIOSH HHEs available for each OES is often limited.

To map a facility that is the subject of a NIOSH HHE, the information in the HHE report should be used. Specifically, the HHE report typically includes general process information for the facility, information on how the chemical is used, worker activities, and the facility's SIC code. This information should be sufficient to map the facility to a single representative OES. Additionally, given the extent of information available about the subject facilities in NIOSH HHE reports, 100% of these facilities can be mapped to an OES. Additionally, Appendix B.5.5 shows two examples of how to map NIOSH HHE facilities to OES.

B.4 COU Mapping Procedures

As discussed in Appendix B.1, there is not always a one-to-one mapping between COUs and OESs.

Figure_Apx B-6 depicts the steps that should be followed to map sites from the standard sources discussed in this document to COUs. Each step is explained in the text below the figure. Additionally, Appendix B.5.6 shows step-by-step examples for using the mapping procedures to determine the COU for three example facilities.



Figure_Apx B-6. COU Mapping Procedures for Standard Sources Already Mapped to OES

To map facilities from standard sources (*i.e.*, CDR, TRI, DMR, OSHA CEHD, NIOSH HHE) to COUs, the following procedures should be used:

1. **Map the Facility to an OES:** To map a facility from a standard source to a COU, the facility should first be mapped to an OES following the procedures for the specific source of data (discussed in Section B.3).
2. **Use the COU Table with Mapped OES to Assign COUs:** At the point of the risk evaluation process where EPA are mapping data from standard sources to OES and COU, EPA have already mapped OES to each of the COUs from the scope document, like is shown in Table_Apx B-2. This crosswalk between COUs and OES should be used to identify the COU(s) for the facility using the OES mapped per Section B.3.

¹⁸ More information about NIOSH HHEs is available at: <https://www.osha.gov/opengov/health-samples> and <https://www.cdc.gov/niosh/hhe/about.html> (both hyperlinks accessed July 29, 20206).

- 10174 3. **Refine the COU Assignment:** In some instances, more than one COU may map to the facility. In
10175 such cases, the following information should be used to try to narrow down the list of potentially
10176 applicable COUs:
- 10177 a. Information from the standard sources (*e.g.*, if EPA assigned a grouped OES like
10178 “Industrial Processing Aid” and the facility’s NAICS code in TRI is related to battery
10179 manufacturing, the COU can be identified as the “Processing Aid” category and
10180 Process solvent used in battery manufacture” subcategory).
 - 10181 b. Internet research of the types of products made at the facility (*e.g.*, if a facility’s website
10182 indicates the facility makes adhesives, the COU category of “Processing – Incorporation
10183 into formulation, mixture or reaction product” and subcategory of “Adhesives and sealant
10184 chemicals” can be assigned and the remaining subcategories [*e.g.*, solvents for cleaning
10185 or degreasing, solvents which become part of the product formulation or mixture] are not
10186 applicable) and information from sources cited in the COU table and scoping document,
10187 such as public and stakeholder comments (*i.e.*, EPA will review sources cited in the COU
10188 table and scoping document to see if there is any information specific to the reporting site
10189 that can be used to inform the mapping).
- 10190 4. **List all Potential COUs:** Where the above information does not narrow down the list of
10191 potentially applicable COUs, EPA will list all the potential COUs and will not attempt to select
10192 just one from the list where there is insufficient information to do so.

10193 **B.5 Example Case Studies**

10194 This section contains step-by-step examples of how to implement the OES and COU mapping
10195 procedures listed in Appendices B.3 and B.4 to determine OES for facilities that report to standard
10196 engineering sources.

10197 **B.5.1 CDR Mapping Examples**

10198 This section includes examples of how to implement the OES mapping procedures for sites reporting to
10199 CDR, as listed in Section B.3.1. Specifically, this section includes examples for three example sites that
10200 reported to 2020 CDR. These example sites are referred to as Facility A, Facility B, and Facility C.

10201
10202 To map Facilities A, B, and C to an OES, the following procedures are used with the non-CBI 2020
10203 CDR database.

- 10204 1. **Review Manufacturing and Import Activity Information:** The first step in the process is to
10205 review the reported activity information to identify if the facility imports or manufactures the
10206 chemical. Table_Apx B-3 summarizes the information gathered from 2020 CDR for the three
10207 example sites for this step.

Table Apx B-3. Step 1 for CDR Mapping Facilities

Facility Name	Step 1a: Reported Activity	Step 1b: Byproduct Information	Step 1c: Check Other Activities?	OES Determination
Facility A	Domestically Manufactured/Imported	Not Known or Reasonably Ascertainable	Not needed – per Step 1 in Section B.3.1	Per Step 1a, this site maps to the Manufacturing OES
Facility B	Imported	CBI	Yes	Cannot be determined in Step 1 – Proceed with Step 2
Facility C	Imported	Not Known or Reasonably Ascertainable	Yes	Cannot be determined in Step 1 – Proceed with Step 2

2. **For Importation Sites, Review Fields for “Imported Never at Site,” “Volume Exported,” and “Volume Used”:** The next step is to review these additional fields to determine if the reporting facility conducts more than just importation activities. Table_Apx B-4 summarizes the information gathered from 2020 CDR for the three example sites for this step.

Table Apx B-4. Step 2 for CDR Mapping Example Facilities

Facility Name	Step 2a: Imported Never at Site	Step 2b: Volume Exported	Step 2c: Volume Used	OES Determination
Facility A	N/A – OES determined in Step 1			
Facility B	CBI	CBI	CBI	Cannot be determined in Step 2 – Proceed with Step 3.
Facility C	Yes	0	0	Because the facility only imports and does not use the chemical, this site maps to the Import/Repackaging OES.

3. **Refine OES Assignments:** If multiple OES were identified from the previous steps, a single primary OES must be selected using additional facility information as discussed in Steps 3a to 3f. Table_Apx B-5 summarizes the information gathered from 2020 CDR for the three example sites for this step.

Table Apx B-5. Step 3 for CDR Mapping Example Facilities

Facility Name	Step 3a: NAICS	Step 3b: Processing/Use Information	Step 3c: Internet Research	Step 3d–e: Other Databases and OES Grouping	OES Determination
Facility A	N/A – OES determined in Step 1				
Facility B	325110, Petrochemical Manufacturing	CBI	Research indicates the facility is a petrochemical plant and does not indicate how the chemical is used.	Check other databases per Step 4.	Cannot be determined in Step 2 – Proceed with Step 4.
Facility C	N/A – OES determined in Step 2				

4. **Review Information from Other Databases:** Lastly, other databases/sources (such as TRI and DMR) should be checked to see if the facility has reported to these. If the facility does not report to these databases, but additional OES are possible per Step 2, search available facility

information on the internet. Table_Apx B-6 summarizes the information gathered from 2020 CDR for the three example sites for this step.

Table_Apx B-6. Step 4 for CDR Mapping Example Facilities

Facility Name	Step 4: Other Databases	OES Determination
Facility A	N/A – OES determined in Step 1	
Facility B	Using the FRS ID reported in CDR, this facility does not report to TRI or DMR. The Agency searched the facility in EPA’s ECHO database and found that the facility does not have any listed NAICS codes, SIC codes, or permits, and appears to be a warehouse from aerial imagery. Therefore, this facility is likely just an importer.	Using the information from Step 4, this site maps to the Import/repackaging OES.
Facility C	N/A – OES determined in Step 2	

B.5.2 TRI Mapping Examples

This appendix includes examples of how to implement the OES mapping procedures for sites reporting to TRI, as listed in Section B.3.2. Specifically, this appendix includes examples for three example sites that reported to TRI. These example sites are referred to as Facility D, Facility E, and Facility F.

To map Facilities D, E, and F to an OES, the following procedures are used with information from TRI.

1. **Assign Chemical Data Reporting Codes Using TRI-to-CDR Crosswalk:** The first step in the TRI mapping process is to map the uses and sub-uses reported by each facility to one or more 2016 CDR IFC codes. The uses and sub-uses reported to TRI by each example site are compiled in Table_Apx .

Table_Apx B-7. Step 1 for TRI Mapping Example Facilities

Facility Name	TRI Form Type	TRI Uses (Sub-Uses)	2016 CDR IFC Codes
Facility D	R	Manufacture: produce, import, for onsite use/processing, for sale/distribution, as a byproduct Processing: as a reactant, as a formulation component (P299 Other) Otherwise Used: ancillary or other use (Z399 Other)	PK, U001, U003, U016, U013, U014, U018, U019, U020, U023, U027, U028, or U999
Facility E	R	Otherwise Used: ancillary or other use (Z399 Other)	U001, U013, U014, U018, U020, or U023
Facility F	A	None – not reported in Form A submissions	

2. **Develop Chemical-Specific Crosswalk to Link CDR Codes to OES:** The next step is to develop a separate CDR IFC code-to-OES crosswalk that links CDR IFC codes to OES for the chemical. To create this crosswalk, match the COUs and OESs from the COU table in the published scope documents to the list of 2016 CDR IFC codes. The categories and subcategories of COUs typically match the IFC code category. See Table_Apx B-8 for the completed crosswalk for the chemical.

10246 **Table Apx B-8. Step 2 for TRI Mapping Example Facilities**

COU and OES from Published Scope Document				Mapping		
Life Cycle Stage	Category	Subcategory	OES	2016 CDR IFC Code	2016 CDR IFC Code Name	Rationale
Manufacturing	Domestic manufacturing	Domestic manufacturing	Manufacturing	None	None	Per Section B.5.1, there is no corresponding CDR code for this COU/OES
Repackaging	Repackaging	Repackaging	Repackaging	PK	Processing – repackaging	Category matches CDR code
Processing	Processing – As a reactant	Intermediate in petrochemical manufacturing	Processing as a Reactant	U015; U016; U019; U024	Processing as a reactant	Category matches CDR code
		Plastic material and resin manufacturing				
		All other basic organic chemical manufacturing				
Processing	Processing – Incorporation into formulation, mixture, or reaction product	Fuels and fuel additives: All other petroleum and coal products manufacturing	Incorporated into Formulation, Mixture, or Reaction Product	U012	Fuel and fuel additives	Category matches CDR code
		Formulation of adhesives and sealants		U002	Adhesives and sealant chemicals	Category matches CDR code
		Processing aids: Specific to petroleum production		U025	Processing aids: specific to petroleum production	Category matches CDR code
Distribution in commerce	Distribution in commerce	Distribution in commerce	Distribution in Commerce	None	None	Per Section B.5.1, there is no corresponding CDR code for this COU/OES
Industrial Use	Adhesives and sealants	Adhesives and sealants	Adhesives and Sealants	U002	Adhesives and sealant chemicals	Category matches CDR code
	Functional fluids (closed systems)	Engine Coolant Additive	Functional Fluids (Closed Systems)	U013	Functional Fluids (closed systems)	Category matches CDR code

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COU and OES from Published Scope Document				Mapping		
Life Cycle Stage	Category	Subcategory	OES	2016 CDR IFC Code	2016 CDR IFC Code Name	Rationale
Industrial use	Lubricants and greases	Paste lubricants and greases	Lubricants and Greases	U017	Lubricants and Lubricant additives	Category matches CDR code
	Oxidizing/reducing agents	Oxidation inhibitor in controlled oxidative chemical reactions	Oxidizing/Reducing Agents	U019	Oxidizing/reducing agents	Category matches CDR code
	Cleaning and degreasing	Industrial and commercial non-aerosol cleaning/degreasing	Solvents (for Cleaning and Degreasing)	U029	Solvents (for cleaning or degreasing)	Category matches CDR code
Commercial use	Cleaning and degreasing	Commercial aerosol products (aerosol degreasing, aerosol lubricants, automotive care products)				
Commercial use	Plastic and rubber products	Products such as: Plastic and rubber products	Plastics and Rubber Products	None	None	Per Section B.5.1, there is no corresponding CDR code for this COU/OES.
	Fuels and related products	Fuels and related products	Fuels and Related Products	U012	Fuels and Fuel Additives	Category matches CDR code
	Other use	Laboratory chemical	Other Use	None	Use-non-incorporative activities	This use does not match any other CDR codes and is non-incorporative
		Embalming agent				
Waste handling, disposal, treatment, and recycling	Waste handling, disposal, treatment, and recycling	Waste handling, disposal, treatment, and recycling	Waste Handling, Disposal, Treatment, and Recycling	None	None	Per Section B.5.1, there is no corresponding CDR code for this COU/OES.

10247

3. **Assign OES:** Each TRI facility is then mapped to one or more OESs using the CDR IFC codes assigned to each facility in Step 1 and the CDR IFC code-to-OES crosswalk developed in Step 2. Table_Apx B-9 includes the potential OES for each example facility per this step.

Table_Apx B-9. Step 3 for TRI Mapping Example Facilities

Facility Name	TRI Form Type	2016 CDR IFC Codes	Crosswalked OES	OES Determination
Facility D	R	PK, U001, U003, U016, U013, U014, U018, U019, U020, U023, U027, U028, or U999	Repackaging, processing as a reactant, functional fluids (closed systems), or Oxidizing/reducing agents	Cannot be determined in Step 3 – proceed to Step 4
Facility E	R	U001, U013, U014, U018, U020, or U023	Functional fluids (closed systems)	Since the facility maps to only one OES, the OES is Functional fluids (closed systems)
Facility F	A	None – not reported in Form A submissions		Cannot be determined in Step 3 – proceed to Step 4

4. **Refine OES Assignments:** If a facility maps to more than one OES in Step 3, a single primary OES must be selected using additional facility information per Steps 4a to 4e. Table_Apx B-10 summarizes the information gathered for the three example sites for this step.

Table_Apx B-10. Step 4 for TRI Mapping Example Facilities

Facility Name	Step 4a: NAICS Code	Step 4b: Internet Research	Step 4c: Other Databases	Step 4d–e: Most Likely OES or OES Grouping	OES Determination
Facility D	486990, All Other Pipeline Transportation	The facility is a large chemical manufacturing plant	Check databases per Step 5	Based on the type of facility, the Processing as a reactant OES seems the most likely OES from Step 3	Most likely Processing as a reactant OES; check other databases in Step 5 to verify
Facility E		N/A – OES determined in Step 3			
Facility F	325199, All Other Basic Organic Chemical Manufacturing	The facility is a chemical supplier that does not appear to produce chemicals	Check databases per Step 5	Based on the NAICS code and type of facility, the Repackaging OES seems the most likely	Most likely Repackaging OES; check other databases in Step 5 to verify

5. **Review Information from Other Databases:** Other databases/sources (including CDR and DMR) should be checked to see if the facility has reported to these. If so, the OES determined from the mapping procedures for those databases (discussed in other sections of this document) should also be used. It is important that the same facility is mapped consistently across multiple

databases/sources. The facility's TRFID and FRS ID can be used to identify sites that report to CDR and DMR. Table_Apx B-11 summarizes the information gathered from other databases for the three example sites for this step.

Table_Apx B-11. Step 5 for TRI Mapping Example Facilities

Facility Name	Step 5: Other Databases	OES Determination
Facility D	The facility did not report to 2016 or 2020 CDR. The facility-reported DMRs for the past few years but reported no releases of the chemical to DMR.	The DMR information corroborates the most likely OES determined in Step 4d; therefore, this site maps to the Processing as a reactant OES
Facility E	N/A – OES determined in Step 3	
Facility F	The facility did not report to 2016 or 2020 CDR, or the past few years of DMR	Because no additional information was determined in Step 5, the site maps to the Repackaging OES per Step 4d

B.5.3 DMR Mapping Examples

This section includes examples of how to implement the OES mapping procedures for sites reporting to DMR, as listed in Section B.3.3. Specifically, this appendix includes examples for two example sites that reported to DMR for the chemical. These example sites are referred to as Facility I and J.

To map Facilities I and J to an OES, the following procedures are used with information from DMR:

1. **Review Information from Other Databases:** Given the limited facility information reported in DMRs, the first step for mapping facilities reporting to DMR should be to check other databases/sources (including CDR and TRI). For these examples, neither Facility I nor J reported to other databases.
2. **Assign OES:** If the facility does not report to other databases, the reported SIC code from DMR and internet research should be used to map the facility to an OES, per Steps 2a and 2b. See Table_Apx B-12 for completed Step 2 for the example facilities.

Table_Apx B-12. Step 2 for DMR Mapping Example Facilities

Facility Name	Step 2a: SIC Code	Step 2b: Internet Research	OES Determination
Facility I	4613, Refined Petroleum Pipeline	Internet research indicates that the facility is a fuel terminal	Cannot be determined in Step 2 – Proceed with Step 3
Facility J	2821, Plastics Materials and Resins	Internet research indicates the facility makes poly vinyl chloride; the chemical is known to be used as a reactant in this process	This facility maps to the Processing as a reactant OES, based on the SIC code (which matches the subcategory of use in the COU table) and internet research

3. **Refine OES:** If the specific OES still cannot be determined using the information in Step 2, information in Steps 3a to 3d should be considered. This includes searching for the facility NPDES permit and trying to determine which OES (or group of OES) is the most likely. See Table_Apx for completed Step 3 for the example facilities.

Table_Apx B-13. Step 3 for DMR Mapping Example Facilities

Facility Name	Step 3a: NPDES Permit Number	Step 3b: Finding the NPDES Permit	Steps 3c–d: Most Likely OES or Grouped OED	OES Determination
Facility I	VAG83##### → A search of VA NPDES permits indicates that permit numbers starting in “VAG0083” are remediation general permits.	The facility’s NPDES permit could not be found online	None of COUs or OES for the chemical cover remediation	Because the facility’s permit is for remediation, the facility most likely does not use the chemical but the chemical is present as a contaminant at the site. This does not correspond to an in-scope OES. However, the OES should be designated as “Remediation” for EPA to determine how/if to present the release data.
Facility J	N/A – This facility was mapped to an OES in Step 2.			

B.5.4 OSHA CEHD Mapping Examples

This section includes examples of how to implement the OES mapping procedures for sites in the OSHA CEHD dataset, as listed in Section B.3.4. Specifically, this section includes examples for two example sites in the OSHA CEHD dataset for the chemical. These example sites are referred to as Facility K and L.

To map Facilities K and L to an OES, the following procedures are used with information from OSHA CEHD:

1. ***Review Information from Other Databases:*** Given the limited facility information reported in OSHA CEHD, the first step for mapping facilities should be to check other databases/sources (including CDR, TRI, and TRI). For these examples, neither Facility K nor L reported to other databases.
2. ***Assign OES:*** If the facility does not report to other databases, the reported SIC code from OSHA CEHD and internet research should be used to map the facility to an OES, per Steps 2a and 2b. See Table_Apx B-14 for completed Step 2 for the example facilities.

Table_Apx B-14. Step 2 for OSHA CEHD Mapping Example Facilities

Facility Name	Step 2a: SIC or NAICS Code	Step 2b: Internet Research	OES Determination
Facility K	339112, Surgical and Medical Instrument Manufacturing	Internet research indicates that the facility produces medical equipment for cardiovascular procedures	Based on the OES in OES to COU crosswalk, the most applicable OES are likely Processing as a reactant (for the production of plastics used in equipment), Solvents (for Cleaning or Degreasing), Plastics and rubber products, or Other use. The specific OES cannot be determined in Step 2 – Proceed with Step 3.
Facility L	5169, Chemicals and Allied Products, Not Elsewhere Classified	Internet research indicates the facility is a waste management company	This facility maps to the <i>Waste handling, disposal, treatment, and recycling</i> , based on information from internet research

3. **Refine OES:** If the specific OES still cannot be determined using the information in Step 2, an evaluation of the OES that is most likely or a group of OES should be considered per Steps 3a and 3b. See Table_Apx B-15. Step 3 for OSHA CEHD Mapping Example FacilitiesTable_Apx B-15 for completed Step 3 for the example facilities.

Table_Apx B-15. Step 3 for OSHA CEHD Mapping Example Facilities

Facility Name	Step 3a: Mostly Likely OES	Step 3b: Grouped OED	OES Determination
Facility K	The scope document for chemical A indicates that the chemical is used to make chemical B that is then used in medical devices. The use of chemical A to produce chemical B falls under the Processing as a reactant OES (as an intermediate for plastics).	Not needed – the OES was determined as Processing as a Reactant in Step 3a	Per Step 3a, this facility maps to the Processing as a reactant OES. To further support this determination, EPA may contact OSHA for additional information on the visit to this facility, per Step 4b.
Facility L	N/A – This facility was mapped to an OES in Step 2.		

B.5.5 NIOSH HHE Mapping Examples

This section includes examples of how to implement the OES mapping procedures listed in Section B.3.5, for two example NIOSH HHEs for chemical A. To map facilities that are the subject of a NIOSH HHE, the process information and other narrative descriptions in the NIOSH HHE should be used.

1. The first example is for the following NIOSH HHE:
<https://www.cdc.gov/niosh/hhe/reports/pdfs/80-186-1149.pdf> (accessed July 29, 2026). The following information is found in the NIOSH HHE:

- a. The facility produces plastic products, primarily plastic tubes for packaging.
- b. Chemical A was used as a bonding agent for sealing packaging.

OES Determination: Based on the OES for chemical A (listed in the OES to COU crosswalk table), the use of chemical A for sealants falls under the Adhesives and Sealants OES.

2. The second example is for the following NIOSH HHE:
<https://www.cdc.gov/niosh/hhe/reports/pdfs/77-73-610.pdf> (accessed July 29, 2026). The following information is found in the NIOSH HHE:

- a. The facility is a chemical manufacturer.
- b. The facility uses chemical A as a solvent in a reaction to produce another chemical.

OES Determination: Based on the OES for chemical A (listed in the OES to COU crosswalk table), the use of chemical A as a reactant falls under the Processing as a Reactant OES.

As discussed in Section B.3.5, NIOSH HHEs typically contain detailed process information and description of how the chemical is used at the facility. Therefore, the mapping of NIOSH HHE facilities to OES is straightforward.

B.5.6 COU Mapping Examples

This appendix includes examples of how to implement the COU mapping procedures for sites from standard sources (*i.e.*, CDR, TRI, DMR, OSHA CEHD, NIOSH HHE, as listed in Section B.4 . Specifically, this appendix uses the same example facilities (Facility D, Facility E, and Facility F) for the TRI examples in Section B.5.2.

To map Facilities D, E, and F to an COUs, the following procedures should be used:

1. **Map the Facility to an OES:** To map a facility from a standard source to a COU, the facility should first be mapped to an OES following the procedures for the specific source of data. This mapping was completed in completed in Section B.5.2 and is summarized in Table_Apx B-16.

Table_Apx B-16. Step 1 for COU Mapping Example Facilities

Facility Name	Step 1: OES Determination from Appendix A.2
Facility D	Processing as a Reactant
Facility E	Functional Fluids (Closed Systems)
Facility F	Repackaging

2. **Use the COU Table with Mapped OES to Assign COUs:** At the point of the risk evaluation process where EPA are mapping data from standard sources to OES and COU, EPA have already mapped OES to each of the COUs from the scope document. This crosswalk between COUs and

OES, for the example facilities should be used to identify the COU(s). See Table_Apx B-17 for completed Step 2 for the example facilities.

Table_Apx B-17. Step 2 for COU Mapping Example Facilities

Facility Name	OES Determination from Appendix B.2	Step 2: Mapped COUs		
Facility D	Processing as a reactant	Using the COU to OES crosswalk previously developed, the COUs that map to this OES are:		
		Life Cycle Stage	Category	Subcategory
		Processing	Processing – As a reactant	Intermediate in petrochemical manufacturing
				Plastic material and resin manufacturing
				All other basic organic chemical manufacturing
Facility E	Functional fluids (closed systems)	Using the COU to OES crosswalk previously developed, only one COU maps to this OES:		
		Life Cycle Stage	Category	Subcategory
		Industrial Use	Functional fluids (closed systems)	Engine coolant additive
Facility F	Repackaging	Using the COU to OES crosswalk previously developed, only one COU maps to this OES:		
		Life Cycle Stage	Category	Subcategory
		Repackaging	Repackaging	Repackaging

- 3. Refine the COU Assignment:** In some instances, more than one COU may map to the facility. In such cases, the reported NAICS code and internet research should be used to try to narrow down the list of potentially applicable COUs, per Steps 3a to 3b. See Table_Apx for completed Step 3 for the example facilities.

Table_Apx B-18. Step 3 for COU Mapping Example Facilities

Facility Name	Step 3a: NAICS Code	Step 3b: Internet Research	COU Determination
Facility D	486990, All Other Pipeline Transportation	The facility is a large chemical manufacturing plant	The COU subcategory for “Plastic material and resin manufacturing” can be eliminated. However, the COU cannot be narrowed down between the remaining two subcategories of use. Proceed to Step 4.
Facility E	N/A – COU determined in Step 2		
Facility F	N/A – COU determined in Step 2		

4. **List all Potential COUs:** Where the above information does not narrow down the list of potentially applicable COUs, EPA will list all the potential COUs and will not attempt to select just one from the list where there is insufficient information to do so. Because a singular OES was identified for Facility D and F, this step is not applicable to those facilities. For Facility F, there are two possible COUs that are listed in Table_Apx B-19. While a COU consists of a life cycle stage, category, and subcategory, all three should be presented in this step.

Table_Apx B-19. Step 4 for COU Mapping Example Facilities

Facility Name	Step 4: All Potential COUs		
Facility D	All potential COUs for this facility are as follows:		
	Life Cycle Stage	Category	Subcategory
	Processing	Processing – As a reactant	Intermediate in petrochemical manufacturing
			All other basic organic chemical manufacturing

B.6 TRI to CDR Use Mapping Crosswalk

Table_Apx B-20 presents the TRI-CDR Crosswalk used to map facilities to the OES for each chemical. “N/A” in the 2016 CDR code column indicates there is no corresponding CDR code that matches the TRI code. 2020 CDR introduced new codes for chemicals designated as high priority for risk evaluation; however, reporters may still use the same 2016 CDR codes listed in Table_Apx B-20 for all other chemicals. For 2020 CDR reporting facilities using the new codes, the crosswalk between 2016 CDR codes and 2020 CDR codes in Table 4-15 of the [2024 CDR reporting instructions](#) (accessed July 29, 2026) should be used with Table_Apx B-20.

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Table Apx B-20. Toxics Release Inventory-Chemical Data Recording (TRI-CDR) Use Code Crosswalk

TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
3.1.a	Manufacture: Produce	N/A	N/A	N/A	N/A	N/A
3.1.b	Manufacture: Import	N/A	N/A	N/A	N/A	N/A
3.1.c	Manufacture: For on-site use/processing	N/A	N/A	N/A	N/A	N/A
3.1.d	Manufacture: For sale/distribution	N/A	N/A	N/A	N/A	N/A
3.1.e	Manufacture: As a byproduct	N/A	N/A	N/A	N/A	N/A
3.1.f	Manufacture: As an impurity	N/A	N/A	N/A	N/A	N/A
3.2.a	Processing: As a reactant	N/A	N/A	PC	Processing as a Reactant	Chemical substance is used in chemical reactions for the manufacturing of another chemical substance or product
3.2.a	Processing: As a reactant	P101	Feedstocks	N/A	N/A	N/A
3.2.a	Processing: As a reactant	P102	Raw Materials	N/A	N/A	N/A
3.2.a	Processing: As a reactant	P103	Intermediates	U015	Intermediates	Chemical substances consumed in a reaction to produce other chemical substances for commercial advantage. A residual of the intermediate chemical substance which has no separate function may remain in the reaction product.
3.2.a	Processing: As a reactant	P104	Initiators	U024	Process Regulators	Chemical substances used to change the rate of a chemical reaction, start or stop the reaction, or otherwise influence the course of the reaction. Process regulators may be consumed or become part of the reaction product.
3.2.a	Processing: As a reactant	P199	Other	U016	Ion Exchange Agents	Chemical substances, usually in the form of a solid matrix, are used to selectively remove targeted ions

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						from a solution. Examples generally consist of an inert hydrophobic matrix such as styrene divinylbenzene or phenol-formaldehyde, cross-linking polymer such as divinylbenzene, and ionic functional groups including sulfonic, carboxylic or phosphonic acids. This code also includes aluminosilicate zeolites.
3.2.a	Processing: As a reactant	P199	Other	U019	Oxidizing/ Reducing Agent	Chemical substances used to alter the valence state of another substance by donating or accepting electrons or by the addition or removal of hydrogen to a substance. Examples of oxidizing agents include nitric acid, perchlorates, hexavalent chromium compounds, and peroxydisulfuric acid salts. Examples of reducing agents include hydrazine, sodium thiosulfate, and coke produced from coal.
3.2.a	Processing: As a reactant	P199	Other	U999	Other (Specify)	Chemical substances used in a way other than those described by other codes.
3.2.b	Processing: As a formulation component	N/A	N/A	PF	Processing – Incorporation into Formulation, Mixture, or Reaction Product	Chemical substance is added to a product (or product mixture) prior to further distribution of the product.
3.2.b	Processing: As a formulation component	P201	Additives	U007	Corrosion Inhibitors and Antiscaling Agents	Chemical substances used to prevent or retard corrosion or the formation of scale. Examples include phenylenediamine, chromates, nitrates, phosphates, and hydrazine.
3.2.b	Processing: As a formulation component	P201	Additives	U009	Fillers	Chemical substances used to provide bulk, increase strength, increase hardness, or improve resistance to impact. Fillers incorporated in a matrix reduce production costs by minimizing the amount of more expensive substances used in the production of articles. Examples include calcium carbonate, barium sulfate, silicates, clays, zinc oxide and aluminum oxide.

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
3.2.b	Processing: As a formulation component	P201	Additives	U010	Finishing Agents	Chemical substances used to impart such functions as softening, static proofing, wrinkle resistance, and water repellence. Substances may be applied to textiles, paper, and leather. Examples include quaternary ammonium compounds, ethoxylated amines, and silicone compounds.
3.2.b	Processing: As a formulation component	P201	Additives	U017	Lubricants and Lubricant Additives	Chemical substances used to reduce friction, heat, or wear between moving parts or adjacent solid surfaces, or that enhance the lubricity of other substances. Examples of lubricants include mineral oils, silicate and phosphate esters, silicone oil, greases, and solid film lubricants such as graphite and PTFE. Examples of lubricant additives include molybdenum disulphide and tungsten disulphide.
3.2.b	Processing: As a formulation component	P201	Additives	U034	Paint Additives and Coating Additives Not Described by Other Codes	Chemical substances used in a paint or coating formulation to enhance properties such as water repellence, increased gloss, improved fade resistance, ease of application, foam prevention, etc. Examples of paint additives and coating additives include polyols, amines, vinyl acetate ethylene emulsions, and aliphatic polyisocyanates.
3.2.b	Processing: As a formulation component	P202	Dyes	U008	Dyes	Chemical substances used to impart color to other materials or mixtures (<i>i.e.</i> , substrates) by penetrating the surface of the substrate. Example types include azo, anthraquinone, amino azo, aniline, eosin, stilbene, acid, basic or cationic, reactive, dispersive, and natural dyes.
3.2.b	Processing: As a formulation component	P202	Dyes	U021	Pigments	Chemical substances used to impart color to other materials or mixtures (<i>i.e.</i> , substrates) by attaching themselves to the surface of the substrate through binding or adhesion. This code includes fluorescent agents, luminescent agents, whitening agents, pearling agents, and opacifiers. Examples include metallic oxides of iron, titanium, zinc, cobalt, and

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						chromium; metal powder suspensions; lead chromates; vegetable and animal products; and synthetic organic pigments.
3.2.b	Processing: As a formulation component	P203	Reaction Diluents	U030	Solvents (which Become Part of Product Formulation or Mixture)	Chemical substances used to dissolve another substance (solute) to form a uniformly dispersed mixture (solution) at the molecular level. Examples include diluents used to reduce the concentration of an active material to achieve a specified effect and low gravity materials added to reduce cost.
3.2.b	Processing: As a formulation component	P203	Reaction Diluents	U032	Viscosity Adjustors	Chemical substances used to alter the viscosity of another substance. Examples include viscosity index (VI) improvers, pour point depressants, and thickeners.
3.2.b	Processing: As a formulation component	P204	Initiators	U024	Process Regulators	Chemical substances used to change the rate of a chemical reaction, start, or stop the reaction, or otherwise influence the course of the reaction. Process regulators may be consumed or become part of the reaction product.
3.2.b	Processing: As a formulation component	P205	Solvents	U030	Solvents (which Become Part of Product Formulation or Mixture)	Chemical substances used to dissolve another substance (solute) to form a uniformly dispersed mixture (solution) at the molecular level. Examples include diluents used to reduce the concentration of an active material to achieve a specified effect and low gravity materials added to reduce cost.
3.2.b	Processing: As a formulation component	P206	Inhibitors	U024	Process Regulators	Chemical substances used to change the rate of a chemical reaction, start, or stop the reaction, or otherwise influence the course of the reaction. Process regulators may be consumed or become part of the reaction product.
3.2.b	Processing: As a formulation component	P207	Emulsifiers	U003	Adsorbents and Absorbents	Chemical substances used to retain other substances by accumulation on their surface or by assimilation. Examples of adsorbents include silica gel, activated alumina, and activated carbon. Examples of

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						absorbents include straw oil, alkaline solutions, and kerosene.
3.2.b	Processing: As a formulation component	P208	Surfactants	U002	Adhesives and Sealant Chemicals	Chemical substances used to promote bonding between other substances, promote adhesion of surfaces, or prevent seepage of moisture or air. Examples include epoxides, isocyanates, acrylamides, phenol, urea, melamine, and formaldehyde.
3.2.b	Processing: As a formulation component	P208	Surfactants	U023	Plating Agents and Surface Treating Agents	Chemical substances applied to metal, plastic, or other surfaces to alter physical or chemical properties of the surface. Examples include metal surface treating agents, strippers, etchants, rust and tarnish removers, and descaling agents.
3.2.b	Processing: As a formulation component	P208	Surfactants	U031	Surface Active Agents	Chemical substances used to modify surface tension when dissolved in water or water solutions or reduce interfacial tension between two liquids or between a liquid and a solid or between liquid and air. Examples include carboxylates, sulfonates, phosphates, carboxylic acid, esters, and quaternary ammonium salts.
3.2.b	Processing: As a formulation component	P209	Lubricants	U017	Lubricants and Lubricant Additives	Chemical substances used to reduce friction, heat, or wear between moving parts or adjacent solid surfaces, or that enhance the lubricity of other substances. Examples of lubricants include mineral oils, silicate and phosphate esters, silicone oil, greases, and solid film lubricants such as graphite and PTFE. Examples of lubricant additives include molybdenum disulphide and tungsten disulphide.
3.2.b	Processing: As a formulation component	P210	Flame Retardants	U011	Flame Retardants	Chemical substances used on the surface of or incorporated into combustible materials to reduce or eliminate their tendency to ignite when exposed to heat or a flame for a short period of time. Examples include inorganic salts, chlorinated, or brominated organic compounds, and organic phosphates/phosphonates.

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
3.2.b	Processing: As a formulation component	P211	Rheological Modifiers	U022	Plasticizers	Chemical substances used in plastics, cement, concrete, wallboard, clay bodies, or other materials to increase their plasticity or fluidity. Examples include phthalates, trimellitates, adipates, maleates, and lignosulphonates.
3.2.b	Processing: As a formulation component	P211	Rheological Modifiers	U032	Viscosity Adjustors	Chemical substances used to alter the viscosity of another substance. Examples include viscosity index (VI) improvers, pour point depressants, and thickeners.
3.2.b	Processing: As a formulation component	P299	Other	U003	Adsorbents and Absorbents	Chemical substances used to retain other substances by accumulation on their surface or by assimilation. Examples of adsorbents include silica gel, activated alumina, and activated carbon. Examples of absorbents include straw oil, alkaline solutions, and kerosene.
3.2.b	Processing: As a formulation component	P299	Other	U016	Ion Exchange Agents	Chemical substances, usually in the form of a solid matrix, are used to selectively remove targeted ions from a solution. Examples generally consist of an inert hydrophobic matrix such as styrene divinylbenzene or phenol-formaldehyde, cross-linking polymer such as divinylbenzene, and ionic functional groups including sulfonic, carboxylic or phosphonic acids. This code also includes aluminosilicate zeolites.
3.2.b	Processing: As a formulation component	P299	Other	U018	Odor Agents	Chemical substances used to control odors, remove odors, mask odors, or impart odors. Examples include benzenoids, terpenes and terpenoids, musk chemicals, aliphatic aldehydes, aliphatic cyanides, and mercaptans.
3.2.b	Processing: As a formulation component	P299	Other	U019	Oxidizing/Reducing Agent	Chemical substances used to alter the valence state of another substance by donating or accepting electrons or by the addition or removal of hydrogen to a substance. Examples of oxidizing agents include nitric acid, perchlorates, hexavalent chromium compounds,

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						and peroxydisulfuric acid salts. Examples of reducing agents include hydrazine, sodium thiosulfate, and coke produced from coal.
3.2.b	Processing: As a formulation component	P299	Other	U020	Photosensitive Chemicals	Chemical substances used for their ability to alter their physical or chemical structure through absorption of light, resulting in the emission of light, dissociation, discoloration, or other chemical reactions. Examples include sensitizers, fluorescents, photovoltaic agents, ultraviolet absorbers, and ultraviolet stabilizers.
3.2.b	Processing: As a formulation component	P299	Other	U027	Propellants and Blowing Agents	Chemical substances used to dissolve or suspend other substances and either to expel those substances from a container in the form of an aerosol or to impart a cellular structure to plastics, rubber, or 363hermos set resins. Examples include compressed gasses and liquids and substances which release ammonia, carbon dioxide, or nitrogen.
3.2.b	Processing: As a formulation component	P299	Other	U028	Solid Separation Agents	Chemical substances used to promote the separation of suspended solids from a liquid. Examples include flotation aids, flocculants, coagulants, dewatering aids, and drainage aids.
3.2.b	Processing: As a formulation component	P299	Other	U999	Other (Specify)	Chemical substances used in a way other than those described by other codes.
3.2.c	Processing: As an article component	N/A	N/A	PA	Processing – Incorporation into Article	Chemical substance becomes an integral component of an article distributed for industrial, trade, or consumer use.
3.2.c	Processing: As an article component	N/A	N/A	U008	Dyes	Chemical substances used to impart color to other materials or mixtures (<i>i.e.</i> , substrates) by penetrating the surface of the substrate. Example types include azo, anthraquinone, amino azo, aniline, eosin, stilbene, acid, basic or cationic, reactive, dispersive, and natural dyes.

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
3.2.c	Processing: As an article component	N/A	N/A	U009	Fillers	Chemical substances used to provide bulk, increase strength, increase hardness, or improve resistance to impact. Fillers incorporated in a matrix reduce production costs by minimizing the amount of more expensive substances used in the production of articles. Examples include calcium carbonate, barium sulfate, silicates, clays, zinc oxide and aluminum oxide.
3.2.c	Processing: As an article component	N/A	N/A	U021	Pigments	Chemical substances used to impart color to other materials or mixtures (<i>i.e.</i> , substrates) by attaching themselves to the surface of the substrate through binding or adhesion. This code includes fluorescent agents, luminescent agents, whitening agents, pearlizing agents, and opacifiers. Examples include metallic oxides of iron, titanium, zinc, cobalt, and chromium; metal powder suspensions; lead chromates; vegetable and animal products; and synthetic organic pigments.
3.2.c	Processing: As an article component	N/A	N/A	U034	Paint Additives and Coating Additives Not Described by Other Codes	Chemical substances used in a paint or coating formulation to enhance properties such as water repellence, increased gloss, improved fade resistance, ease of application, foam prevention, etc. Examples of paint additives and coating additives include polyols, amines, vinyl acetate ethylene emulsions, and aliphatic polyisocyanates.
3.2.c	Processing: As an article component	N/A	N/A	U999	Other (Specify)	Chemical substances used in a way other than those described by other codes.
3.2.d	Processing: Repackaging	N/A	N/A	PK	Processing – Repackaging	Preparation of a chemical substance for distribution in commerce in a different form, state, or quantity. This includes transferring the chemical substance from a bulk container into smaller containers. This definition does not apply to sites that only relabel or redistribute the reportable chemical substance without removing

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						the chemical substance from the container in which it is received or purchased.
3.2.e	Processing: As an impurity	N/A	N/A	N/A	N/A	N/A
3.2.f	Processing: Recycling	N/A	N/A	N/A	N/A	N/A
3.3.a	Otherwise Use: As a chemical processing aid	N/A	N/A	U	Use-Non Incorporative Activities	Chemical substance is otherwise used (<i>e.g.</i> , as a chemical processing or manufacturing aid).
3.3.a	Otherwise Use: As a chemical processing aid	Z101	Process Solvents	U029	Solvents (for Cleaning or Degreasing)	Chemical substances used to dissolve oils, greases, and similar materials from textiles, glassware, metal surfaces, and other articles. Examples include trichloroethylene, perchloroethylene, methylene chloride, liquid carbon dioxide, and n-propyl bromide.
3.3.a	Otherwise Use: As a chemical processing aid	Z102	Catalysts	U020	Photosensitive Chemicals	Chemical substances used for their ability to alter their physical or chemical structure through absorption of light, resulting in the emission of light, dissociation, discoloration, or other chemical reactions. Examples include sensitizers, fluorescents, photovoltaic agents, ultraviolet absorbers, and ultraviolet stabilizers.
3.3.a	Otherwise Use: As a chemical processing aid	Z102	Catalysts	U025	Processing Aids, Specific to Petroleum Production	Chemical substances added to water-, oil-, or synthetic drilling muds or other petroleum production fluids to control viscosity, foaming, corrosion, alkalinity and pH, microbiological growth, hydrate formation, etc., during the production of oil, gas, and other products from beneath the earth's surface.
3.3.a	Otherwise Use: As a chemical processing aid	Z102	Catalysts	U026	Processing Aids, Not Otherwise Listed	Chemical substances used to improve the processing characteristics or the operation of process equipment or to alter or buffer the pH of the substance or mixture, when added to a process or to a substance or mixture to be processed. Processing agents do not become a part of the reaction product and are not

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						intended to affect the function of a substance or article created. Examples include buffers, dehumidifiers, dehydrating agents, sequestering agents, and chelators.
3.3.a	Otherwise Use: As a chemical processing aid	Z103	Inhibitors	U024	Process Regulators	Chemical substances used to change the rate of a chemical reaction, start or stop the reaction, or otherwise influence the course of the reaction. Process regulators may be consumed or become part of the reaction product.
3.3.a	Otherwise Use: As a chemical processing aid	Z103	Inhibitors	U025	Processing Aids, Specific to Petroleum Production	Chemical substances added to water-, oil-, or synthetic drilling muds or other petroleum production fluids to control viscosity, foaming, corrosion, alkalinity and pH, microbiological growth, hydrate formation, etc., during the production of oil, gas, and other products from beneath the earth's surface.
3.3.a	Otherwise Use: As a chemical processing aid	Z103	Inhibitors	U026	Processing Aids, Not Otherwise Listed	Chemical substances used to improve the processing characteristics or the operation of process equipment or to alter or buffer the pH of the substance or mixture, when added to a process or to a substance or mixture to be processed. Processing agents do not become a part of the reaction product and are not intended to affect the function of a substance or article created. Examples include buffers, dehumidifiers, dehydrating agents, sequestering agents, and chelators.
3.3.a	Otherwise Use: As a chemical processing aid	Z104	Initiators	U024	Process Regulators	Chemical substances used to change the rate of a chemical reaction, start, or stop the reaction, or otherwise influence the course of the reaction. Process regulators may be consumed or become part of the reaction product.
3.3.a	Otherwise Use: As a chemical processing aid	Z104	Initiators	U025	Processing Aids, Specific to Petroleum Production	Chemical substances added to water-, oil-, or synthetic drilling muds or other petroleum production fluids to control viscosity, foaming, corrosion, alkalinity and pH, microbiological growth, hydrate

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						formation, etc., during the production of oil, gas, and other products from beneath the earth's surface.
3.3.a	Otherwise Use: As a chemical processing aid	Z104	Initiators	U026	Processing Aids, Not Otherwise Listed	Chemical substances used to improve the processing characteristics or the operation of process equipment or to alter or buffer the pH of the substance or mixture, when added to a process or to a substance or mixture to be processed. Processing agents do not become a part of the reaction product and are not intended to affect the function of a substance or article created. Examples include buffers, dehumidifiers, dehydrating agents, sequestering agents, and chelators.
3.3.a	Otherwise Use: As a chemical processing aid	Z105	Reaction Terminators	U024	Process Regulators	Chemical substances used to change the rate of a chemical reaction, start, or stop the reaction, or otherwise influence the course of the reaction. Process regulators may be consumed or become part of the reaction product.
3.3.a	Otherwise Use: As a chemical processing aid	Z105	Reaction Terminators	U025	Processing Aids, Specific to Petroleum Production	Chemical substances added to water-, oil-, or synthetic drilling muds or other petroleum production fluids to control viscosity, foaming, corrosion, alkalinity and pH, microbiological growth, hydrate formation, etc., during the production of oil, gas, and other products from beneath the earth's surface.
3.3.a	Otherwise Use: As a chemical processing aid	Z105	Reaction Terminators	U026	Processing Aids, Not Otherwise Listed	Chemical substances used to improve the processing characteristics or the operation of process equipment or to alter or buffer the pH of the substance or mixture, when added to a process or to a substance or mixture to be processed. Processing agents do not become a part of the reaction product and are not intended to affect the function of a substance or article created. Examples include buffers, dehumidifiers, dehydrating agents, sequestering agents, and chelators.

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
3.3.a	Otherwise Use: As a chemical processing aid	Z106	Solution Buffers	U026	Processing Aids, Not Otherwise Listed	Chemical substances used to improve the processing characteristics or the operation of process equipment or to alter or buffer the pH of the substance or mixture, when added to a process or to a substance or mixture to be processed. Processing agents do not become a part of the reaction product and are not intended to affect the function of a substance or article created. Examples include buffers, dehumidifiers, dehydrating agents, sequestering agents, and chelators.
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U002	Adhesives and Sealant Chemicals	Chemical substances used to promote bonding between other substances, promote adhesion of surfaces, or prevent seepage of moisture or air. Examples include epoxides, isocyanates, acrylamides, phenol, urea, melamine, and formaldehyde.
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U006	Bleaching Agents	Chemical substances used to lighten or whiten a substrate through chemical reaction, usually an oxidative process which degrades the color system. Examples generally fall into one of two groups: chlorine containing bleaching agents (<i>e.g.</i> , chlorine, hypochlorite, N-chloro compounds and chlorine dioxide); and, peroxygen bleaching agents (<i>e.g.</i> , hydrogen peroxide, potassium permanganate, and sodium perborate).
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U018	Odor Agents	Chemical substances used to control odors, remove odors, mask odors, or impart odors. Examples include benzenoids, terpenes and terpenoids, musk chemicals, aliphatic aldehydes, aliphatic cyanides, and mercaptans.
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U023	Plating Agents and Surface Treating Agents	Chemical substances applied to metal, plastic, or other surfaces to alter physical or chemical properties of the surface. Examples include metal surface treating agents, strippers, etchants, rust and tarnish removers, and descaling agents.

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U025	Processing Aids, Specific to Petroleum Production	Chemical substances added to water-, oil-, or synthetic drilling muds or other petroleum production fluids to control viscosity, foaming, corrosion, alkalinity and pH, microbiological growth, hydrate formation, etc., during the production of oil, gas, and other products from beneath the earth's surface.
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U026	Processing Aids, Not Otherwise Listed	Chemical substances used to improve the processing characteristics or the operation of process equipment or to alter or buffer the pH of the substance or mixture, when added to a process or to a substance or mixture to be processed. Processing agents do not become a part of the reaction product and are not intended to affect the function of a substance or article created. Examples include buffers, dehumidifiers, dehydrating agents, sequestering agents, and chelators.
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U028	Solid Separation Agents	Chemical substances used to promote the separation of suspended solids from a liquid. Examples include flotation aids, flocculants, coagulants, dewatering aids, and drainage aids.
3.3.b	Otherwise Use: As a manufacturing aid	N/A	N/A	U	Use – Non Incorporative Activities	Chemical substance is otherwise used (<i>e.g.</i> , as a chemical processing or manufacturing aid).
3.3.b	Otherwise Use: As a manufacturing aid	Z201	Process Lubricants	U017	Lubricants and Lubricant Additives	Chemical substances used to reduce friction, heat, or wear between moving parts or adjacent solid surfaces, or that enhance the lubricity of other substances. Examples of lubricants include mineral oils, silicate and phosphate esters, silicone oil, greases, and solid film lubricants such as graphite and PTFE. Examples of lubricant additives include molybdenum disulphide and tungsten disulphide.
3.3.b	Otherwise Use: As a manufacturing aid	Z202	Metalworking Fluids	U007	Corrosion Inhibitors and Antiscaling Agents	Chemical substances used to prevent or retard corrosion or the formation of scale. Examples include

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						phenylenediamine, chromates, nitrates, phosphates, and hydrazine.
3.3.b	Otherwise Use: As a manufacturing aid	Z202	Metalworking Fluids	U014	Functional Fluids (Open Systems)	Liquid or gaseous chemical substances used for one or more operational properties in an open system. Examples include antifreezes and de-icing fluids such as ethylene and propylene glycol, sodium formate, potassium acetate, and sodium acetate. This code also includes substances incorporated into metal working fluids.
3.3.b	Otherwise Use: As a manufacturing aid	Z203	Coolants	U013	Functional Fluids (Closed Systems)	Liquid or gaseous chemical substances used for one or more operational properties in a closed system. Examples include heat transfer agents (<i>e.g.</i> , coolants and refrigerants) such as polyalkylene glycols, silicone oils, liquified propane, and carbon dioxide; hydraulic/transmission fluids such as mineral oils, organophosphate esters, silicone, and propylene glycol; and dielectric fluids such as mineral insulating oil and high flash point kerosene. This code does not include fluids used as lubricants.
3.3.b	Otherwise Use: As a manufacturing aid	Z204	Refrigerants	U013	Functional Fluids (Closed Systems)	Liquid or gaseous chemical substances used for one or more operational properties in a closed system. Examples include heat transfer agents (<i>e.g.</i> , coolants and refrigerants) such as polyalkylene glycols, silicone oils, liquified propane, and carbon dioxide; hydraulic/transmission fluids such as mineral oils, organophosphate esters, silicone, and propylene glycol; and dielectric fluids such as mineral insulating oil and high flash point kerosene. This code does not include fluids used as lubricants.
3.3.b	Otherwise Use: As a manufacturing aid	Z205	Hydraulic Fluids	U013	Functional Fluids (Closed Systems)	Liquid or gaseous chemical substances used for one or more operational properties in a closed system. Examples include: heat transfer agents (<i>e.g.</i> , coolants and refrigerants) such as polyalkylene glycols, silicone oils, liquified propane, and carbon dioxide;

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						hydraulic/transmission fluids such as mineral oils, organophosphate esters, silicone, and propylene glycol; and dielectric fluids such as mineral insulating oil and high flash point kerosene. This code does not include fluids used as lubricants.
3.3.b	Otherwise Use: As a manufacturing aid	Z299	Other	U013	Functional Fluids (Closed Systems)	Liquid or gaseous chemical substances used for one or more operational properties in a closed system. Examples include: heat transfer agents (<i>e.g.</i> , coolants and refrigerants) such as polyalkylene glycols, silicone oils, liquified propane, and carbon dioxide; hydraulic/transmission fluids such as mineral oils, organophosphate esters, silicone, and propylene glycol; and dielectric fluids such as mineral insulating oil and high flash point kerosene. This code does not include fluids used as lubricants.
3.3.b	Otherwise Use: As a manufacturing aid	Z299	Other	U023	Plating Agents and Surface Treating Agents	Chemical substances applied to metal, plastic, or other surfaces to alter physical or chemical properties of the surface. Examples include metal surface treating agents, strippers, etchants, rust and tarnish removers, and descaling agents.
3.3.c	Otherwise Use: Ancillary or other use	N/A	N/A	U	Use – Non-Incorporative Activities	Chemical substance is otherwise used (<i>e.g.</i> , as a chemical processing or manufacturing aid).
3.3.c	Otherwise Use: Ancillary or other use	Z301	Cleaner	U007	Corrosion Inhibitors and Antiscaling Agents	Chemical substances used to prevent or retard corrosion or the formation of scale. Examples include phenylenediamine, chromates, nitrates, phosphates, and hydrazine.
3.3.c	Otherwise Use: Ancillary or other use	Z301	Cleaner	U029	Solvents (for Cleaning or Degreasing)	Chemical substances used to dissolve oils, greases, and similar materials from textiles, glassware, metal surfaces, and other articles. Examples include trichloroethylene, perchloroethylene, methylene chloride, liquid carbon dioxide, and n-propyl bromide.

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
3.3.c	Otherwise Use: Ancillary or other use	Z302	Degreaser	U003	Adsorbents and Absorbents	Chemical substances used to retain other substances by accumulation on their surface or by assimilation. Examples of adsorbents include silica gel, activated alumina, and activated carbon. Examples of absorbents include straw oil, alkaline solutions, and kerosene.
3.3.c	Otherwise Use: Ancillary or other use	Z302	Degreaser	U029	Solvents (for Cleaning or Degreasing)	Chemical substances used to dissolve oils, greases, and similar materials from textiles, glassware, metal surfaces, and other articles. Examples include trichloroethylene, perchloroethylene, methylene chloride, liquid carbon dioxide, and n-propyl bromide.
3.3.c	Otherwise Use: Ancillary or other use	Z303	Lubricant	U017	Lubricants and Lubricant Additives	Chemical substances used to reduce friction, heat, or wear between moving parts or adjacent solid surfaces, or that enhance the lubricity of other substances. Examples of lubricants include mineral oils, silicate and phosphate esters, silicone oil, greases, and solid film lubricants such as graphite and PTFE. Examples of lubricant additives include molybdenum disulphide and tungsten disulphide.
3.3.c	Otherwise Use: Ancillary or other use	Z304	Fuel	U012	Fuels and Fuel Additives	Chemical substances used to create mechanical or thermal energy through chemical reactions, or which are added to a fuel for the purpose of controlling the rate of reaction or limiting the production of undesirable combustion products, or which provide other benefits such as corrosion inhibition, lubrication, or detergency. Examples of fuels include coal, oil, gasoline, and various grades of diesel fuel. Examples of fuel additives include oxygenated compound such as ethers and alcohols, antioxidants such as phenylenediamines and hindered phenols, corrosion inhibitors such as carboxylic acids, amines, and amine salts, and blending agents such as ethanol.
3.3.c	Otherwise Use: Ancillary or other use	Z305	Flame Retardant	U011	Flame Retardants	Chemical substances used on the surface of or incorporated into combustible materials to reduce or

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						eliminate their tendency to ignite when exposed to heat or a flame for a short period of time. Examples include inorganic salts, chlorinated, or brominated organic compounds, and organic phosphates/phosphonates.
3.3.c	Otherwise Use: Ancillary or other use	Z306	Waste Treatment	U006	Bleaching Agents	Chemical substances used to lighten or whiten a substrate through chemical reaction, usually an oxidative process which degrades the color system. Examples generally fall into one of two groups: chlorine containing bleaching agents (<i>e.g.</i> , chlorine, hypochlorites, N-chloro compounds and chlorine dioxide); and peroxygen bleaching agents (<i>e.g.</i> , hydrogen peroxide, potassium permanganate, and sodium perborate).
3.3.c	Otherwise Use: Ancillary or other use	Z306	Waste Treatment	U018	Odor Agents	Chemical substances used to control odors, remove odors, mask odors, or impart odors. Examples include benzenoids, terpenes and terpenoids, musk chemicals, aliphatic aldehydes, aliphatic cyanides, and mercaptans.
3.3.c	Otherwise Use: Ancillary or other use	Z306	Waste Treatment	U019	Oxidizing/Reducing Agent	Chemical substances used to alter the valence state of another substance by donating or accepting electrons or by the addition or removal of hydrogen to a substance. Examples of oxidizing agents include nitric acid, perchlorates, hexavalent chromium compounds, and peroxydisulfuric acid salts. Examples of reducing agents include hydrazine, sodium thiosulfate, and coke produced from coal.
3.3.c	Otherwise Use: Ancillary or other use	Z306	Waste Treatment	U028	Solid Separation Agents	Chemical substances used to promote the separation of suspended solids from a liquid. Examples include flotation aids, flocculants, coagulants, dewatering aids, and drainage aids.
3.3.c	Otherwise Use: Ancillary or other use	Z307	Water Treatment	U006	Bleaching Agents	Chemical substances used to lighten or whiten a substrate through chemical reaction, usually an oxidative process which degrades the color system.

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						Examples generally fall into one of two groups: chlorine containing bleaching agents (<i>e.g.</i> , chlorine, hypochlorites, N-chloro compounds and chlorine dioxide); and peroxygen bleaching agents (<i>e.g.</i> , hydrogen peroxide, potassium permanganate, and sodium perborate).
3.3.c	Otherwise Use: Ancillary or other use	Z307	Water Treatment	U018	Odor Agents	Chemical substances used to control odors, remove odors, mask odors, or impart odors. Examples include benzenoids, terpenes and terpenoids, musk chemicals, aliphatic aldehydes, aliphatic cyanides, and mercaptans.
3.3.c	Otherwise Use: Ancillary or other use	Z307	Water Treatment	U019	Oxidizing/Reducing Agent	Chemical substances used to alter the valence state of another substance by donating or accepting electrons or by the addition or removal of hydrogen to a substance. Examples of oxidizing agents include nitric acid, perchlorates, hexavalent chromium compounds, and peroxydisulfuric acid salts. Examples of reducing agents include hydrazine, sodium thiosulfate, and coke produced from coal.
3.3.c	Otherwise Use: Ancillary or other use	Z307	Water Treatment	U028	Solid Separation Agents	Chemical substances used to promote the separation of suspended solids from a liquid. Examples include flotation aids, flocculants, coagulants, dewatering aids, and drainage aids.
3.3.c	Otherwise Use: Ancillary or other use	Z308	Construction Materials	N/A	N/A	N/A
3.3.c	Otherwise Use: Ancillary or other use	Z399	Other	U001	Abrasives	Chemical substances used to wear down or polish surfaces by rubbing against the surface. Examples include sandstones, pumice, silex, quartz, silicates, aluminum oxides, and glass.
3.3.c	Otherwise Use: Ancillary or other use	Z399	Other	U013	Functional Fluids (Closed Systems)	Liquid or gaseous chemical substances used for one or more operational properties in a closed system. Examples include heat transfer agents (<i>e.g.</i> , coolants and refrigerants) such as polyalkylene glycols, silicone oils, liquified propane, and carbon dioxide;

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TRI Section	TRI Description	TRI Sub-Use Code	TRI Sub-Use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						hydraulic/transmission fluids such as mineral oils, organophosphate esters, silicone, and propylene glycol; and dielectric fluids such as mineral insulating oil and high flash point kerosene. This code does not include fluids used as lubricants.
3.3.c	Otherwise Use: Ancillary or other use	Z399	Other	U014	Functional Fluids (Open Systems)	Liquid or gaseous chemical substances used for one or more operational properties in an open system. Examples include antifreezes and de-icing fluids such as ethylene and propylene glycol, sodium formate, potassium acetate, and sodium acetate. This code also includes substances incorporated into metal working fluids.
3.3.c	Otherwise Use: Ancillary or other use	Z399	Other	U018	Odor Agents	Chemical substances used to control odors, remove odors, mask odors, or impart odors. Examples include benzenoids, terpenes and terpenoids, musk chemicals, aliphatic aldehydes, aliphatic cyanides, and mercaptans.
3.3.c	Otherwise Use: Ancillary or other use	Z399	Other	U020	Photosensitive Chemicals	Chemical substances used for their ability to alter their physical or chemical structure through absorption of light, resulting in the emission of light, dissociation, discoloration, or other chemical reactions. Examples include sensitizers, fluorescents, photovoltaic agents, ultraviolet absorbers, and ultraviolet stabilizers.
3.3.c	Otherwise Use: Ancillary or other use	Z399	Other	U023	Plating Agents and Surface Treating Agents	Chemical substances applied to metal, plastic, or other surfaces to alter physical or chemical properties of the surface. Examples include metal surface treating agents, strippers, etchants, rust and tarnish removers, and descaling agents.

10380

Appendix C ESTIMATING DAILY WASTEWATER DISCHARGES FROM DISCHARGE MONITORING REPORTS AND TOXICS RELEASE INVENTORY DATA

This appendix provides steps and examples for estimating daily wastewater discharges from industrial and commercial facilities manufacturing, processing, or using chemicals undergoing risk evaluation under the TSCA. Wastewater discharges are reported either via DMRs under the NPDES or TRI.

The following estimation methods are provided:

- Average daily wastewater discharge rate (kg/site-day);
- High-end daily wastewater discharge rate (kg/site-day);
- One-day maximum wastewater discharge rate (kg/site-day); and
- Trends over 5 years for a facility including the minimum, maximum, and median wastewater discharge rate that has occurred for a facility within the past 5 years.

These estimates will be used in modeling to estimate surface water concentrations in receiving waters for the assessment of risks to aquatic species and to the general population from drinking water.

C.1 Collecting and Mapping Wastewater Discharge Data to COUs and OESs

The first step in estimating daily releases is obtaining and mapping the relevant data to the COUs for the chemical that were identified in the scoping document. Some COUs may be broad categories of use and additional steps may be taken in the draft risk evaluation to further define the COUs into more specific OESs. A methodology for how to do this mapping step has been developed and the key steps are described below.

1. Query the Loading Tool and TRI for each of the past 5 years, starting with the most recent calendar year for which TRI data are available. In general, when a facility reports under both the NPDES program and TRI, EPA will perform comparisons of the data to determine if any discrepancies exist and, if so, which data are more appropriate to use in the risk evaluation. However, the two datasets are not updated concurrently. The Loading Tool automatically and continuously checks ICIS-NPDES for newly submitted DMRs. The Loading Tool processes the data weekly and calculates pollutant loading estimates; therefore, water discharge data (DMR data) are available on a continual basis. Although the Loading Tool process data weekly, each permitted discharging facility is only required to report their monitoring results for each pollutant at a frequency specified in the permit (*e.g.*, monthly, every 2 months, quarterly). TRI data is only reported annually for the previous calendar year and is typically released in July (*i.e.*, 2020 TRI data is released in July 2021). To ensure EPA is making an appropriate comparison between the two datasets, EPA should only use data for years where data from both datasets are available.
2. Remove the following DMR facility types from further analysis:
 - a. Facilities reporting zero discharges for the chemical of interest for each of the 5 years queried as EPA cannot confirm if the pollutant is present at the facility.
3. Map each remaining facility to a COU and OES; the OES will inform estimates of average operating days per year for the facility.

C.2 Estimating the Number of Facility Operating Days per Year

The number of operating days per year (days/year) for each facility that reports wastewater discharges

may be available but will most likely be unknown. An approach has been developed for use in TSCA risk evaluations for estimating the number of facility operating days before and is described below.

1. **Facility-Specific Data:** Use facility-specific data if available. If facility-specific data is not available, estimate the days/year using one of the following approaches:
 - a. If facilities have known or estimated average daily use rates, calculate the days/year (days/year = estimated annual use rate for the site [kg/year] / average daily use rate from sites with available data [kg/day]).
 - b. If sites with days/year data do not have known or estimated average daily use rates, use the average number of days/year from the sites with such data.
2. **Industry-Specific Data:** Industry-specific data may be available in the form of GSs, ESDs, trade publications, or other relevant literature. In such cases, these estimates should take precedent over other approaches, unless facility-specific data are available.
3. **Manufacture of Large-Production Volume (PV) Commodity Chemicals:** For the manufacture of the large-PV commodity chemicals, a value of 350 days/year should be used. This assumes the plant runs 7 day/week and 50 week/year (with 2 weeks down for turnaround) and assumes that the plant always produces the chemical.
4. **Manufacture of Lower-PV Specialty Chemicals:** For the manufacture of lower-PV specialty chemicals, it is unlikely the chemical is being manufactured continuously throughout the year. Therefore, a value of 250 days/year should be used. This assumes the plant manufactures the chemical 5 days/week and 50 weeks/year (with 2 weeks down for turnaround).
5. **Processing as Reactant (Intermediate Use) in the Manufacture of Commodity Chemicals:** Similar to #3, the manufacture of commodity chemicals is assumed to occur 350 days/year such that the use of a chemical as a reactant to manufacture a commodity chemical will also occur 350 days/year.
6. **Processing as Reactant (Intermediate Use) in the Manufacture of Specialty Chemicals:** Similar to #4, the manufacture of specialty chemicals is not likely to occur continuously throughout the year. Therefore, a value of 250 days/year can be used.
7. **Other Chemical Plant OESs** (e.g., Processing into formulation and use of industrial processing aids): For these OES, it is reasonable to assume that the chemical of interest is not always in use at the facility, even if the facility operates 24/7. Therefore, in general, a value of 300 days/year can be used based on the “SpERC fact sheet – Formulation & (re)packing of substances and mixtures – Industrial (Solvent-borne)” which uses a default of 300 days/year for the chemical industry. However, in instances where the OES uses a low volume of the chemical of interest, 250 days/year can be used as a lower estimate for the days/year.
8. **POTWs:** Although POTWs are expected to operate continuously over 365 days/year, the discharge frequency of the chemical of interest from a POTW will be dependent on the discharge patterns of the chemical from the upstream facilities discharging to the POTW. The upstream discharge patterns will be addressed in a second-tier analysis. However, there can be multiple upstream facilities (possibly with different OES) discharging to the same POTW and information to determine when the discharges from each facility occur on the same day or separate days is typically not available. Therefore, an exact number of days/year the chemical of interest is discharged from the POTW cannot be determined and a value of 365 days/year should be used.

- 10460 9. **All Other OESs:** Regardless of what the facility operating schedule is, other OES are unlikely to
10461 use the chemical of interest every day. Therefore, a value of 250 days/year should be used for
10462 these OESs.

10463 **C.3 Approach for Estimating Daily Discharges**

10464 After the initial steps of selecting and mapping of the water discharge data and estimating the number of
10465 facility operating days/year have been completed, the next steps in the analysis are to make estimates of
10466 daily wastewater discharges. This guidance presents approaches for making the following estimates:

- 10467 • Average daily wastewater discharges – this approach averages out the yearly discharges into an
10468 average daily discharge rate for the entire year for the facility
- 10469 • High-end daily wastewater discharges – this approach estimates a high-end daily discharge rate
10470 that may take place for a period of time during the year for the facility
- 10471 • 1-Day maximum discharge rate – this approach estimates a discharge rate that may represent a 1-
10472 day maximum rate for the facility.

10473 **C.3.1 Average Daily Wastewater Discharges**

10474 The following steps should be used to estimate the average daily wastewater discharge for each facility
10475 for each year:

- 10476 1. Obtain total annual loads calculated from the Loading Tool and reported annual surface water
10477 discharges in TRI.
- 10478 2. For facilities with both TRI and DMR data, compare the annual surface water discharges
10479 reported to each to see if they agree. If not, select the data representing the highest annual
10480 discharge.
- 10481 3. Divide the annual discharge over the number of estimated operating days for the OES to which
10482 the facility has been mapped. The number of operating days will differ for each OES and
10483 chemical but typically ranges from 200 to 350 days/year.

10484 This approach can be used for both direct discharges to surface water and indirect discharges to POTW
10485 or non-POTW WWT. However, special care should be given to facilities reporting transfers to POTW or
10486 non-POTW WWT plants in TRI as the subsequent discharge to surface water from these transfers may
10487 already be accounted for in the receiving facilities DMRs.

10488 **C.3.2 High-End Daily Direct Discharge for Facilities with DMR Data**

10489 The following steps should be used to estimate the high-end daily direct discharge for each facility with
10490 DMR data for each year:

- 10491 1. Use the Loading Tool to obtain the reporting periods (*e.g.*, monthly, bimonthly, quarterly,
10492 biannually, annually) and required reporting statistics (*e.g.*, average monthly concentration, max
10493 daily concentration) for each external outfall at each facility. When there is one outfall reported
10494 in the Loading Tool, assume it is an external outfall. If multiple outfalls are reported in the
10495 Loading Tool, further investigation to determine the external outfall would be required, such as a
10496 review of facility's permits.
- 10497 2. For each external outfall at each facility, calculate the average daily load for each reporting
10498 period by multiplying the period average concentration by the period average wastewater
10499 flowrate. If there is one outfall reported in the Loading Tool, assume it is an external outfall.
10500 Further investigation is needed if multiple outfalls are reported in the Loading Tool to determine
10501 the external outfall, such as a review of the facility's permit.
- 10502 3. Sum the average daily loads from each external outfall for each period.

- 10503 4. Select the period with the highest average daily load across all external outfalls as an estimate of
10504 the high-end daily discharge assessed over the number of days in the period. The number of days
10505 in the reporting period does not necessarily equate to the number of operating days in the
10506 reporting period. For example, for a plant that operates 200 days/year, use 200 rather than 365
10507 days/year for average daily discharge. Therefore, discharges will not occur every day of the
10508 reporting period, but only for a fraction ($200/365 = 68\%$). The number of days of the reporting
10509 period should be multiplied by this factor to maintain consistency between operating days/year
10510 and operating days/reporting period.

10511 **C.3.3 High-End Daily Direct Consecutive Discharge for Facilities Without DMRs**

10512 Some facilities may report surface water discharges to TRI but are not required to monitor or report
10513 those discharges under the NPDES. In such cases, EPA will only have the annual discharge value and
10514 not discharge values from multiple periods throughout the year. To estimate the high-end daily direct
10515 discharges for these facilities the following steps should be used:

- 10516 1. Identify facilities that report under the NPDES program for the same chemical, same year, and
10517 same OES as the TRI facility and report DMRs monthly. Note: if no monthly reporters exist,
10518 reporters with less frequent reporting can be substituted provided the number of release days per
10519 year are adjusted in subsequent steps.
- 10520 2. For each facility identified in #1, calculate the percentage of the total annual discharge that
10521 occurred in the highest one-month period.
- 10522 3. Calculate a generic factor for the OES as the average of the percentages calculated in #2.
- 10523 4. Estimate the high-end daily discharge for each facility without DMRs by multiplying the annual
10524 discharge by the generic factor from #3. For example, a facility reports 500 lb released per year
10525 and has a generic factor of 15% for the OES from #3. The estimated high-end chronic daily
10526 discharge for the facility would be ($500 \text{ lb} \times 15\% = 75 \text{ lb/month}$).
- 10527 5. Use the value calculated in #4 as an estimate of the high-end daily discharge assessed over 30
10528 days per year. For example, the high-end daily discharge assessed over 30 days per year for the
10529 facility with the estimated high-end chronic daily discharge of 75 lb/month (from #4 above) is
10530 ($75 \text{ lb/month} / 30 \text{ days} = 2.5 \text{ lb/day for 30 days}$).

10531 This approach can also be applied to facilities that have less frequent reporting periods under the
10532 NPDES program (e.g., facilities that report quarterly or biannually). Use the facility specific permit data
10533 for less frequent reporting periods. Refer to Section C.5 for additional details.

10534 **C.3.4 High-End Daily Indirect Discharges**

10535 In general, EPA is unlikely to have detailed information to estimate high-end daily indirect discharges to
10536 POTWs or non-POTW WWT plants and will only be able to calculate average daily discharges.
10537 However, in some cases, EPA may have site-specific information that allows for the estimation of a
10538 range for the release days per year (e.g., such information can be found in ECHO). In such instances, EPA
10539 can calculate the high-end daily discharge as the annual discharge divided by the minimum number of
10540 release days per year.

10541 **C.3.5 1-Day Discharges**

10542 Facilities required to report under the NPDES may sometimes be required to report a daily maximum
10543 discharge concentration for the period. These values can be used to estimate 1-day discharges by
10544 multiplying the maximum daily concentration by the corresponding month's maximum daily wastewater
10545 flow rate.

C.4 Trends in Wastewater Discharge Data – 5 Year Data Characterization

Wastewater discharge data may vary from year to year for a facility due to factors including the economy. A trend of the releases from each facility can be used to characterize results and develop a range of potential discharges from each site. A 5-year period will be used for this analysis. Prior to calculating the 5-year statistics, it is recommended that an evaluation be done of whether the 5-year range includes any outlier years and remove them from the analysis to ensure no atypical years are being included in the statistics. The interquartile rule for outliers can be used for this analysis.

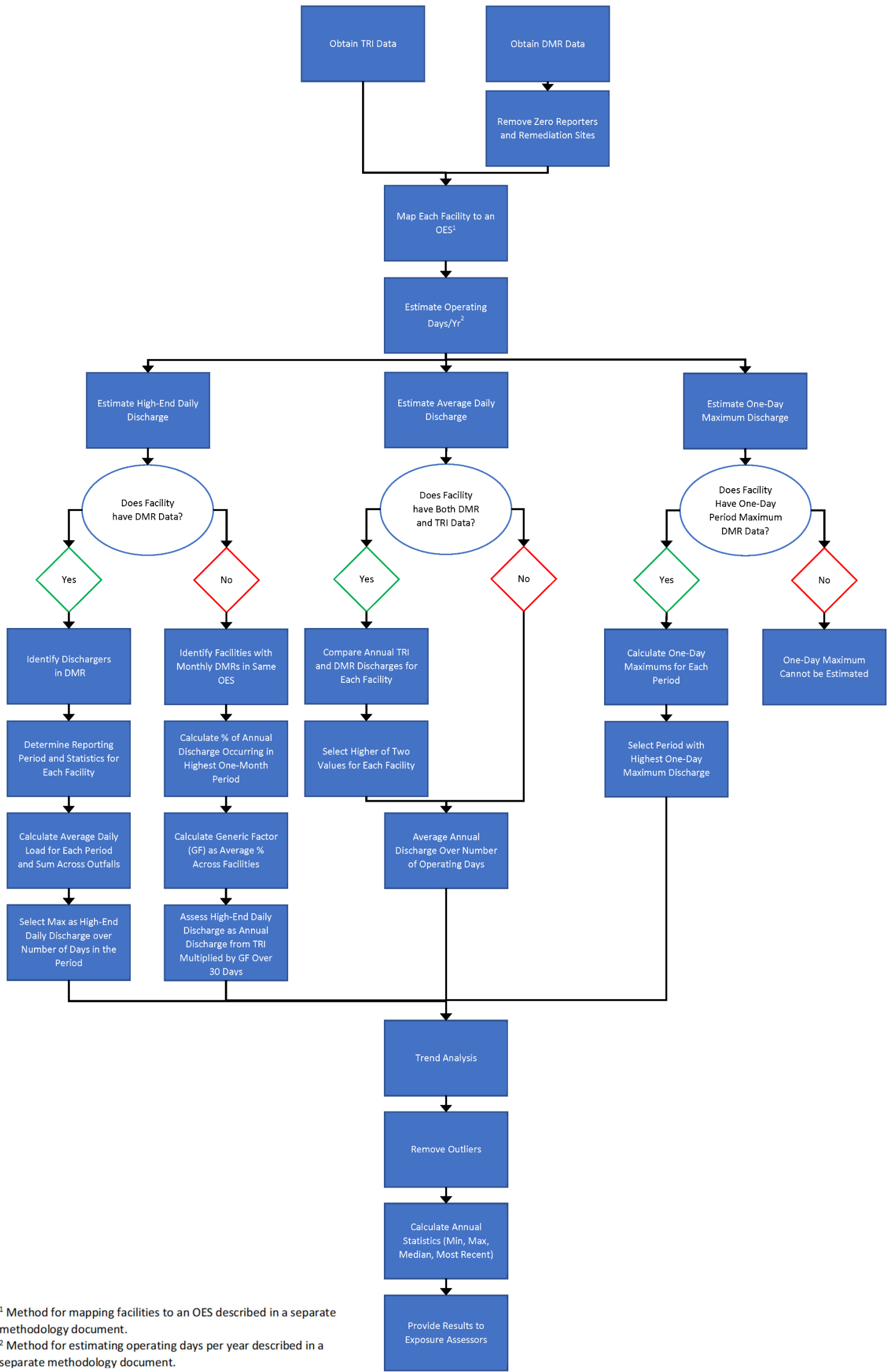
The interquartile rule for outliers states that if the distance between a data point and the first or third quartile is greater than 1.5 times the interquartile range (IQR), the data point is an outlier. The IQR is the difference between the third quartile (*i.e.*, 75th percentile) and first quartile (*i.e.*, 25th percentile) of a dataset. Therefore, any values less than 25th percentile minus 1.5 IQR or values exceeding the 75th percentile plus 1.5 IQR would be considered outliers.

After any outliers are removed, the following 5-year statistics should be determined for each facility:

1. minimum, maximum, median, and most recent (if different than the maximum) annual discharge;
2. minimum, maximum, median, and most recent (if different than the maximum) average chronic daily discharge;
3. minimum, maximum, median, and most recent (if different than the maximum) high-end chronic daily discharge; and
4. minimum, maximum, median, and most recent (if different than the maximum) acute 1-day discharge.

C.4.1 Decision Tree for DMR and TRI Wastewater Discharge Estimates

A *Decision Tree for Wastewater Discharge Estimates Using TRI and/or DMR Data*, provided as Figure_Apx C-1 below, helps visualize the process for estimating daily discharges.



Figure_Apx C-1. Decision Tree for Wastewater Discharge Estimates Using TRI and DMR Data

C.5 Example Facilities

This section illustrates examples, which are the same for all years that were analyzed, of how to calculate both high-end and average daily discharges for situations where a facility has both TRI and DMR data and where a facility only has TRI data. It also includes calculations for 1-day daily discharges from DMR data. The examples provided are for two facilities reporting for a pollutant chemical:

1. Westlake Vinyls in Calvert City, Kentucky – reports both DMR and TRI; and
2. Axiall LLC in Plaquemine, Louisiana – reports to TRI only.

For purposes of this example, only a single year for each database is presented.

Obtaining DMR Data

DMR data can be obtained through multiple methods; however, this method focuses on a single approach for simplicity. To query the loading tool for all pollutant data, the user should go to the following webpage: <https://echo.epa.gov/trends/loading-tool/get-data/custom-search> (accessed July 29, 2026), select the reporting year of interest and then enter a chemical CAS number as shown in Figure_Apx C-2.

Reporting Year: 2019 (Select reporting year)

Search Criteria

Facility Location

State: Select a State

County: Select a State

City:

ZIP Code (5-Digit):

EPA Region (View EPA Regional Map): Select an EPA Region

Facility Latitude: Facility Longitude:

Radius (miles): miles

Facility Outfall/Monitoring Locations

Permit Feature ID (outfall/pipe number):

Monitoring Location Code:

Receiving Watershed

Hydrologic Units: HUC Region:

Facility Characteristics

Facility Name:

Facility ID (NPDES, FRS, TRI, or CWNS):

☐ Only include facilities that link to TRI ID(s)

Major/Non-Major Designation: ☒ Any ☐ Major ☐ Non-Major

Permit Type: Select a Permit Type

Facility Type: Select a Facility Type

Treatment Technologies: CWNS Data Dictionary

Select a Treatment Category:

Limit to facilities where technology is: ☐ Present ☐ Not Present

☐ Facilities with an approved pretreatment program

☐ Facilities with one or more CSO outfalls

☐ Pesticide-producing establishments regulated under FIFRA

☐ Abandoned, inactive, or uncontrolled hazardous waste sites

☐ Facilities subject to SPCC/FRP to prevent and respond to oil spills

☐ Facilities with intermittent discharges

Pollutant

Chemical Abstract Service (CAS) Number: 107062 (Enter CAS number)

Figure_Apx C-2. Loading Tool – Data Query

After clicking submit, the Loading Tool will present a list of data elements that can be selected or

deselected for the query. By default, all data elements will be selected and for this methodology, it is suggested to leave that unchanged to ensure all relevant data fields are downloaded. The user should then click “download,” as shown in Figure_Apx C-3. This will provide an Excel spreadsheet with all the facilities that are required to monitor for the pollutant for the selected year and their annual discharge calculated by the Loading Tool.

Data Elements

Select All

Deselect All

Basic Record Information – Required Fields

☐ Period: Year or Monitoring Date

☐ NPDES Permit Number

☐ Facility Name

Facility Information

☒ SIC Code

☒ NAICS Code

☒ FRS ID

☒ TRI ID(s)

☒ CWNS ID(s)

☒ Facility Type Indicator

☒ Permit Type

☒ Permit Effective Date

☒ Permit Expiration Date

☒ Street Address

☒ City

☒ State

☒ ZIP Code

☒ County

☒ EPA Region

☒ Congressional District

☒ Facility Latitude

☒ Facility Longitude

☒ Major/Non-Major Status

☒ 12-Digit WBD HUC (FRS Derived))

☒ WBD Subwatershed Name

☒ State Water Body Name (ICIS)

☒ Reach Code

☒ Listed for Impairment (ATTAINS)

☒ Impairment Class (ATTAINS)

☒ Number of Combined Sewer Overflow (CSO) Outfalls

☒ Total Facility Design Flow (MGD)

☒ Actual Average Facility Flow (MGD)

Discharge Identification Information

☐ Outfall Number

☐ Monitoring Location Code

☒ Permit Feature Latitude

☒ Permit Feature Longitude

☐ Parameter Code

☐ Parameter Description

☒ CAS Number

☒ Toxic Weighting Factor (TWF)

☒ Substance Registry System (SRS) ID

Permit and DMR Data

☒ Limit Quantity 1 (Avg, kg/day)

☒ Limit Quantity 2 (Max, kg/day)

☒ Limit Concentration 1 (Min, mg/L)

☒ Limit Concentration 2 (Avg, mg/L)

☒ Limit Concentration 3 (Max, mg/L)

Pollutant Loadings Data

☒ Pollutant Load (kg/yr)

☒ Max Allowable Load (kg/yr)

☒ Wastewater Flow (MGal/day)

☒ Average Daily Load (kg/day)

☒ Average Concentration (mg/L)

☒ Average Daily Flow (MGD)

☒ Average Wastewater Temp (*F)

☒ Average Wastewater pH

☒ Load Over Limit (Option 1) (kg/yr)

☒ Load Over Limit (Option 2) (kg/yr)

☐ Includes Non-detects

☐ Estimation Factor

☐ Potential Outlier

TRI Release Data

☒ Chemical Name

☒ TRI Direct Release

☒ TRI Indirect Release

Download

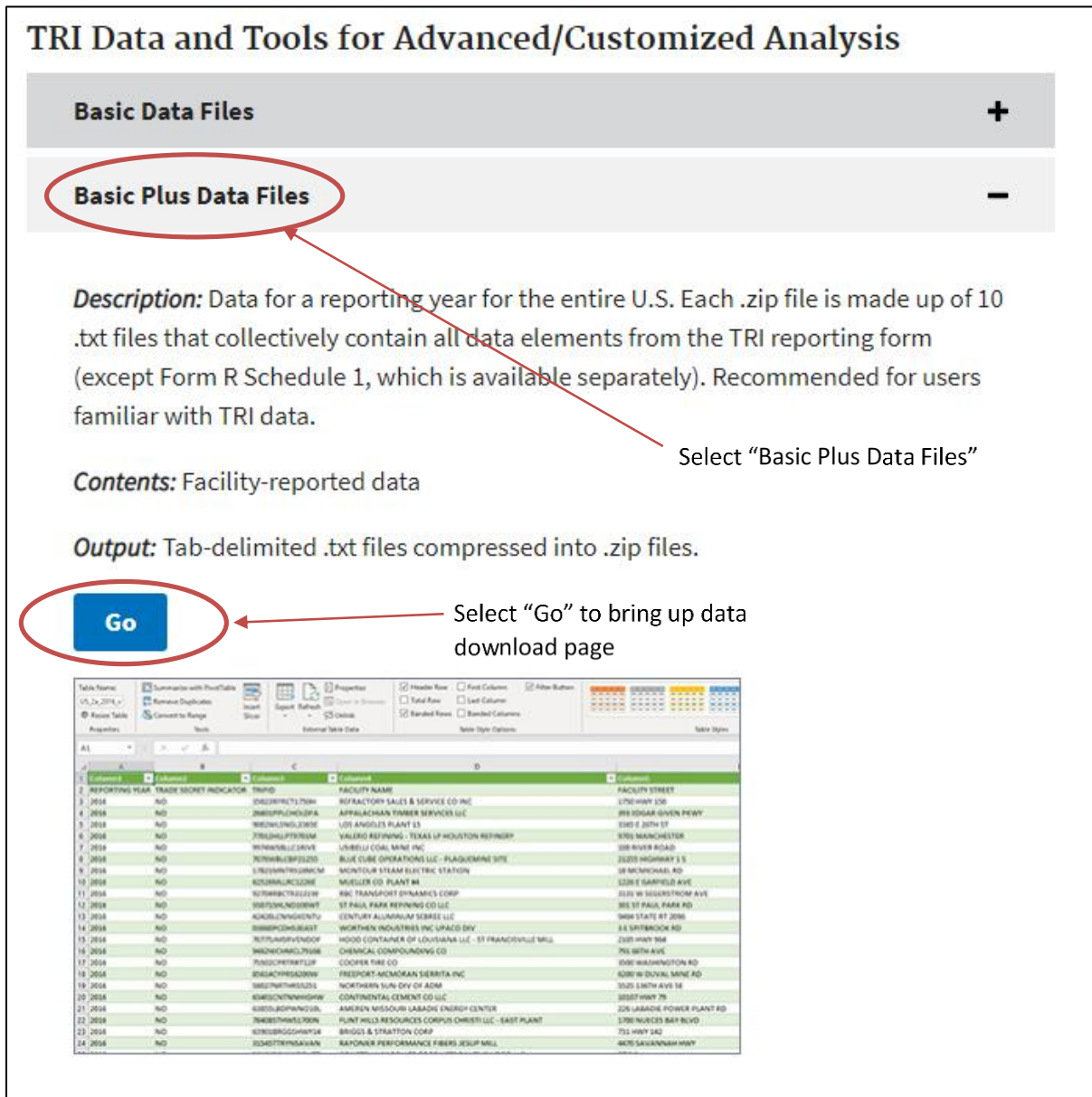
New Search

Download data

Figure_Apx C-3. Loading Tool – Download Facility Discharges from Query Results

Obtaining TRI Data

TRI data is available in several formats with various levels of detail depending on the type of information a user intends to use. For this analysis, the “Basic Plus Data Files” were used. This data can be obtained by going to the following website: <https://www.epa.gov/toxics-release-inventory-tri-program/tri-data-and-tools> (accessed July 29, 2026), selecting “Basic Plus Data Files,” then “Go” as shown in Figure_Apx C-4.



Figure_Apx C-4. Accessing Basic Plus Data Files^a

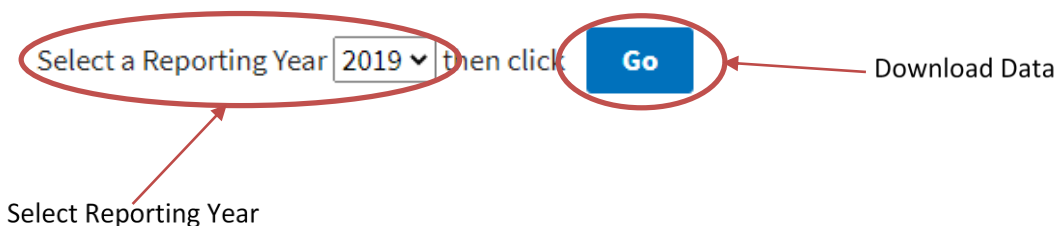
^a See [Guides for accessing, downloading, and importing the Basic Plus Data files](#) (accessed July 29, 2026) for further information.

The subsequent webpage can then be used to select the reporting year of interest and download the data files as shown in Figure_Apx C-5. This will provide a zip file containing multiple tab-delimited.txt files, which can be imported into Excel Spreadsheets and contain all the 2019 TRI data for all chemicals, including annual direct and indirect wastewater discharges. The files can then be filtered for the

chemical of interest and facilities with non-zero discharges.¹⁹ Table_Apx C-1 provides a list of key data fields and from which Basic Plus data file they can be obtained.

The ten file types of Basic Plus data files are:

- 1a: Facility, chemical, releases and other waste management summary information
- 1b: Chemical activities and uses
- 2a: On- and off-site disposal, energy recovery, recycling and treatment; non-production-related waste quantities; production/activity ratio; source reduction activities
- 2b: Detailed on-site waste treatment methods and efficiency
- 3a: Transfers off site for disposal and further waste management
- 3b: Transfers to Publicly Owned Treatment Works (POTWs) Reporting Years 1987 thru 2011
- 3c: Transfers to Publicly Owned Treatment Works (POTWs) Reporting Years 2012 and Later
- 4: Facility information
- 5: Optional information on source reduction, recycling and pollution control
- 6: Additional miscellaneous and optional information



Figure_Apx C-5. TRI – Downloading Basic Data Plus Files

¹⁹ Facilities using a Form A rather than a Form R to report to TRI do not report any release information; therefore, the wastewater discharges for these facilities will be shown as “0” in the TRI data files. However, these may not be true zero discharges. Discharges from these facilities may need to be estimated separately and is outside the scope of this draft TSD.

10623 **Table Apx C-1. List of Key Data Fields from TRI Basic Plus Data**

TRI Basic Plus Data File	Field Name
US_1a_[Year]	1. FORM TYPE
US_1a_[Year]	2. REPORTING YEAR
US_1a_[Year]	9. TRIFD
US_1a_[Year]	10. FACILITY NAME
US_1a_[Year]	11. FACILITY STREET
US_1a_[Year]	12. FACILITY CITY
US_1a_[Year]	13. FACILITY COUNTY
US_1a_[Year]	14. FACILITY STATE
US_1a_[Year]	15. FACILITY ZIP CODE
US_1a_[Year]	41. PRIMARY NAICS CODE
US_1a_[Year]	47. LATITUDE
US_1a_[Year]	48. LONGITUDE
US_1a_[Year]	74. FRS FACILITY ID
US_1a_[Year]	76. CAS NUMBER
US_1a_[Year]	77. CHEMICAL NAME
US_1a_[Year]	81. UNIT OF MEASURE
US_1a_[Year]	112. DISCHARGES TO STREAM A – STREAM NAME
US_1a_[Year]	113. DISCHARGES TO STREAM A – RELEASE POUNDS
US_1a_[Year]	114. DISCHARGES TO STREAM A – RELEASE RANGE CODE
US_1a_[Year]	115. TOTAL DISCHARGES TO STREAM A
US_1a_[Year]	116. DISCHARGES TO STREAM A – BASIS OF ESTIMATE
US_1a_[Year]	117. DISCHARGES TO STREAM A – % FROM STORMWATER
US_1a_[Year]	118. DISCHARGES TO STREAM B – STREAM NAME
US_1a_[Year]	119. DISCHARGES TO STREAM B – RELEASE POUNDS
US_1a_[Year]	120. DISCHARGES TO STREAM B – RELEASE RANGE CODE
US_1a_[Year]	121. TOTAL DISCHARGES TO STREAM B
US_1a_[Year]	122. DISCHARGES TO STREAM B – BASIS OF ESTIMATE
US_1a_[Year]	123. DISCHARGES TO STREAM B – % FROM STORMWATER
US_1a_[Year]	124. DISCHARGES TO STREAM C – STREAM NAME
US_1a_[Year]	125. DISCHARGES TO STREAM C – RELEASE POUNDS
US_1a_[Year]	126. DISCHARGES TO STREAM C – RELEASE RANGE CODE
US_1a_[Year]	127. TOTAL DISCHARGES TO STREAM C
US_1a_[Year]	128. DISCHARGES TO STREAM C – BASIS OF ESTIMATE
US_1a_[Year]	129. DISCHARGES TO STREAM C – % FROM STORMWATER
US_1a_[Year]	130. DISCHARGES TO STREAM D – STREAM NAME
US_1a_[Year]	131. DISCHARGES TO STREAM D – RELEASE POUNDS

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TRI Basic Plus Data File	Field Name
US_1a_[Year]	132. DISCHARGES TO STREAM D – RELEASE RANGE CODE
US_1a_[Year]	133. TOTAL DISCHARGES TO STREAM D
US_1a_[Year]	134. DISCHARGES TO STREAM D – BASIS OF ESTIMATE
US_1a_[Year]	135. DISCHARGES TO STREAM D – % FROM STORMWATER
US_1a_[Year]	136. DISCHARGES TO STREAM E – STREAM NAME
US_1a_[Year]	137. DISCHARGES TO STREAM E – RELEASE POUNDS
US_1a_[Year]	138. DISCHARGES TO STREAM E – RELEASE RANGE CODE
US_1a_[Year]	139. TOTAL DISCHARGES TO STREAM E
US_1a_[Year]	140. DISCHARGES TO STREAM E – BASIS OF ESTIMATE
US_1a_[Year]	141. DISCHARGES TO STREAM E – % FROM STORMWATER
US_1a_[Year]	142. DISCHARGES TO STREAM F – STREAM NAME
US_1a_[Year]	143. DISCHARGES TO STREAM F – RELEASE POUNDS
US_1a_[Year]	144. DISCHARGES TO STREAM F – RELEASE RANGE CODE
US_1a_[Year]	145 TOTAL DISCHARGES TO STREAM F
US_1a_[Year]	146 DISCHARGES TO STREAM F – BASIS FOR ESTIMATE
US_1a_[Year]	147. DISCHARGES TO STREAM F – % FROM STORMWATER
US_1a_[Year]	148. DISCHARGES TO STREAM G – STREAM NAME
US_1a_[Year]	149. DISCHARGES TO STREAM G – RELEASE POUNDS
US_1a_[Year]	150. DISCHARGES TO STREAM G – RELEASE RANGE CODE
US_1a_[Year]	151. TOTAL DISCHARGES TO STREAM G
US_1a_[Year]	152. DISCHARGES TO STREAM G – BASIS FOR ESTIMATE
US_1a_[Year]	153. DISCHARGES TO STREAM G – % FROM STORMWATER
US_1a_[Year]	154. DISCHARGES TO STREAM H – STREAM NAME
US_1a_[Year]	155. DISCHARGES TO STREAM H – RELEASE POUNDS
US_1a_[Year]	156. DISCHARGES TO STREAM H – RELEASE RANGE CODE
US_1a_[Year]	157. TOTAL DISCHARGES TO STREAM H
US_1a_[Year]	158. DISCHARGES TO STREAM H – BASIS FOR ESTIMATE
US_1a_[Year]	159. DISCHARGES TO STREAM H – % FROM STORMWATER
US_1a_[Year]	160. DISCHARGES TO STREAM I – STREAM NAME
US_1a_[Year]	161. DISCHARGES TO STREAM I – RELEASE POUNDS
US_1a_[Year]	162. DISCHARGES TO STREAM I – RELEASE RANGE CODE
US_1a_[Year]	163. TOTAL DISCHARGES TO STREAM I
US_1a_[Year]	164. DISCHARGES TO STREAM I – BASIS FOR ESTIMATE
US_1a_[Year]	165. DISCHARGES TO STREAM I – % FROM STORMWATER
US_1a_[Year]	166. TOTAL NUMBER OF RECEIVING STREAMS
US_1a_[Year]	167. TOTAL SURFACE WATER DISCHARGE
US_1a_[Year]	217. OFF-SITE – POTW RELEASES 81C

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TRI Basic Plus Data File	Field Name
US_1a_[Year]	218. OFF-SITE – POTW RELEASES 81D
US_1a_[Year]	219. OFF-SITE – POTW RELEASES
US_1a_[Year]	222. OFF-SITE – WASTEWATER TREATMENT RELEASE (EXCLUDING POTWs) – METALS AND METAL COMPOUNDS ONLY
US_1a_[Year]	224. OFF-SITE – WASTEWATER TREATMENT (EXCLUDING POTWS) METALS AND METAL COMPOUNDS ONLY
US_1a_[Year]	249. OFF-SITE – POTW TREATMENT
US_1a_[Year]	253. OFF-SITE – WASTEWATER TREATMENT (EXCLUDING POTWs) – NON-METALS ONLY
US_1a_[Year]	259. TOTAL POTW TRANSFER
US_1b_[Year]	1. FORM TYPE
US_1b_[Year]	2. REPORTING YEAR
US_1b_[Year]	3. TRADE SECRET INDICATOR
US_1b_[Year]	4. SANITIZED INDICATOR
US_1b_[Year]	5. TITLE OF CERTIFYING OFFICIAL
US_1b_[Year]	6. NAME OF CERTIFYING OFFICIAL
US_1b_[Year]	7. CERTIFYING OFFICIAL’S SIGNATURE INDICATOR
US_1b_[Year]	8. DATE SIGNED
US_1b_[Year]	9. TRIFD
US_1b_[Year]	10. FACILITY NAME
US_1b_[Year]	11. FACILITY STREET
US_1b_[Year]	12. FACILITY CITY
US_1b_[Year]	13. FACILITY COUNTY
US_1b_[Year]	14. FACILITY STATE
US_1b_[Year]	15. FACILITY ZIP CODE
US_1b_[Year]	16. BIA CODE
US_1b_[Year]	17. TRIBE NAME
US_1b_[Year]	18. MAILING NAME
US_1b_[Year]	19. MAILING STREET
US_1b_[Year]	20. MAILING CITY
US_1b_[Year]	21. MAILING STATE
US_1b_[Year]	22. MAILING PROVINCE
US_1b_[Year]	23. MAILING ZIP CODE
US_1b_[Year]	24. ENTIRE FACILITY IND
US_1b_[Year]	25. PARTIAL FACILITY IND
US_1b_[Year]	26. FEDERAL FACILITY IND
US_1b_[Year]	27. GOCO FACILITY IND
US_1b_[Year]	28. ASSIGNED FED FACILITY FLAG

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TRI Basic Plus Data File	Field Name
US_1b_[Year]	29. ASSIGNED PARTIAL FACILITY FLAG
US_1b_[Year]	30. PUBLIC CONTACT NAME
US_1b_[Year]	31. PUBLIC CONTACT PHONE
US_1b_[Year]	32. PUBLIC CONTACT PHONE EXT
US_1b_[Year]	33. PUBLIC CONTACT EMAIL
US_1b_[Year]	34. PRIMARY SIC CODE
US_1b_[Year]	35. SIC CODE 2
US_1b_[Year]	36. SIC CODE 3
US_1b_[Year]	37. SIC CODE 4
US_1b_[Year]	38. SIC CODE 5
US_1b_[Year]	39. SIC CODE 6
US_1b_[Year]	40. NAICS ORIGIN
US_1b_[Year]	41. PRIMARY NAICS CODE
US_1b_[Year]	42. NAICS CODE 2
US_1b_[Year]	43. NAICS CODE 3
US_1b_[Year]	44. NAICS CODE 4
US_1b_[Year]	45. NAICS CODE 5
US_1b_[Year]	46. NAICS CODE 6
US_1b_[Year]	47. LATITUDE
US_1b_[Year]	48. LONGITUDE
US_1b_[Year]	49. D and B NR A
US_1b_[Year]	50. D and B NR B
US_1b_[Year]	51. RCRA NR A
US_1b_[Year]	52. RCRA NR B
US_1b_[Year]	53. RCRA NR C
US_1b_[Year]	54. RCRA NR D
US_1b_[Year]	55. RCRA NR E
US_1b_[Year]	56. RCRA NR F
US_1b_[Year]	57. RCRA NR G
US_1b_[Year]	58. RCRA NR H
US_1b_[Year]	59. RCRA NR I
US_1b_[Year]	60. RCRA NR J
US_1b_[Year]	61. NPDES NR A
US_1b_[Year]	62. NPDES NR B
US_1b_[Year]	63. NPDES NR C
US_1b_[Year]	64. NPDES NR D
US_1b_[Year]	65. NPDES NR E

TRI Basic Plus Data File	Field Name
US_1b_[Year]	66. NPDES NR F
US_1b_[Year]	67. NPDES NR G
US_1b_[Year]	68. NPDES NR H
US_1b_[Year]	69. NPDES NR I
US_1b_[Year]	70. NPDES NR J
US_1b_[Year]	71. PARENT COMPANY NAME
US_1b_[Year]	72. PARENT COMPANY D and B NR
US_1b_[Year]	73. STANDARDIZED PARENT COMPANY NAME
US_1b_[Year]	74. FRS FACILITY ID
US_1b_[Year]	75. DOCUMENT CONTROL NUMBER
US_1b_[Year]	76. CAS NUMBER
US_1b_[Year]	77. CHEMICAL NAME
US_1b_[Year]	78. MIXTURE NAME
US_1b_[Year]	79. ELEMENTAL METAL INCLUDED
US_1b_[Year]	80. CLASSIFICATION
US_1b_[Year]	81. UNIT OF MEASURE
US_1b_[Year]	82. METAL IND
US_1b_[Year]	83. REVISION CODE 1
US_1b_[Year]	84. REVISION CODE 2
US_1b_[Year]	85. PRODUCE THE CHEMICAL
US_1b_[Year]	86. IMPORT THE CHEMICAL
US_1b_[Year]	87. ON-SITE USE OF THE CHEMICAL
US_1b_[Year]	88. SALE OR DISTRIBUTION OF THE CHEMICAL
US_1b_[Year]	89. AS A BYPRODUCT
US_1b_[Year]	90. AS A MANUFACTURED IMPURITY
US_1b_[Year]	91. USED AS A REACTANT
US_1b_[Year]	92. P101 FEEDSTOCKS
US_1b_[Year]	93. P102 RAW MATERIALS
US_1b_[Year]	94. P103 INTERMEDIATES
US_1b_[Year]	95. P104 INITIATORS
US_1b_[Year]	96. P199 OTHER
US_1b_[Year]	97. ADDED AS A FORMULATION COMPONENT
US_1b_[Year]	98. P201 ADDITIVES
US_1b_[Year]	99. P202 DYES
US_1b_[Year]	100. P203 REACTION DILUENTS
US_1b_[Year]	101. P204 INITIATORS
US_1b_[Year]	102. P205 SOLVENTS

TRI Basic Plus Data File	Field Name
US_1b_[Year]	103. P206 INHIBITORS
US_1b_[Year]	104. P207 EMULSIFIERS
US_1b_[Year]	105. P208 SURFACTANTS
US_1b_[Year]	106. P209 LUBRICANTS
US_1b_[Year]	107. P210 FLAME RETARDANTS
US_1b_[Year]	108. P211 RHEOLOGICAL MODIFIERS
US_1b_[Year]	109. P299 OTHER
US_1b_[Year]	110. USED AS AN ARTICLE COMPONENT
US_1b_[Year]	111. REPACKAGING
US_1b_[Year]	112. AS A PROCESS IMPURITY
US_1b_[Year]	113. PROCESSED / RECYCLING
US_1b_[Year]	114. USED AS A CHEMICAL PROCESSING AID
US_1b_[Year]	115. Z101 PROCESS SOLVENTS
US_1b_[Year]	116. Z102 CATALYSTS
US_1b_[Year]	117. Z103 INHIBITORS
US_1b_[Year]	118. Z104 INITIATORS
US_1b_[Year]	119. Z105 REACTION TERMINATORS
US_1b_[Year]	120. Z106 SOLUTION BUFFERS
US_1b_[Year]	121. Z199 OTHER
US_1b_[Year]	122. USED AS A MANUFACTURING AID
US_1b_[Year]	123. Z201 PROCESS LUBRICANTS
US_1b_[Year]	124. Z202 METALWORKING FLUIDS
US_1b_[Year]	125. Z203 COOLANTS
US_1b_[Year]	126. Z204 REFRIGERANTS
US_1b_[Year]	127. Z205 HYDRAULIC FLUIDS
US_1b_[Year]	128. Z299 OTHER
US_1b_[Year]	129. ANCILLARY OR OTHER USE
US_1b_[Year]	130. Z301 CLEANER
US_1b_[Year]	131. Z302 DEGREASER
US_1b_[Year]	132. Z303 LUBRICANT
US_1b_[Year]	133. Z304 FUEL
US_1b_[Year]	134. Z305 FLAME RETARDANT
US_1b_[Year]	135. Z306 WASTE TREATMENT
US_1b_[Year]	136. Z307 WATER TREATMENT
US_1b_[Year]	137. Z308 CONSTRUCTION MATERIALS
US_1b_[Year]	138. Z399 OTHER
US_3c_[Year]	1. FORM TYPE

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TRI Basic Plus Data File	Field Name
US_3c_[Year]	2. TRIFID
US_3c_[Year]	3. DOCUMENT CONTROL NUMBER
US_3c_[Year]	4. CAS NUMBER
US_3c_[Year]	5. CHEMICAL NAME
US_3c_[Year]	7. MIXTURE NAME
US_3c_[Year]	6. ELEMENTAL METAL INCLUDED
US_3c_[Year]	8. CLASSIFICATION
US_3c_[Year]	9. UNIT OF MEASURE
US_3c_[Year]	10. METAL INDICATOR
US_3c_[Year]	11. REVISION CODE 1
US_3c_[Year]	12. REVISION CODE 2
US_3c_[Year]	13. REPORTING YEAR
US_3c_[Year]	14. TRADE SECRET INDICATOR
US_3c_[Year]	15. FACILITY NAME
US_3c_[Year]	16. FACILITY STREET
US_3c_[Year]	17. FACILITY CITY
US_3c_[Year]	18. FACILITY COUNTY
US_3c_[Year]	19. FACILITY STATE
US_3c_[Year]	20. FACILITY ZIP CODE
US_3c_[Year]	21. ASSIGNED FED FACILITY FLAG
US_3c_[Year]	22. ASSIGNED PARTIAL FACILITY FLAG
US_3c_[Year]	23. BIA CODE
US_3c_[Year]	24. TRIBE NAME
US_3c_[Year]	25. ENTIRE FACILITY IND
US_3c_[Year]	26. PARTIAL FACILITY IND
US_3c_[Year]	27. FEDERAL FACILITY IND
US_3c_[Year]	28. GOCO FACILITY IND
US_3c_[Year]	29. PUBLIC CONTACT NAME
US_3c_[Year]	30. PUBLIC CONTACT PHONE
US_3c_[Year]	31. PUBLIC CONTACT PHONE EXT
US_3c_[Year]	32. PUBLIC CONTACT EMAIL
US_3c_[Year]	33. PRIMARY SIC CODE
US_3c_[Year]	34. SIC CODE 2
US_3c_[Year]	35. SIC CODE 3
US_3c_[Year]	36. SIC CODE 4
US_3c_[Year]	37. SIC CODE 5
US_3c_[Year]	38. SIC CODE 6

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TRI Basic Plus Data File	Field Name
US_3c_[Year]	39. NAICS ORIGIN
US_3c_[Year]	40. PRIMARY NAICS CODE
US_3c_[Year]	41. NAICS CODE 2
US_3c_[Year]	42. NAICS CODE 3
US_3c_[Year]	43. NAICS CODE 4
US_3c_[Year]	44. NAICS CODE 5
US_3c_[Year]	45. NAICS CODE 6
US_3c_[Year]	46. LATITUDE
US_3c_[Year]	47. LONGITUDE
US_3c_[Year]	48. DB NR A
US_3c_[Year]	49. DB NR B
US_3c_[Year]	50. RCRA NR A
US_3c_[Year]	51. RCRA NR B
US_3c_[Year]	52. RCRA NR C
US_3c_[Year]	53. RCRA NR D
US_3c_[Year]	54. RCRA NR E
US_3c_[Year]	55. RCRA NR F
US_3c_[Year]	56. RCRA NR G
US_3c_[Year]	57. RCRA NR H
US_3c_[Year]	58. RCRA NR I
US_3c_[Year]	59. RCRA NR J
US_3c_[Year]	60. NPDES NR A
US_3c_[Year]	61. NPDES NR B
US_3c_[Year]	62. NPDES NR C
US_3c_[Year]	63. NPDES NR D
US_3c_[Year]	64. NPDES NR E
US_3c_[Year]	65. NPDES NR F
US_3c_[Year]	66. NPDES NR G
US_3c_[Year]	67. NPDES NR H
US_3c_[Year]	68. NPDES NR I
US_3c_[Year]	69. NPDES NR J
US_3c_[Year]	70. PARENT COMPANY NAME
US_3c_[Year]	71. PARENT COMPANY DB NR
US_3c_[Year]	72. STANDARDIZED PARENT COMPANY NAME
US_3c_[Year]	73. FRS FACILITY ID
US_3c_[Year]	74. POTW NAME
US_3c_[Year]	75. POTW ADDRESS

TRI Basic Plus Data File	Field Name
US_3c_[Year]	76. POTW CITY
US_3c_[Year]	77. POTW STATE
US_3c_[Year]	78. POTW COUNTY
US_3c_[Year]	79. POTW ZIP
US_3c_[Year]	80. POTW REGISTRY ID
US_3c_[Year]	81. QUANTITY TRANSFERRED
US_3c_[Year]	82. BASIS OF ESTIMATE
US_3c_[Year]	83. DISCHARGES TO WATER STREAMS
US_3c_[Year]	84. DISCHARGES TO WATER STREAMS – BASIS OF ESTIMATE
US_3c_[Year]	85. DISCHARGES TO OTHER ACTIVITIES
US_3c_[Year]	86. DISCHARGES TO OTHER ACTIVITIES – BASIS OF ESTIMATE
US_3c_[Year]	87. RELEASED TO AIR
US_3c_[Year]	88. RELEASED TO AIR – BASIS OF ESTIMATE
US_3c_[Year]	89. SLUDGE TO DISPOSAL
US_3c_[Year]	90. SLUDGE TO DISPOSAL – BASIS OF ESTIMATE
US_3c_[Year]	91. SLUDGE TO INCINERATION – METALS
US_3c_[Year]	92. SLUDGE TO INCINERATION – METALS – BASIS OF ESTIMATE
US_3c_[Year]	93. SLUDGE TO AGRICULTURAL APPLICATIONS
US_3c_[Year]	94. SLUDGE TO AGRICULTURAL APPLICATIONS – BASIS OF ESTIMATE
US_3c_[Year]	95. OTHER OR UNKNOWN DISPOSAL
US_3c_[Year]	96. OTHER OR UNKNOWN DISPOSAL – BASIS OF ESTIMATE
US_3c_[Year]	97. OFF-SITE POTW RELEASES – 8.1C
US_3c_[Year]	98. OFF-SITE POTW RELEASES – 8.1D
US_3c_[Year]	99. OFF-SITE – POTW RELEASES
US_3c_[Year]	100. OTHER OR UNKNOWN TREATMENT
US_3c_[Year]	101. OTHER OR UNKNOWN TREATMENT – BASIS OF ESTIMATE
US_3c_[Year]	102. SLUDGE TO INCINERATION – NONMETALS
US_3c_[Year]	103. SLUDGE TO INCINERATION – NONMETALS – BASIS OF ESTIMATE
US_3c_[Year]	104. EXPERIMENTAL AND ESTIMATED TREATMENT
US_3c_[Year]	105. EXPERIMENTAL AND ESTIMATED TREATMENT – BASIS OF ESTIMATE
US_3c_[Year]	106. TOTAL TREATED

Mapping Facilities to an OES and Selecting the Number of Operating Days per Year

Both facilities used in this example reported to the 2016 CDR as domestic manufacturers of the chemical. Therefore, they are mapped to the manufacturing OES. Because the chemical is a commodity chemical, each facility is assumed to operate 350 days/year.

Annual Facility Discharges

Annual facility discharges can be obtained directly from the Loading Tool and TRI data file downloads for each facility. The 2019 annual discharges for the two facilities in this example are provided in Table_Apx C-2.

Table_Apx C-2. Example Facilities' 2019 Annual Discharges

Facility	Annual Surface Water Discharge from Loading Tool (kg)	Annual Reported Discharge from TRI (kg)
Westlake Vinyls in Calvert City, KY	209 kg ^a	212 kg to surface water 0 kg to POTW and non-POTW WWT
Axiall LLC in Plaquemine, LA	N/A – No DMR data for this facility	10 kg to surface water 0 kg to POTW and non-POTW WWT

^a The Loading Tool estimates this discharge a 495 lb (or 224 kg) as the sum of outfalls 001, 002, and 009. However, the NPDES permit for this facility indicates that 002 and 009 are internal outfalls that discharge into 001. Therefore, discharges from 001 includes those from 002 and 009 and the total annual discharge shown in the table is equal to the Loading Tool's estimate for outfall 001 only (461 lb or 209 kg). Review of NPDES permits is generally outside the scope of this methodology document; however, permit information for Westlake Vinyls can be obtained at http://dep.gateway.ky.gov/eSearch/search_ai_detail.aspx?AgencyID=2967 (accessed July 29, 2026).

Average Daily Discharges

To calculate average daily discharges at each facility, the annual discharge is averaged over the number of operating as shown in the calculations below:

Equation_Apx C-1.

$$ADR = \frac{YR}{OD}$$

Where:

$$\begin{aligned} ADR &= \text{Average daily discharge (kg/day)} \\ YR &= \text{Annual discharge (kg/year)} \\ OD &= \text{Operating days (days/year)} \end{aligned}$$

For Westlake Vinyls the annual discharge of 209 kg/year is averaged over 350 days/year (operating days for manufacturers) to calculate the daily discharge using DMR as:

Equation_Apx C-2.

$$ADR = \frac{YR}{OD} = \frac{209 \text{ kg/yr}}{350 \text{ days/yr}} = 0.6 \text{ kg/day}$$

Similarly, for Westlake Vinyls the average daily discharge using TRI is calculated as the 212 kg/year annual discharge over 350 days/year, as shown below:

Equation_Apx C-3.

$$ADR = \frac{YR}{OD} = \frac{212 \text{ kg/yr}}{350 \text{ days/yr}} = 0.6 \text{ kg/day}$$

For Axiall LLC, the average daily discharge is calculated as the annual discharge of 10 kg/year over 350 days/year:

Equation_Apx C-4.

$$ADR = \frac{YR}{OD} = \frac{10 \text{ kg/yr}}{350 \text{ days/yr}} = 0.03 \text{ kg/day}$$

High-End Daily Discharges for Facilities with DMRs

To estimate high-end daily discharge for sites with DMRs, the reporting frequency and pollutant load for each reporting period throughout the year must be determined. This information can be obtained from the Loading Tool by going to the “Top Facility Discharges” table in the query results and clicking on the desired facility name as shown in Figure_Apx C-6.²⁰ This will open the details of the facility’s DMR.

Select facility of interest

Top Facility Discharges (2019)										
NPDES ID	Facility Name	City, State	Report	SIC Code	HUC-12 Code	Avg Conc (mg/L)	Max Conc (mg/L)	Total Pounds (lb/yr)	Total TWPE (lb-eq/yr)	Avg Flow (MGD)
KY0003484	WESTLAKE VINYL	CALVERT CITY, KY	LE CP	2812	060400060502	0.0191	0.2320	495	4.95	1.68
MI0000868	DOW CHEMICAL-MIDLAND	MIDLAND, MI	LE CP	2869	040802010604	0.0019	0.0167	415	4.15	5.52
TX0085570	FORMOSA PLASTICS CORPORATION, TEXAS	POINT COMFORT, TX	LE CP	2821	121004010100	0.0008	0.0445	244	2.44	19.92
LA0002933	OCCIDENTAL CHEMICAL CORP GEISMAR PLANT	GEISMAR, LA	LE CP	2869	080702040101	0.0029	0.0351	164	1.64	0.9016
TX0007412	OXY VINYL LP - DEER PARK PVC	DEER PARK, TX	LE CP	2812	120401040703	0.0076	0.0320	143	1.43	4.27
KY0003603	ARKEMA INC	CALVERT CITY, KY	LE CP	2819	060400060502	0.0083	0.0192	137	1.37	0.9300
LA0000761	EAGLE US 2 LLC - LAKE CHARLES COMPLEX	LAKE CHARLES, LA	LE CP	2869	080802060301	0.1138	0.3830	78.97	0.7897	40.72
LA0000281	WESTLAKE VINYL CO	GEISMAR, LA	LE CP	2869	080702040103	0.0020	0.0097	25.74	0.2574	0.8815
KY0023540	CENTRAL CITY STP	CENTRAL CITY, KY	LE CP	4952	051100030505	0.0050	0.0050	25.01	0.2501	1.28
NJ0005100	CHEMOURS CHAMBERS WORKS	DEEPWATER, NJ	LE CP	2869	020402060103	0.0017	0.0066	22.87	0.2287	3.67

Download All Data Browse All Facilities

Figure_Apx C-6. Loading Tool – Accessing Facility-Specific Data

From the facility’s DMR, the user can select the “View Permit Limits and Monitoring Requirements” to determine the reporting frequency and the “View NPDES Monitoring Data Download” to obtain the

²⁰ If the facility of interest is not listed in this table, the user can select “browse all facilities” to bring up a list of all facilities monitoring for the chemical of interest.

facility's DMRs for each pollutant at each outfall for each reporting period and the reporting period's corresponding wastewater flowrate in an Excel Spreadsheet, as shown in Figure_Apx C-7 and Figure_Apx C-8.

WESTLAKE VINYL, CALVERT CITY, 42029

NPDES ID: KY0003484
FRS ID: 110027373072
Other NPDES IDs associated with this FRS ID: None
TRI ID(s): 42029WSTLK24681
Facility Type: NON-POTW
Permit Type: NPDES Individual Permit
Permit Effective Date: 10/01/2018
Permit Expiration Date: 09/30/2023
Major/Non-Major Indicator: Major
Permit Issuance: STATE OF KENTUCKY
Approved Pretreatment Program: N/A
Combined Sewer Overflow (CSO) Outfall: N/A
County: MARSHALL
Congressional District: Kentucky's 1st District

Latitude: 37.051111
Longitude: -88.334167
Facility Design Flow (Permit Application) (MGD): 4.65
Actual Average Facility Flow (Permit Application) (MGD): 3.83
Average Facility Flow in 2019 (MGD): 1.68
4-Digit SIC Code: 2812 - ALKALIES AND CHLORINE
6-Digit NAICS Code: --
Likely Point Source Category: 415 - Inorganic chemicals manufacturing

[View Detailed Facility Report](#)
[View Effluent Charts](#)
[View Permit Limits and Monitoring Requirements](#)
[View NPDES Monitoring Data Download](#)
[View DMR and TRI Multi-Year Loading Report](#)

Select Reporting Year: 2019 ⚠

[Top Pollutants](#) | [Facility Loading Calculations](#) ⓘ

View Permit Limits to Obtain Reporting Frequency

Download DMRs

Figure_Apx C-7. Loading Tool – Accessing Monitoring Requirements and Reporting Period Discharge Data

Select Reporting Year: 2019

Pollutant Name	Parameter Code	Permit Feature Number	Monitoring Period Date Range	Limit Set Designator	Monitoring Frequency	Limit Season ID	Limit Qty 1 (kg/day)	Limit Qty 2 (kg/day)	Limit Conc 1 (mg/L)	Limit Conc 2 (mg/L)	Limit Conc 3 (mg/L)
1,2-Dichloroethane	32103	1	10/01/2018 09/30/2023	1	monthly	0	--	--	--	monitoring only average	monitoring only maximum
1,2-Dichloroethane	32103	2	10/01/2018 09/30/2023	1	monthly	0	0.2395 average	0.7433 maximum	--	--	--
1,2-Dichloroethane	32103	9	10/01/2018 09/30/2023	1	monthly	0	1.03 average	3.28 maximum	--	--	--

Outfall Number

Reporting Frequency

Figure_Apx C-8. Loading Tool – Reviewing Facility Reporting Frequency for Each Outfall

Westlake Vinyls is required to report the chemical monthly for three outfalls; however, review of Westlake Vinyl's NPDES permit indicates outfalls 002 and 009 are internal outfalls that discharge into

outfall 001, and, therefore, are not included for further analysis.²¹ For the chemical, Westlake Vinyls reports a monthly average concentration and a maximum daily concentration. Westlake Vinyls must also report a monthly average wastewater flow rate and a maximum daily wastewater flow rate. The reporting period load is then calculated by multiplying the monthly average concentration by the monthly average wastewater flow and multiplying by the number of days in the period as shown in the equation below.

Equation_Apx C-5.

$$PR = C \times FR \times 3.785 \frac{L}{gal} \times 1 \times 10^{-6} \frac{kg}{mg} \times PD$$

Where:

PR = Period discharge (kg/period)
C = Pollutant concentration (mg/L)
FR = Wastewater flowrate (gal/day)
PD = Number of days in the period (days/period)

The results from these calculations for Westlake Vinyl for the chemical in 2019 are presented in Table_Apx C-3.

Table_Apx C-3. Westlake Vinyl Total Period Discharge Results

Reporting Period End Date	Monthly Average Concentration (mg/L)	Monthly Average Wastewater Flow (MGD)	Days per Period	Period Discharge (kg/period)
01/31/2019	0.014	3.3756	31	5.5
02/28/2019	0.004	3.6760	28	1.6
03/31/2019	0.232	3.6855	31	100
04/30/2019	0.015	3.5123	30	6.0
05/31/2019	0.007	3.3281	31	2.7
06/30/2019	0.122	3.2704	30	45
07/31/2019	0.060	3.0358	31	21
08/31/2019	0.013	3.0535	31	4.7
09/30/2019	0.027	3.1075	30	9.5
10/31/2019	0.012	2.5449	31	3.6
11/30/2019	0.012	3.1966	30	4.3
12/31/2019	0.010	3.6309	31	4.3
MGD = million gallons per day				

As shown in Table_Apx C-3 the period ending March 31, 2019, has the highest total discharge for Westlake Vinyls. Using the highest period discharge, the high-end daily discharge can be calculated using the following equation:

²¹ Review of NPDES permits is generally outside the scope of this methodology document; however, an online, [searchable database](#) (accessed July 29, 2026) is available.

Equation_Apx C-6.

$$HDR = \frac{MPR}{PD} = \frac{100 \text{ kg/period}}{31 \text{ day/period}} = 3.2 \text{ kg/day}$$

Where:

<i>HDR</i>	=	High-end daily discharge (kg/day)
<i>MPR</i>	=	Maximum period discharge (kg/period)
<i>PD</i>	=	Number of days in the period (days/period)

High-End Daily Discharges for Facilities Without DMRs

To estimate the high-end daily discharge for TRI facilities without DMRs, a generic factor developed using data from facilities mapped to the same OES with DMRs should be applied to the discharge from facilities without DMRs. The first step is to identify facilities with DMRs for the same chemical, same year, and same OES as the TRI facility and report DMRs monthly. For purposes of this example, only the Westlake Vinyl's facility will be considered; however, in many instances data from multiple facilities will be considered.

After identifying the relevant facility, the percentage of the total annual discharge that occurred in the highest 1-month period should be calculated using the equation below and values from Westlake Vinyls:

Equation_Apx C-7.

$$GF = \frac{MPR}{YR} = \frac{100 \text{ kg/period}}{209 \text{ kg/yr}} \times 100 = 48\%$$

Where:

<i>GF</i>	=	Generic factor (year/period)
<i>MPR</i>	=	Maximum period discharge (kg/period)
<i>YR</i>	=	Annual discharge (kg/year)

If multiple facilities are included in the analysis, the GF used in the next steps should be the average of the factors calculated for each facility. For this example, the factor of 48% will be used.

To calculate the high-end daily discharge from TRI sites without DMRs, the reported annual discharge should be multiplied by the generic factor and divide by the number of days in a month (30 days) as shown in the equation below using values for Axiall LLC:

Equation_Apx C-8.

$$HDR = \frac{GF \times YR}{30 \text{ days}} = 48\% \times 10 \text{ kg} = 0.2 \text{ kg/day}$$

Where:

<i>HDR</i>	=	High-end daily discharge (kg/day)
<i>GF</i>	=	Generic factor (unitless)
<i>YR</i>	=	Annual discharge (kg/year)

This value is assessed over 30 days/period to approximate the high-end period of 1 month the results are based on. Note, the GF calculated in this example is based on a facility with monthly reporting periods which is the preferred method for estimating the GF and hence assesses over 30 days. In situations where the GF is calculated using data from facilities with longer reporting periods, the number of days should be adjusted accordingly.

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1-Day Discharges

Data to estimate 1-day discharges can be obtained using a similar method as the high-end daily discharges from DMR except concentration and flowrate values reported for the daily maximum for each period should be used. The daily discharge is simply the daily maximum concentration multiplied by the daily maximum flowrate (with proper unit conversions) as shown in the equation below.

Equation_Apx C-9.

$$ODR = C \times FR \times 3.785 \frac{L}{gal} \times 1 \times 10^{-6} \frac{kg}{mg}$$

Where:

ODR = 1-Day discharge (kg/day)
 C = Pollutant concentration (mg/L)
 FR = Wastewater flowrate (gal/day)

The daily maximum for each period for Westlake Vinyls is provided in Table_Apx C-4.

Table_Apx C-4. Westlake Vinyl 1-Day Discharges

Reporting Period End Date	Daily Maximum Concentration (mg/L)	Daily Maximum Wastewater Flow (MGD)	Period Discharge (kg/day)
01/31/2019	0.014	4.0153	0.2
02/28/2019	0.004	5.6582	0.1
03/31/2019	0.232	3.9410	3.5
04/30/2019	0.015	3.7962	0.2
05/31/2019	0.007	3.6638	0.1
06/30/2019	0.122	3.5840	1.7
07/31/2019	0.060	3.4168	0.8
08/31/2019	0.013	3.9349	0.2
09/30/2019	0.027	3.6647	0.4
10/31/2019	0.012	2.7171	0.1
11/30/2019	0.012	3.9522	0.2
12/31/2019	0.010	3.7360	0.1
MGD = million gallons per day			

Summary of Results

The detailed results from each facility are provided in the accompanying spreadsheet; however, an overview of the results for each facility are provided in Table_Apx C-5.

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Facility	Annual Surface Water Discharge from Loading Tool (kg)	Annual Reported Discharge from TRI (kg)	Average Daily Discharge (kg/day)	Release Days for Average Daily Discharge (days/yr)	High-End Daily Discharge (kg/day)	Release Days for High-End Daily Discharge (days/period)	Maximum 1-Day Discharge (kg/day)
Westlake Vinyls in Calvert City, KY	209 kg	212 kg to surface water 0 kg to POTW and non-POTW WWT	0.6 (DMR) 0.6 (TRI)	350	3.2	31	3.5
Axiall LLC in Plaquemine, LA	N/A – No DMR data for this facility	10 kg to surface water 0 kg to POTW and non-POTW WWT	0.03	350	0.2	30	N/A – data not available to estimate 1-day discharge

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Appendix D GUIDANCE FOR USING THE TOXIC RELEASE INVENTORY FOR ESTIMATING AIR RELEASES

This appendix provides guidance for using EPA's TRI data to estimate air releases for certain chemicals undergoing risk evaluation under TSCA. These estimates will be used as inputs to air modeling for the purposes of estimating ambient air concentrations.

D.1 Background

EPA's TRI programs require individual facilities to report information on airborne chemical releases to the Agency. TRI includes data for some of the chemicals undergoing TSCA risk evaluation. When available, the TRI data include information on the sources, magnitude, and nature (*e.g.*, stack vs. fugitive) of airborne releases from industrial/commercial facilities and other smaller emissions sources. Thus, this database may provide useful information for estimating air releases of TRI covered chemicals, for certain OESs. This appendix describes an approach for using TRI data to estimate air emissions.

D.2 Obtaining Air Emissions Data

D.2.1 Obtaining TRI Data

TRI data may be downloaded from EPA's public TRI Program, TRI Toolbox website.²² Once the .csv file(s) has (have) been downloaded, the data are filtered by the chemical of interest using the CASRN and/or chemical name. Relevant TRI data fields include reporting year, facility identifying information (*e.g.*, name, address, FRS ID, and TRIFID), chemical information (chemical name, CASRN), primary NAICS codes, fugitive air releases, and stack air releases.

D.3 Mapping TRI DATA to Occupational Exposure Scenarios

Once TRI data is obtained, the next step is to map the data to OESs. For procedures for mapping facilities from TRI to occupational exposure scenarios, refer to Appendix B.

D.4 Estimating Air Releases Using TRI Data

EPA will use the mapped TRI data to develop facility- and/or release-point-specific emissions estimates for chemicals undergoing TSCA risk evaluation. The data summary will include pertinent information for risk evaluation and emission modeling, such as facility location, annual releases, daily releases, operating information, release type (*i.e.*, stack vs. fugitive), and stack parameters.

D.4.1 Evaluation of Sub-Annual Emissions

As air emissions data in TRI are reported as annual values, sub-annual (*e.g.*, daily) emissions must be calculated from information on release duration, release days, and release pattern. While TRI does not report information on release duration or pattern. Other sources of release duration and pattern information include GSs and ESDs, literature sources, process information, and standard engineering methodology for estimating number of release days. These sources are described in further detail below, in order of preference.

Sources for Estimating Release Duration

1. *Models*: Models used to estimate air emissions and associated inhalation exposures (*e.g.*, Tank Truck and Railcar Loading and Unloading Release and Inhalation Exposure Model, Open-Top

²² See <https://www.epa.gov/toxics-release-inventory-tri-program/tri-toolbox> (accessed July 29, 2026).

Vapor Degreasing Near-Field/Far-Field Inhalation Exposure Model, Spot Cleaning Near-Field/Far-Field Inhalation Exposure Model, models from GSs/ESDs) sometimes include data on release duration—which are usually either cited from literature or based on generic assumptions about the activity being modeled. Release duration information from models may be presented with non-modeled air emission data from TRI, if the model is applicable and expected to represent the primary release source for the OES (e.g., release duration from the Tank Truck and Railcar Loading and Unloading Release and Inhalation Exposure Model may be used with estimates of air emissions for a facility in the Repackaging OES). For models that calculate release duration as a distribution, such as from Monte Carlo simulations, the mean and range of release durations from the model should be presented with the air emission estimate.

2. *Literature*: Literature sources from systematic review, including GSs/ESDs, are another source of information for release duration. Often, release duration information from literature sources may be broad, such as a range of durations for a given operation. Alternatively, literature sources may describe release duration qualitatively, such as “on and off throughout the day” or “over half the day.” Therefore, literature sources may inform release duration at the OES-level, as opposed to at the facility-level. All details from literature sources on release duration, including qualitative descriptions, should be presented with air emission estimates if they are available and there is no other source of this data.
3. *List as “Unknown”*: Often, no information on release duration is available at either the facility or OES-level from the above sources. In these cases, engineers should list that the release duration is unknown.

Sources for Estimating Release Pattern

1. *Models*: Models used to estimate air emissions (e.g., Tank Truck and Railcar Loading and Unloading Release and Inhalation Exposure Model, Open-Top Vapor Degreasing Near-Field/Far-Field Inhalation Exposure Model, Spot Cleaning Near-Field/Far-Field Inhalation Exposure Model, models from GSs/ESDs) sometimes, albeit rarely, include data on release pattern from the underlying data sources. Release pattern information from models may be presented with non-modeled air emission data (e.g., TRI) if the model is applicable and expected to represent the primary release source for the OES (e.g., release pattern from the Tank Truck and Railcar Loading and Unloading Release and Inhalation Exposure Model may be used with estimates of air emissions for a facility in the Repackaging OES).
2. *Literature*: Literature sources from systematic review, including GSs/ESDs, are another source of information for release pattern. Often, literature sources provide general release pattern information for a given operation. Therefore, literature sources may inform release pattern at the OES-level, as opposed to at the facility-level. All details from literature sources on release pattern, even if general and/or limited, should be presented with air emission estimates, if they are available and there is no other source of this information.
3. *List as “Unknown” and Provide Operating Days*: Often, no information on release pattern is available at either the facility or OES-level from the above sources. In these cases, engineers should do the following:
 - a. List that the release pattern is unknown.
 - b. Provide the number of operating days for the facility based on project-level engineering methodology, which is summarized below.
 - c. Provide any information based on process knowledge (e.g., commercial aerosol degreasing using cans may occur on/off throughout a day and year).

Estimating Number of Operating Days for Point Sources

A hierarchical approach for estimating the number of facility operating days per year is described below.

1. *Facility-Specific Use Rates:* If information on facility-specific use rates is available, estimate days/year using one of the following approaches:
 - a. If facilities have known or estimated average daily use rates, calculate the days/year (days/year = estimated annual use rate for the site [kg/year] ÷ average daily use rate from sites with available data [kg/day]).
 - b. If sites without days/year data do not have known or estimated average daily use rates, use the average number of days/year from the sites with such data.
2. *Industry-Specific Data:* Industry-specific data may be available in the form of GSs, ESDs, trade publications, or other relevant literature. In such cases, these estimates should take precedent over other approaches, unless facility-specific data are available.
3. *Manufacture of Large-Production Volume (PV) Commodity Chemicals:* For the manufacture of the large-PV commodity chemicals, a value of 350 days/year should be used. This assumes the plant runs 7 day/week and 50 week/year (with 2 weeks down for turnaround) and assumes that the plant always produces the chemical.
4. *Manufacture of Lower-PV Specialty Chemicals:* For the manufacture of lower-PV specialty chemicals, it is unlikely the chemical is being manufactured continuously throughout the year. Therefore, a value of 250 days/year should be used. This assumes the plant manufactures the chemical 5 days/week and 50 weeks/year (with 2 weeks down for turnaround).
5. *Processing as Reactant (Intermediate Use) in the Manufacture of Commodity Chemicals:* As noted above, the manufacture of commodity chemicals is assumed to occur 350 days/year such that the use of a chemical as a reactant to manufacture a commodity chemical will also occur 350 days/year.
6. *Processing as Reactant (Intermediate Use) in the Manufacture of Specialty Chemicals:* As noted above, the manufacture of specialty chemicals is not likely to occur continuously throughout the year. Therefore, a value of 250 days/year can be used.
7. *Other Chemical Plant OES (e.g., Processing into Formulation and Use of Industrial Processing Aids):* For these OES, it is reasonable to assume that the chemical of interest is not always in use at the facility, even if the facility operates 24/7. Therefore, a value of 300 days/year can be used, based on the European Solvent Industry Group's "SpERC fact sheet – Formulation & (re)packing of substances and mixtures – Industrial (Solvent-borne)" default of 300 days/year for the chemical industry. However, in instances where the OES uses a low volume of the chemical of interest, 250 days/year can be used as a lower estimate for the days/year.
8. *All Other OESs:* Regardless of facility operating schedule, other OES are unlikely to use the chemical of interest every day. Therefore, a value of 250 days/year should be used for these OES.

Estimating Number of Operating Days for Area Sources

For area sources, EPA will also estimate operating days per year using information such as general information about the OES and values from literature.

Facility operating days per year will be used to calculate daily emissions from the TRI annual emissions data, as follows:

$$\text{Daily emissions (kg/day)} = \text{Annual emissions (kg/year)} \div \text{Operating days per year (days/year)}$$

Appendix E ESTIMATING NUMBER OF WORKERS AND OCCUPATIONAL NON-USERS

This appendix summarizes the methods that EPA/OPPT used to estimate the number of workers who are potentially exposed to *trans*-1,2-dichloroethylene in each of its OES under TSCA. The method consists of the following steps:

1. Check relevant emission scenario documents (ESDs) and generic scenarios (GSs) for estimates on the number of workers potentially exposed.
2. Identify the NAICS codes for the industry sectors associated with each COU.
3. Estimate total employment by industry/occupation combination using the Bureau of Labor Statistics' Occupational Employment Statistics data ([U.S. BLS, 2023](#)).
4. Refine the Occupational Employment Statistics estimates where they are not sufficiently granular by using the U.S. Census' ([U.S. Census Bureau, 2017](#)) Statistics of U.S. Businesses (SUSB) data on total employment by 6-digit NAICS.
5. Estimate the percentage of employees likely to be using *trans*-1,2-dichloroethylene instead of other chemicals (*i.e.*, the market penetration of *trans*-1,2-dichloroethylene in the COU).
6. Estimate the number of sites and number of potentially exposed employees per site.
7. Estimate the number of potentially exposed employees within the COU.

Step 1: Identifying Affected NAICS Codes

As a first step, EPA/OPPT identified NAICS industry codes associated with each COU. EPA/OPPT generally identified NAICS industry codes for a COU by:

- Querying the U.S. Census Bureau's NAICS Search tool ([U.S. Census Bureau, 2022](#)) using keywords associated with each COU to identify NAICS codes with descriptions that match the condition of use.
- Referencing EPA/OPPT GS's and Organisation for Economic Co-operation and Development (OECD) ESDs for a COU to identify NAICS codes cited by the GS or ESD.
- Reviewing CDR data for the chemical, identifying the industrial sector codes reported for downstream industrial uses, and matching those industrial sector codes to NAICS codes using Table D-2 provided in the CDR reporting instructions ([U.S. EPA, 2016a](#)).

Each COU section in the main body of this draft TSD identifies the NAICS codes EPA/OPPT identified for the respective COU.

Step 2: Estimating Total Employment by Industry and Occupation

BLS's Occupational Employment Statistics data provide employment data for workers in specific industries and occupations ([U.S. BLS, 2023](#)). The industries are classified by NAICS codes that were previously identified and occupations are classified by Standard Occupational Classification (SOC) codes ([BLS, 2018](#)).

Among the relevant NAICS codes (identified previously), EPA/OPPT reviewed the occupation description and identified those occupations (SOC codes) where workers are potentially exposed to *trans*-1,2-dichloroethylene.

Table_Apx E-1 shows the SOC codes by NAICS codes EPA/OPPT classified as occupations potentially exposed to *trans*-1,2-dichloroethylene for an example associated with 4-digit NAICS code 221300 Water, Sewage and Other Systems. These occupations are classified as workers (W) and occupational non-users (O) by NAICS code. All relevant SOC codes by NAICS codes combinations can be found in supplemental file *Draft Estimates of Number of Workers and ONUs for trans-1,2-dichloroethylene* ([U.S.](#)

[EPA, 2026j](#)) on sheet “Affected SOC codes” and all other SOC codes by NAICS codes combinations are assumed to represent occupations where exposure is unlikely. After identifying relevant NAICS and SOC codes, EPA/OPPT used BLS data to determine total employment by industry and by occupation based on the NAICS and SOC combinations. For example, there are 1,520 employees associated with 4-digit NAICS 221300 (Water, Sewage and Other Systems) and SOC 49-9040 (Industrial Machinery Installation, Repair, and Maintenance Workers).

Using a combination of NAICS and SOC codes to estimate total employment provides more accurate estimates for the number of workers than using NAICS codes alone. Using only NAICS codes to estimate number of workers typically result in an overestimate, because not all workers employed in that industry sector will be exposed. However, in some cases, BLS only provide employment data at the 4-digit or 5-digit NAICS level; therefore, further refinement of this approach may be needed (see next step).

Step 3: Refining Employment Estimates to Account for Lack of NAICS Granularity

The third step in EPA/OPPT’s methodology was to further refine the employment estimates by using total employment data in the U.S. Census Bureau’s SUSB ([U.S. Census Bureau, 2017](#)). In some cases, BLS Occupational Employment Statistics’ occupation-specific data are only available at the 4- or 5-digit NAICS level, whereas the SUSB data are available at the 6-digit level (but are not occupation-specific). Identifying specific 6-digit NAICS will ensure that only industries with potential 1,2-dichloroethane exposure are included. As an example, Occupational Employment Statistics data are available for the 4-digit NAICS 221300 Water, Sewage and Other Systems, which includes several 6-digit NAICS:

- NAICS 221310 Water Supply and Irrigation Systems
- NAICS 221320 Sewage Treatment Facilities
- NAICS 221330 Steam and Air-Conditioning Supply.

In this example, only NAICS 221320 Sewage Treatment Facilities is of interest. The Census data allow EPA/OPPT to calculate employment in the specific 6-digit NAICS of interest as a percentage of employment in the BLS 4-digit NAICS.

The 6-digit NAICS 221320 comprises 13.2% of total employment under the 4-digit NAICS 2213. This percentage can be multiplied by the occupation-specific employment estimates given in the BLS Occupational Employment Statistics data to further refine the Agency’s estimates of the number of employees with potential exposure.

Table_Apx E-1 illustrates this granularity adjustment for NAICS 221320.

Table_Apx E-1. Estimated Number of Potentially Exposed Workers and ONUs Under NAICS 221320

NAICS	SOC CODE	SOC Description	Occupation Designation	Employment by SOC at 4-Digit NAICS Level	% of Total Employment	Estimated Employment by SOC at 6-Digit NAICS Level
221300	11-9020	Construction Managers	O	130	13.20%	17
221300	11-9040	Architectural and Engineering Managers	O	70	13.20%	9
221300	17-2000	Engineers	O	620	13.20%	82
221300	17-3010	Drafters	O	70	13.20%	9

NAICS	SOC CODE	SOC Description	Occupation Designation	Employment by SOC at 4-Digit NAICS Level	% of Total Employment	Estimated Employment by SOC at 6-Digit NAICS Level
221300	17-3020	Engineering Technologists and Technicians, Except Drafters	O	**	**	0
221300	17-3030	Surveying and Mapping Technicians	O	**	**	0
221300	19-2031	Chemists	O	50	13.20%	7
221300	19-2041	Environmental Scientists and Specialists, Including Health	O	120	13.20%	16
221300	19-4000	Life, Physical, and Social Science Technicians	O	250	13.20%	33
221300	47-4070	Septic Tank Servicers and Sewer Pipe Cleaners	W	120	13.20%	16
221300	49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	W	1,520	13.20%	200
Total Potentially Exposed Employees				2,950		389
Total Workers						216
Total ONUs						173
W = worker; O = occupational non-user Note: numbers may not sum exactly due to rounding. ** Not reported for this NAICS code. Source: U.S. Census, 2017 (U.S. Census Bureau, 2017); U.S. BLS, 2023 (U.S. BLS, 2023).						

Step 4: Estimating the Percentage of Workers Using 1,2-Dichloroethane Instead of Other Chemicals

In the final step, EPA/OPPT accounted for the market share by applying a factor to the number of workers determined in Step 3. This accounts for the fact that *trans*-1,2-dichloroethylene may be only one of multiple chemicals used for the applications of interest. EPA/OPPT did not identify market penetration data for any COU. In the absence of market penetration data for a given COU, EPA/OPPT assumed *trans*-1,2-dichloroethylene may be used at up to all sites and by up to all workers calculated in this method as a bounding estimate. This assumes a market penetration of 100%.

Step 5: Estimating the Number of Workers and Occupational Non-Users (ONUs) per Site

EPA/OPPT calculated the number of workers and ONUs in each industry/occupation combination using the formula below (granularity adjustment is only applicable where SOC data are not available at the 6-digit NAICS level):

$$\text{Number of Workers or ONUs in NAICS/SOC (Step 2)} \times \text{Granularity Adjustment Percentage (Step 3)} = \text{Number of Workers or ONUs in the Industry/Occupation Combination}$$

EPA/OPPT then estimated the total number of establishments by obtaining the number of establishments reported in the U.S. Census Bureau's SUSB ([U.S. Census Bureau, 2017](#)) data at the 6-digit NAICS level. In this example, there are 652 establishments associated with 6-digit NAICS code 221320 *Sewage Treatment Facilities*.

EPA/OPPT then summed the number of workers and ONUs over all occupations within a NAICS code and divided these sums by the number of establishments in the NAICS code to calculate the average number of workers and ONUs per site.

Step 6: Estimating the Number of Workers and ONUs, and Sites for a COU

EPA/OPPT estimated the number of workers and ONUs potentially exposed to *trans*-1,2-dichloroethylene and the number of sites that use *trans*-1,2-dichloroethylene in a given COU through the following steps:

- 6.A. Obtaining the total number of establishments by:
 - i. Obtaining the number of establishments from SUSB at the 6-digit NAICS level (Step 5) for each NAICS code in the COU and summing these values; or
 - ii. Obtaining the number of establishments from the TRI, DMR, NEI, or literature for the COU.
- 6.B. Estimating the number of establishments that use *trans*-1,2-dichloroethylene by taking the total number of establishments from Step 6.A and multiplying it by the market penetration factor from Step 4.
- 6.C. Estimating the number of workers and ONUs potentially exposed to *trans*-1,2-dichloroethylene by taking the number of establishments calculated in Step 6.B and multiplying it by the average number of workers and ONUs per site from Step 5.

Appendix F GENERAL POPULATION AMBIENT WATER EXPOSURE ASSESSMENT

F.1 Surface Water Tier 1 Analyses

For evaluation of exposures to both environmental and general human populations, Tier 1 surface water concentrations are shown for each evaluated OES based on facility-specific releases.

F.1.1 Surface Water Concentrations

Table_Apx F-1 shows concentrations based on the 7Q10, 30Q5, and harmonic mean flow metrics.

Table_Apx F-1. Facilities with Highest Modeled 7Q10, 30Q5, and Harmonic Mean (HM) Surface Water Concentrations per OES for TRI and DMR Releases 2019–2023 for Tier 1 Surface Water Evaluation

OES (NPDES) ^a	Annual Release (kg/yr)	Operating Days	Daily Release Estimate (kg/d)	7Q10 Flow (MLD)	30Q5 Flow (MLD)	HM Flow (MLD)	7Q10 Conc. (µg/L)	30Q5 Conc. (µg/L)	HM Conc. (µg/L)
Manufacturing (LAJ660151) ^b	15	21	0.71	0.75	1.4	2.5	949	511	283
		350	4.3E-02				57	31	17
Manufacturing as a Byproduct (NA) ^c	9.9	21	0.47	79	125	249	6	3.8	1.9
		350	2.8E-02				0.36	0.23	0.11
Processing – Incorporation into Formulation, Mixture or Reaction Product (NA) ^c	227	21	11	351	528	675	31	20	16
		250	0.91				2.6	1.7	1.3
Waste Handling, Disposal, Treatment, and Recycling – Landfill (PA0043818) ^b	0.14	21	6.9E-03	5.3E-02	0.11	8.1E-02	130	64	85
		365	4.0E-04				7.5	3.7	4.9
Waste Handling, Disposal, Treatment, and Recycling – Non-POTW WWT (CA7000004) ^d	7.30E-02	21	3.5E-03	0.13	0.13	0.13	27	27	27
		365	2.0E-04				1.6	1.6	1.6
Waste Handling, Disposal, Treatment, and Recycling – POTW (TX0023418) ^{b d}	121	21	5.8	11	12	17	509	479	337
		365	0.33				29	28	19
Waste Handling, Disposal, Treatment, and Recycling – Remediation or Monitoring (IL0000141) ^{b d}	28	21	1.3	5.7E-02	5.7E-02	0.1	2.4E04	2.4E04	1.3E04
		365	7.7E-02				1,355	1,355	746
7Q10 = the modeled 7Q10 flow, in MLD (million liters per day); 30Q5 = the lowest monthly average flow from NHD, in MLD; NPDES = National Pollutant Discharge Elimination System facility permit number									
^a Each OES is represented by the facility within that OES with the highest estimated surface water concentration for that OES as described in Section 6.2.1.1									
^b Concentrations based on flows from NHDplus EROM dataset									
^c Concentrations based on flows from surrogate water body identified in NHDplus EROM dataset									
^d Concentrations based on plant flow for representative facility extracted from Enforcement and Compliance History Online Dataset (ECHO)									

F.1.2 Environmental Exposure Evaluation

Based on the estimated Tier 1 surface water concentrations (Table_Apx F-1), EPA screened for preliminary risk to aquatic species including invertebrates, vertebrates and algae. Table_Apx F-2 summarizes the calculated acute and chronic risk quotients and highlights where acute and chronic preliminary risk is identified for aquatic biota with a calculated risk quotient greater than 1.

Table_Apx F-2. Risk Quotients from Facilities with Highest Modeled Instream Concentration per OES for TRI and DMR Releases 2019–2023 for Tier 1 Evaluation.

OES (NPDES) ^a	Annual Release (kg/yr)	Operating Days	Release Estimate (kg/d)	7Q10 Flow (MLD)	7Q10 Conc. (µg/L)	Risk Quotient ^e		
						Acute Aquatic	Chronic Aquatic	Algae
Manufacturing (LAJ660151) ^b	15	21	0.71	0.75	949	0.32	1.2	1.8E-02
		350	4.3E-02		57	1.9E-02	7.2E-02	1.1E-03
Manufacturing as a Byproduct (NA) ^c	9.9	21	0.47	79	6	2.0E-03	7.6E-03	1.2E-04
		350	2.8E-02		0.36	1.2E-04	4.6E-04	7.0E-06
Processing – Incorporation into Formulation, Mixture or Reaction Product (NA) ^c	227	21	11	351	31	1.0E-02	3.9E-02	6.0E-04
		250	0.91		2.6	8.6E-04	3.3E-03	5.1E-05
Waste Handling, Disposal, Treatment, and Recycling – Landfill (PA0043818)	0.14	21	6.9E-03	5.3E-02	130	4.3E-02	0.17	2.5E-03
		365	4.0E-04		7.5	2.5E-03	9.5E-03	1.5E-04
Waste Handling, Disposal, Treatment, and Recycling – non-POTW WWT (CA7000004) ^d	7.3E-02	21	3.5E-03	0.13	27	9.0E-03	3.4E-02	5.2E-04
		365	2.0E-04		1.6	5.2E-04	2.0E-03	3.1E-05
Waste Handling, Disposal, Treatment, and Recycling – POTW (TX0023418) ^{b d}	121	21	5.8	11	509	0.17	0.65	9.9E-03
		365	0.33		29	9.8E-03	3.7E-02	5.6E-04
Waste Handling, Disposal, Treatment, and Recycling – Remediation or Monitoring (IL0000141) ^{b d}	28	21	1.3	5.7E-02	2.4E04	7.9	30	0.47
		365	7.7E-02		1,355	0.45	1.7	0.03

7Q10 = the modeled 7Q10 flow, in MLD (million liters per day); NPDES = National Pollutant Discharge Elimination System facility permit number
^a Each OES is represented by the facility within that OES with the highest estimated surface water concentration for that OES as described in Section 6.2.1.1
^b Concentrations based on flows from NHDPlus EROM dataset
^c Concentrations based on flows from surrogate water body identified in NHDPlus EROM dataset
^d Concentrations based on plant flow for representative facility extracted from Enforcement and Compliance History Online Dataset (ECHO)
^e Risk quotients based on acute aquatic COC = 3,005 µg/L, chronic aquatic COC = 788 µg/L, and algal COC = 51,467 µg/L respectively as shown in *Draft Human Health and Environmental Hazard Assessment for trans-1,2-Dichloroethylene* ([U.S. EPA, 2026m](#))
Values identifying preliminary risk are bolded.

F.1.3 Dermal Exposure via Swimming in Surface Water Evaluation

Based on the estimated dermal doses in Table_Apx F-3. Calculated from Tier 1 surface water concentrations in Table_Apx F-1, EPA screened for preliminary risk to adults (21+ years), youth (11–15 years), and children (6–10 years). Table_Apx F-4 summarizes the intermediate MOEs based on the dermal doses. Using the total intermediate dose, the MOEs are greater than the benchmark of 30. Based

on the conservative modeling parameters for surface water concentration and exposure factors parameters, preliminary risk for non-cancer health effects for dermal absorption through swimming is not expected.

Table_Apx F-3. Facility-Specific Intermediate Dermal Doses While Swimming for Adult, Youth, and Child Lifestages by OES (Tier 1)

OES ^a	Modeled Surface Water Concentrations		Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)
	30Q5 Conc. (µg /L)	HM Conc. (µg/L)	IDR (mg/kg-day)	IDR (mg/kg-day)	IDR (mg/kg-day)
Manufacturing	31	17	2.1E–04	1.6E–04	9.5E–05
Manufacturing as a Byproduct	0.23	0.11	1.5E–06	1.2E–06	7.1E–07
Processing – Incorporation into Formulation, Mixture or Reaction Product	1.7	1.3	1.1E–05	8.8E–06	5.3E–06
Waste Handling, Disposal, Treatment, and Recycling – Landfill	3.7	4.9	2.5E–05	1.9E–05	1.1E–05
Waste Handling, Disposal, Treatment, and Recycling – non-POTW WWT	1.6	1.6	1.0E–05	8.0E–06	4.8E–06
Waste Handling, Disposal, Treatment, and Recycling – POTW	28	19	1.8E–04	1.4E–04	8.6E–05
Waste Handling, Disposal, Treatment, and Recycling – Remediation or Monitoring	1,355	746	9.1E–03	6.9E–03	4.2E–03
30Q5 = 30 consecutive days of lowest flow over a 5-year period; HM = harmonic mean; IDR = intermediate dose rate					
^a Each OES is represented by the facility within that OES with the highest estimated surface water concentration for that OES as described in Section 6.2.1.1					

Table_Apx F-4. Facility-Specific Dermal Intermediate Risk While Swimming for Adult, Youth, and Child Lifestages by OES (Tier 1)

OES ^a	Modeled Surface Water Concentrations		Intermediate MOE ^b (BM = 30)		
	30Q5 Conc. (µg/L)	HM Conc. (µg/L)	Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)
Manufacturing	31	17	1.0E05	1.4E05	2.2E05
Manufacturing as a Byproduct	0.23	0.11	1.4E07	1.8E07	3.0E07
Processing – Incorporation into Formulation, Mixture or Reaction Product	1.7	1.3	1.9E06	2.4E06	4.0E06
Waste Handling, Disposal,	3.7	4.9	8.7E05	1.1E06	1.9E06

OES ^a	Modeled Surface Water Concentrations		Intermediate MOE ^b (BM = 30)		
	30Q5 Conc. (µg/L)	HM Conc. (µg/L)	Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)
Treatment, and Recycling – Landfill					
Waste Handling, Disposal, Treatment, and Recycling – Non-POTW WWT	1.6	1.6	2.1E06	2.7E06	4.4E06
Waste Handling, Disposal, Treatment, and Recycling – POTW	28	19	1.2E05	1.5E05	2.5E05
Waste Handling, Disposal, Treatment, and Recycling – Remediation or Monitoring	1,355	746	2,357	3,079	5,076
30Q5 = 30 consecutive days of lowest flow over a 5-year period; HM = harmonic mean; MOE = margin of exposure; BM = Benchmark ^a Each OES is represented by the facility within that OES with the highest estimated surface water concentration for that OES as described in Section 6.2.1.1. ^b MOEs calculated based on doses presented in Table_Apx F-3.					

F.1.4 Oral Exposure via Swimming in Surface Water Evaluation

Based on the estimated dermal doses in Table_Apx F-5. Calculated from Tier 1 surface water concentrations in Table_Apx F-1, EPA screened for risk to adults (21+ years), youth (11–15 years), and children (6–10 years). Table_Apx F-6 summarizes the intermediate MOEs based on the oral ingestion doses. Using the total intermediate dose, the MOEs are greater than the benchmark of 30. Based on the conservative modeling parameters for surface water concentration and exposure factors parameters, preliminary risk for non-cancer health effects for oral ingestion through swimming is not expected.

Table_Apx F-5. Facility-Specific Intermediate Oral Doses While Swimming for Adult, Youth, and Child Lifestages by OES (Tier 1)

OES ^a	Modeled Surface Water Concentrations		Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)
	30Q5 Conc. (µg/L)	HM Conc. (µg/L)	IDR (mg/kg-day)	IDR (mg/kg-day)	IDR (mg/kg-day)
Manufacturing	31	17	1.1E–04	1.6E–04	9.3E–05
Manufacturing as a Byproduct	0.23	0.11	7.8E–07	1.2E–06	6.9E–07
Processing – Incorporation into Formulation, Mixture or Reaction Product	1.7	1.3	5.9E–06	9.2E–06	5.2E–06
Waste Handling, Disposal, Treatment, and Recycling – Landfill	3.7	4.9	1.3E–05	2.0E–05	1.1E–05

OES ^a	Modeled Surface Water Concentrations		Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)
	30Q5 Conc. (µg/L)	HM Conc. (µg/L)	IDR (mg/kg-day)	IDR (mg/kg-day)	IDR (mg/kg-day)
Waste Handling, Disposal, Treatment, and Recycling – Non-POTW WWT	1.6	1.6	5.4E–06	8.3E–06	4.7E–06
Waste Handling, Disposal, Treatment, and Recycling – POTW	28	19	9.5E–05	1.5E–04	8.3E–05
Waste Handling, Disposal, Treatment, and Recycling – Remediation or Monitoring	1,355	746	4.7E–03	7.3E–03	4.1E–03
30Q5 = 30 consecutive days of lowest flow over a 5-year period; HM = Harmonic Mean; IDR = Intermediate dose rate ^a Each OES is represented by the facility within that OES with the highest estimated surface water concentration for that OES as described in Section 6.2.1.1					

Table_Apx F-6. Facility-Specific Oral Intermediate Risk While Swimming for Adult, Youth, and Child Lifestages by OES (Tier 1).

OES ^a	Modeled Surface Water Concentrations		Intermediate MOE ^b (BM=30)		
	30Q5 Conc. (µg/L)	HM Conc. (µg/L)	Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)
Manufacturing	31	17	2.0E05	1.3E05	2.3E05
Manufacturing as a Byproduct	0.23	0.11	2.7E07	1.8E07	3.1E07
Processing – Incorporation into Formulation, Mixture or Reaction Product	1.7	1.3	3.6E06	2.3E06	4.1E06
Waste Handling, Disposal, Treatment, and Recycling – Landfill	3.7	4.9	1.7E06	1.1E06	1.9E06
Waste Handling, Disposal, Treatment, and Recycling – Non-POTW WWT	1.6	1.6	4.0E06	2.6E06	4.6E06
Waste Handling, Disposal, Treatment, and Recycling – POTW	28	19	2.3E05	1.5E05	2.6E05
Waste Handling, Disposal, Treatment, and Recycling – Remediation or Monitoring	1,355	746	4,577	2,950	5,231
30Q5 = 30 consecutive days of lowest flow over a 5-year period; HM = Harmonic Mean; MOE = Margin of					

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OES ^a	Modeled Surface Water Concentrations		Intermediate MOE ^b (BM=30)		
	30Q5 Conc. (µg/L)	HM Conc. (µg/L)	Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)

exposure; BM = Benchmark

^a Each OES is represented by the facility within that OES with the highest estimated surface water concentration for that OES as described in Section 6.2.1.1

^b MOEs calculated based on doses presented in Table_Apx F-5.

F.1.5 Drinking Water Evaluation

Based on the estimated chronic drinking water doses in Table_Apx F-7 calculated from Tier 1 surface water concentrations in Table_Apx F-1, EPA screened for preliminary risk to adults (21+ years), toddlers (1–5 years), and infants (birth to <1 year). Table_Apx F-8 summarizes the chronic non-cancer MOEs. MOEs are above the benchmark of 300 for chronic non-cancer health effects indicating preliminary risk is not expected for drinking water exposure.

Table_Apx F-7. Facility-Specific Drinking Water Doses for Adult, Infant and Toddler Lifestages by OES Based on Tier 1-Modeled Surface Water Concentrations

OES	Modeled Surface Water Concentrations		Adult (21+ years)	Infant (birth to < 1 year)	Toddler (1-5 years)
	30Q5 Conc. (µg/L)	HM Conc. (µg/L)	ADD (mg/kg-day)		
Manufacturing	31	17	1.8E-04	4.6E-04	2.0E-04
Manufacturing as a Byproduct	0.23	0.11	1.2E-06	3.1E-06	1.3E-06
Processing – Incorporation into Formulation, Mixture or Reaction Product	1.7	1.3	1.0E-05	2.6E-05	1.1E-05
Waste Handling, Disposal, Treatment, and Recycling – Landfill	3.7	4.9	5.4E-05	1.4E-04	5.9E-05
Waste Handling, Disposal, Treatment, and Recycling – Non-POTW WWT	1.6	1.6	1.7E-05	4.4E-05	1.9E-05
Waste Handling, Disposal, Treatment, and Recycling – POTW	28	19	2.1E-04	5.4E-04	2.3E-04
Waste Handling, Disposal, Treatment, and Recycling – Remediation or Monitoring	1,355	746	8.2E-03	2.1E-02	9.0E-03

30Q5 = 30 consecutive days of lowest flow over a 5-year period; HM = Harmonic mean; ADD = Average daily dose; POT = Potential

^a Each OES is represented by the facility within that OES with the highest estimated surface water concentration for that OES as described in Section 6.2.1.1.

Table_Apx F-8. Facility-Specific Drinking Water Risks for Adult, Infant and Toddler Lifestages by OES Based on Tier 1-Modeled Surface Water Concentrations

OES ^a	Modeled Surface Water Concentrations		Adult (21+ years)	Infant (birth to < 1 year)	Toddler (1-5 years)
	30Q5 Conc. (µg/L)	HM Conc. (µg/L)	Chronic Non-cancer MOE (BM = 300)		
Manufacturing	31	17	1.2E05	4.7E04	1.1E05
Manufacturing as a Byproduct	0.23	0.11	1.8E07	7.0E06	1.6E07
Processing – Incorporation into Formulation, Mixture or Reaction Product	1.7	1.3	2.1E06	8.3E05	1.9E06
Waste Handling, Disposal, Treatment, and Recycling – Landfill	3.7	4.9	4.0E05	1.6E05	3.6E05
Waste Handling, Disposal, Treatment, and Recycling – Non-POTW WWT	1.6	1.6	1.3E06	4.9E05	1.1E06
Waste Handling, Disposal, Treatment, and Recycling – POTW	28	19	1.0E05	3.9E04	9.2E04
Waste Handling, Disposal, Treatment, and Recycling – Remediation or Monitoring	1,355	746	2,609	1,021	2,383
30Q5 = 30 consecutive days of lowest flow over a 5-year period; HM = Harmonic mean; MOE = Margin of exposure; BM = Benchmark					
^a Each OES is represented by the facility within that OES with the highest estimated surface water concentration for that OES as described in Section 6.2.1.1					

F.2 Surface Water Tier 2 Analyses

Facilities identified for possible Tier 2 refinement are identified in Table_Apx F-9 based on Tier 1 surface water concentrations and evaluation of preliminary risk for environmental and general populations. Refinements are based off available effluent monitoring data of *trans*-1,2-dichloroethylene as reported in the ECHO database for the specific facility and review of available TRI Form Rs.

Table_Apx F-9. Identified Facilities with Preliminary Environmental Risk Able to Undergo Refinement Based on Reported Effluent Monitoring Information or Alternate Receiving Waterbody Information

Facility	OES	Release Year	Operating Days	Daily Release Estimate (kg/d)	Tier 1 7Q10 Conc. (µg/L) ^a	Refined 7Q10 Conc. (µg/L)	Initial Chronic RQ ^b	Refined Chronic RQ ^b
Westlake US 2 LLC	Manufacturing	2020	21	0.71	949	0.31 ^c	1.2	3.9E-04
		2021	21	0.65	862	0.28 ^c	1.1	3.6E-04
Equistar Chemicals LP Tuscola Plant	Waste Handling, Disposal, Treatment, and Recycling – Remediation or Monitoring	2019	21	0.65	1.1E04	20 ^d	15	2.5E-02
		2020	21	1.3	2.4E04	20 ^d	30	2.5E-02
		2021	21	0.97	1.7E04	20 ^d	22	2.5E-02
		2022	21	0.86	1.5E04	20 ^d	19	2.5E-02
Westinghouse Electric Co. L.L.C.	Waste Handling, Disposal, Treatment, and Recycling – Remediation or Monitoring	2019	21	0.31	1,101	1 ^a	1.4	1.3E-03
7Q10 = the modeled 7Q10 flow, in MLD (million liters per day); RQ = Risk quotient ^a Tier 1 7Q10 surface water concentration for each facility is modeled 21-day release scenario as shown in Table_Apx F-1 ^b Initial and Refined RQ is determined from chronic aquatic COC = 788 µg/L (U.S. EPA, 2026m) ^c Refined surface concentration is based on different reported receiving water body in facility TRI Form R with different flows from initial Tier 1 modeling ^d Refined surface water concentration is based on reported effluent concentrations of <i>trans</i>-1,2-dichloroethylene as reported in the ECHO database for the specific facility								

F.3 Surface Water Exposure Activity Parameters

Table Apx F-10. Dermal Exposure While Swimming Modeling Parameters

Input	Description (Units)	Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)	Notes	Reference
BW	Body weight (kg)	80	56.8	31.8	Mean body weight. Chapter 8 of the <i>Exposure Factors Handbook</i> , Table 8-1	U.S. EPA (2021a)
SA	Skin surface area exposed (cm ²)	19,500	15,900	10,800	U.S. EPA Swimmer Exposure Assessment Model (SWIMODEL)	U.S. EPA (2015b)
ET	Exposure time (hour/day)	3	2	1	High-end default short-term duration from U.S. EPA Swimmer Exposure Assessment Model (SWIMODEL)	U.S. EPA (2015b)
ED	Exposure duration (years for ADD)	57	5	5	Number of years in age group	U.S. EPA (2021a)
AT	Averaging time (years for ADD)	57	5	5	Number of years in age group	U.S. EPA (2021a)
K _p	Permeability coefficient (cm/hour _h)	9.16×10 ⁻³ cm/hour				TDCE Consortium, (2023)

Table Apx F-11. Oral Ingestion While Swimming Modeling Parameters

Input	Description (Units)	Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)	Notes	Reference
IR _{inc}	Ingestion rate (L/hour)	0.092	0.152	0.096	Upper percentile ingestion while swimming. Chapter 3 of the <i>Exposure Factors Handbook</i> , Table 3-7.	U.S. EPA (2019b)
BW	Body weight (kg)	80	56.8	31.8	Mean body weight. Chapter 8 of the <i>Exposure Factors Handbook</i> , Table 8-1.	U.S. EPA (2021a)
ET	Exposure time (hour/day)	3	2	1	High-end default short-term duration from U.S. EPA Swimmer Exposure Assessment Model (SWIMODEL); based on competitive swimmers in the age class	U.S. EPA (2015b)
IR _{inc-daily}	Incidental daily ingestion rate (L/day)	0.276	0.304	0.096	Calculation: ingestion rate × exposure time (IR _{inc} × ET)	
IR/BW	Weighted incidental daily ingestion rate (L/kg-day)	0.0035	0.0054	0.0030	Calculation: ingestion rate/body weight (IR _{inc-daily} / BW)	
ED	Exposure duration (years for ADD)	57	5	5	Number of years in age group	U.S. EPA (2021a)
AT	Averaging time (years for ADD)	57	5	5	Number of years in age group	U.S. EPA (2021a)
CF1	Conversion factor (mg/μg)	1.00E-03				
CF2	Conversion factor (days/year)	365				

Appendix G CONSUMER EXPOSURE ASSESSMENT PRODUCT DESCRIPTIONS

G.1 Degreasers for Mechanical Equipment and Components

Application of degreasers is highly variable depending on the project. Product manufacturers do not offer specific guidance of how much product to use for a given area, instead noting that the product should be applied “as needed” or “generously.” Based on how-to guides and videos of application, the products typically appear to be sprayed at least until the location is dripping, if not completely clear of oil and grease. Furthermore, the mass applied varies with the surface area of the object to be cleaned and user preferences for product application.

Online discussion boards indicate that degreaser product and methods are variable between consumers, with many indicating preference for common cleaners and dish soap along with mechanical cleaning methods such as use of a pressure washer. This will decrease exposure to the products evaluated in this analysis.

In addition to specific product-use investigation, the [Exposure Factors Handbook](#) (accessed July 29, 2026), Chapter 17 about use of general degreasers was also examined for information about reasonable use of these products. These data aligned closely with the CEM default values. Therefore, given the high variability in potential product use, the CEM defaults were used for modeling inputs. Furthermore comparative CEM runs showed that *trans*-1,2 dichloroethylene weight fraction in the modeled product was a driving parameter in exposure. With some products reporting weight fractions of 0.9, the importance of refining the exposure duration to 1- or 2-minute decreases.

G.2 Flux Remover and Contact Cleaners for Electronics and Components

Soldering is a process used to connect pieces of metal by melting a metal wire between the two elements to be connected. It is used across applications from building computers to plumbing. Common consumer applications include soldering computer parts to build a personal gaming computer.

Flux is used in soldering to increase the flow of the molten solder wire and prepare the site for connection, allowing for a more even spread of connection across the connection points and increasing strength. It can be sold separately as a paste or liquid or incorporated into the solder wire. A very small amount of flux is needed in relation to the amount of solder used. In solder incorporated into a solder wire, the percentage of flux is typically less than 3%.

Once the solder has cooled the flux residue must be removed using a solvent such as a flux remover. Flux removers are sprayed generously and agitated lightly with an attached brush. The mass of flux remover used depends on the application and area needed to clean.

More products to reduce the need for soldering are being introduced to the custom computer building market. Additionally, when solder is used, products replacing flux with rosin have been introduced, which negates the need for flux remover since the rosin burns off. Therefore, exposure to solder, flux, and flux remover would decline with increased adoption of these products.

G.3 Gap Filler and Sealant Spray Foam (One Component)

Spray foams may be used by consumers to fill gaps and voids in building envelopes to block penetration of air, moisture, and insects from a building envelope. These products may be used around light

switches and outlet boxes, in concrete cracks, or gaps in framing etc. Potential applications are numerous and therefore difficult to model given the high variation in mass of product, used time of application, etc. These products are typically sold in a can with a nozzle for targeted applications. There is no product mixing required. The product is sold ready to apply by holding the trigger.

G.4 Open Cell Non-Structural Sealant Spray Foam (Two Component)

Open cell spray foams are used to add tight-fitting insulation to building walls before a layer of traditional insulation is applied on top of the foam layer, referred to as “flash and batt” insulation. The open cell foams are manufactured as two-part systems, which are mixed in the nozzle of the spray equipment to start the chemical reaction of the foam expanding and hardening. Once the two components are combined, the mixture begins rapidly expanding so it is essential to apply the product quickly. To emphasize this, the nozzle used to apply the foam must be replaced if the user stops application for more than a few minutes since the foam will harden in the channels of the nozzle. The foam is applied to coat the space between the studs around the entire room or building, meaning nearly the entire surface area of the wall is coated. The product can be applied in multiple layers for more insulation efficacy.

Most of the variability associated with the use of this product depends on the size of the area it is applied to, number of layers, and time required to apply the product.

Appendix H CONSUMER ANALYSIS OF TEST ORDER SPRAY FOAM CHAMBER STUDY

H.1 Background and Objectives

For the COU, inhalation exposures were estimated using Consumer Exposure Chamber Testing for *trans*-1,2 dichloroethylene prepared by members of the TDCE Consortium and using ASTM D5116-25.

Small-scale environmental chambers, as described in ASTM D5116-25²³, provide a controlled environment for measuring VOC emissions from building products and other indoor materials and products. This data may be used to derive accurate estimates of emission parameters for use in indoor air quality models for regulatory purposes.

This analysis aims to estimate emission parameters for *trans*-1,2 dichloroethylene using a double exponential emission model fitted to chamber testing data. The approach used is consistent with the methods in section 9.4.1.4 of ASTM D5116-25 and is designed to support integration with emission model 5a in [IECCU](#) and/or emission model E2 in the [CEM Guide](#) (both accessed July 29, 2026).

H.2 Chamber Study Data

The data analyzed in this study were generated for the Definitive Chamber Emission Tests in the above referenced test order. The experiment used DAP® Touch 'n Seal® Reduced Expansion Quick Cure Polyurethane Foam Sealant, product SKU 756500000656.

Table_Apx H-1. Chamber and Product Parameters in the Definitive Chamber Emission Tests Three Replicates

Parameter	Units	Replicate 1	Replicate 2	Replicate 3
Test specimen wet mass	g	2.77	1.46	1.74
Chamber Volume	m ³	0.067	0.067	0.067
Loading Ratio	g/m ³	41.3	21.8	26.0
Average inlet airflow rate ± Std. Dev.	m ³ /h	0.0673 ± 0.0001	0.06732 ± 0.0001	0.0673 ± 0.0001
Mass-specific airflow rate	m ³ /g-h	0.0243	0.0460	0.0387

Three replicate experiments were conducted, each involving a known mass of the test material (*trans*-1,2-dichloroethylene) placed in a chamber of fixed volume (0.067 m³) with controlled airflow (0.0673 m³/h). Chamber air samples were collected at multiple time points (0.5, 1, 2, 3, 6, 8, and 24 hours), and *trans*-1,2-dichloroethylene concentrations were measured in mg/m³. The resulting concentration-time profiles provide the basis for fitting the emission model.

The product weight fractions were determined from the Definitive Source Characterization Tests. Briefly, the sample was inserted through a hole in the lid into a plastic storage container. To minimize the loss from the rapidly vaporizing portion of the sample, the hole was quickly covered with aluminum

²³ <https://store.astm.org/d5116-25.html> (accessed July 29, 2026), Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products

tape. The air concentration of *trans*-1,2-dichloroethylene above the sample was measured at 24 hours to determine the mass fraction of *trans*-1,2-dichloroethylene (mg/g of wet product).

H.3 Methodology

H.3.1 Mass Balance Check

The test order report acknowledges uncertainty in the reported *trans*-1,2-dichloroethylene mass fraction owing to mass volatilized before the start of headspace study. To confirm this uncertainty and address the implications in subsequent modeling, a mass-balance check was performed using the observed concentrations to estimate emitted mass over 24 hours (the observation period of the chamber study) compared with the initial *trans*-1,2-dichloroethylene mass using Equation_Apx H-1 as shown below.

Equation_Apx H-1. Mass Balance Equation Used to Check for Mass Loss During the Experiment

Estimated mass output over 24 hours

$$= \text{Average AUC concentration} \times \text{Volume chamber} \times \text{AER per hour} \times 24 \text{ hours}$$

Where:

Average AUC concentration = Area under the observed concentration vs. time curve divided by the time of the chamber study (24 hours) in mg/m³. The area under the curve was based on a collection of data at various time points over the 24-hour period and presented in Figure_Apx H-1.

Volume chamber = Volume of the chamber in m³

AER per hour = Air exchange rate per hour in the chamber

Table_Apx H-2 shows the percentage of the emitted mass to the estimated initial *trans*-1,2-dichloroethylene mass using the mass of the sample and the mass fraction.

Table_Apx H-2. Emitted Mass vs. Reported Mass in the Chamber Study

Replicate	Avg AUC Conc. (mg/m ³)	Estimated 24-Hour Mass Output (mg)	Initial <i>trans</i> -1,2-Dichloroethylene Mass (mg)	Mass Emitted (%)
1	43.48	70.23	49.03	143.3%
2	24.84	40.06	25.84	155.0%
3	34.32	55.43	30.80	180.0%

The average apparent emitted fraction over the three replicates was 159%. This indicates that the initial mass of *trans*-1,2-dichloroethylene estimated using the mass of the sample and the weight fraction underestimates the true initial mass of *trans*-1,2-dichloroethylene in the sample by approximately 60%. This confirmed that the reported 1.77% mass fraction in the product was an underestimate and should have been approximately 159%×1.77% = 2.81%. This estimate is still well within the 1-5% range reported on the material safety data sheet from the manufacturer. Rather than directly using this new estimate of 2.81% as the weight fraction in the subsequent modeling, we instead determined a so-called “mass inflation factor” by optimization during parameter estimation.

H.3.2 Chamber Concentration and Emission Kinetics Models

The emission of *trans*-1,2-dichloroethylene from the material is modeled as a double exponential process, representing two parallel emission mechanisms (fast and slow). The chamber mass balance is described by the following equation:

Equation_Apx H-2. Chamber Mass Balance Differential Equation

$$\frac{dC}{dt} = \frac{ER(t)}{V} - NC$$

Where:

C	=	Chamber concentration (mg/m ³),
$\frac{dC}{dt}$	=	Rate of change of chamber concentration (mg/m ³ -h),
V	=	Chamber volume,
N	=	Air change rate (h ⁻¹), and
$ER(t)$	=	Emission rate (mg/h).

The mathematical form of the emission rate for a double exponential process as follows:

Equation_Apx H-3. Mathematical Form for Emission Rate

$$ER(t) = M_1 k_1 e^{-k_1 t} + M_2 k_2 e^{-k_2 t}$$

Where:

M_1, M_2	=	Mass of <i>trans</i> -1,2-dichloroethylene available for fast and slow emission
k_1, k_2	=	Corresponding first-order rate constants for M_1 and M_2 , respectively

As noted previously, Equation_Apx H-3 is consistent with emission model 5b in IECCU and emission model E2 in CEM. This mathematical form of emission model was chosen based on professional judgment to allow for an initial fast evaporation followed by a slower diffusion process.

Since M_1 and M_2 are not directly known, they are calculated from the known total mass of chemical introduced into the chamber as follows.

Equation_Apx H-4. Equations Governing Mass Fractions in the Fast and Slow Emission Rates

$$M_{\text{total}} = M_{\text{wet product}} \times \text{TDCE fraction} \times m_{\text{inf}}$$

$$M_{\text{emitted}} = \rho \times M_{\text{total}}$$

$$M_1 = f \times M_{\text{emitted}} = f \times \rho \times M_{\text{total}}$$

$$M_2 = (1 - f) \times M_{\text{emitted}} = (1 - f) \times \rho \times M_{\text{total}}$$

Where:

$M_{\text{wet product}}$	=	Wet mass of <i>trans</i> -1,2-dichloroethylene -containing product used in the study (known)
$\text{TDCE}_{\text{fraction}}$	=	Weight fraction of <i>trans</i> -1,2-dichloroethylene in the test material (estimate reported as uncertain in the study) as mg/g

m_{inf}	=	Mass inflation factor to be determined by optimization to ensure mass balance in the observed data
M_{total}	=	Total mass of <i>trans</i> -1,2-dichloroethylene in the test material
ρ	=	Fraction of M_{total} that is emitted during the experiment
(i.e., $M_{emitted} = \rho \times M_{total}$)		
f	=	Fraction of the emitted mass in the first exponential

H.3.3 Dual-First Order Decay Empirical Emission Model Equations

Equation_Apx H-5. Dual-first Order Decay Empirical Emission Model

(Also published in the IECCU Guide as Equation 5a.)

$$R = A(E_1 \times e^{-k_1 t} + E_2 \times e^{-k_2 t})$$

Where:

R	=	Emission rate ($\mu\text{g/h}$)
A	=	Source area (m^2)
E_1	=	Initial emission factor for fast emission ($\mu\text{g/m}^2/\text{h}$)
E_2	=	Initial emission factor for slow emission ($\mu\text{g/m}^2/\text{h}$)
k_1	=	First-order decay constant for fast emission ($1/\text{h}$)
k_2	=	First-order decay constant for slow emission ($1/\text{h}$)
t	=	Elapsed time (h)

The initial emission factors for fast and slow emissions (E_1 and E_2) are represented by the following Equation_Apx H-6.

Equation_Apx H-6. Initial Emission Factors in the Dual-First Order Decay Emission Model

$$E_1 = \frac{M \times \rho \times f}{A \times k_1}$$

$$E_2 = \frac{(M \times \rho) - (M \times \rho \times f)}{A \times k_2}$$

Where:

E_1	=	Initial emission factor for rapid emissions ($\text{mg/m}^2/\text{h}$)
E_2	=	Initial emission factor for slow emissions ($\text{mg/m}^2/\text{h}$)
f	=	Fraction of mass emitted in the first exponential
ρ	=	Fraction of total mass emitted in 24 hours
k_1	=	Fast emission rate constant (h^{-1}) for the first exponential
k_2	=	Slow emission rate constant (h^{-1}) for the second exponential
A	=	Area of product application (m^2)
M	=	Mass of <i>trans</i> -1,2-dichloroethylene used (mg)

To determine the decay constants (k_1 and k_2), the fast fraction (f) and the emitted fraction (ρ), the test order experimental conditions, including mass of product used, weight fraction, and air exchange rate in the chamber were used in conjunction with the dual-first order decay empirical emission model form to simulate both emissions and the time profile of the resulting air concentrations. The variables were then modified until the best fitting set of emission model parameters were found. Initially, mass balance modeling was not able to replicate the value of the peak concentration in the test order experiment, a key

concern for adequately modeling the scenarios in IECCU for the exposure analysis. However, the test order study states that the full mass balance was not achieved and there was “missing mass”, likely owing to the rapid volatilization and escape of chemical before the test chamber could be fully sealed at the start of the experiment. To account for the mass that rapidly volatilized, a multiplier was applied to adjust the peak concentration to match that of the experiment; when including this factor, the mass balance modeling approaches could be used to determine the best fitting k_1 , k_2 , f , ρ and based on the test order data. See Appendix I for additional details about fitting the test order data to determine the emission equation.

For each scenario, the required amount of foam and resulting mass of *trans*-1,2-dichloroethylene applied was used to calculate the E1 and E2 inputs in IECCU per equation 5a in the [IECCU user guide](#) (accessed July 29, 2026). The other emission parameters were calculated based on test order chamber data. The exact area of the wall was not a necessary input because the total mass of chemical was used rather than an area normalized mass of chemical. That is, comparison of Equation 11 and Equation 12 shows that the area of emission (A) cancels out between E1 and E2 and then the overall rate R. Thus, the area was set to 1 m² in IECCU as the area variable and in estimation of the E1 and E2.

Table_Apx H-3. Parameters for Equation 12

Parameter	Value	Units
Fast fraction (f)	0.83	unitless
Emitted fraction (ρ)	0.97	unitless
Fast emission rate constant (k_1)	9.1	h ⁻¹
Slow emission rate constant (k_2)	0.26	h ⁻¹
Mass of <i>trans</i> -1,2-dichloroethylene used (M)	Varies by scenario, see below	mg
Area of product application (A)	1	m ²

Finally, in implementing the emission equation, the equation in IECCU assumes the entire mass of product (and thus *trans*-1,2-dichloroethylene) is available at time = 0. This is true in the test order, since the entire amount of mass was introduced at the start of the experiment (as a sample at the bottom of the chamber). In actual use of spray foam, the entire quantity of mass used will not be available at the start of the use; instead, over the course of the use duration, the mass will be applied around what is assumed to be four walls of a room. Allowing the mass from all four walls to be available at the first timestep of the model simulation (*i.e.*, in the first 36 seconds) will overestimate the peak air concentration. To better capture real-use conditions, IECCU was run using the mass used on one wall, where the duration to cover that wall is assumed to be 10 minutes. Then, outside of IECCU, a four-wall scenario was constructed by staggering a second wall (using the same modeled profile) after 10 minutes, a third after a second 10 minutes, and then finally a fourth after a third 10 minutes. These staggered profiles were added together to estimate the exposure in both Zone 1 and Zone 2 over the course of a 24-hour period.

H.3.4 Parameter Estimation Approach

Based on the above equations, the following model parameters were estimated using the chamber study data:

- k_1 : fast emission rate constant (h⁻¹) for the first exponential;
- k_2 : slow emission rate constant (h⁻¹) for the second exponential;

- f : fraction of emitting mass in the first exponential;
- ρ : fraction of total mass emitted during the experiment (in 24 hours); and
- m_{inf} : the mass inflation factor required to ensure mass balance in the chamber study data.

The estimation process consisted of the following steps:

- An initial guess of the parameters was supplied as input.
- These initial parameters were plugged into Equation_Apx H-1 and Equation_Apx H-2.
- Equation_Apx H-1 was integrated numerically using a differential equation solver in Python software to create estimates of concentration from 0 to 24 hours in 500 discrete steps.
- The process was repeated for each replicate.
- The difference in predicted and observed concentration at each time point of observation was computed and is referred to as the residual. (If multiple observed concentrations were available at any time point, they were averaged.)
- A non-linear least squares optimization in Python software was used to minimize the sum of squared residuals between observed and predicted concentrations across all replicates by systematically adjusting the initial guesses to get lower sum of squared residuals at each iteration till a minimum was reached. The fitting was performed using the *scipy optimize least_squares* function with the *Trust Region Reflective* (TRF) algorithm that is recommended for non-linear least squares optimization.
- The following parameter constraints were enforced via transformation
 - Rate constants and the mass inflation factor were optimized in log-space to ensure non-zero estimates.
 - Fractions were optimized in logit-space to constrain them to values between zero and one.
- An option to define residuals as the difference between log concentrations was included in the code for situations where it is more important to fit the tail than the peak. For *trans*-1,2-dichloroethylene, however, this option was not used given the high peak observed.

H.4 Acute Exposure Concentration – Air

For products, the acute exposure concentration ($C_{air,acute}$) is calculated based on the modeled concentration in each zone (zones 1 and 2) and the fraction of each day an age group spends in that zone as shown in Equation_Apx H-7. The fraction of each day is based on movement patterns in CEM's stay-at-home scenario and designation as a user or bystander.

The acute exposure concentration is calculated at 30-second intervals (CEM scenarios) and 36-second intervals (IECCU scenarios) during the first 24 hours after the start of the use. It accounts for the chemical emission rate over time, the volume of the house and each zone, the air exchange rate and interzonal airflow rate, and the exposed individual's locations during and after product use. Exposure concentrations are calculated separately for product users and bystanders, then applied to each age group based on designation as a product user.

Equation_Apx H-7. Acute Exposure Concentration in Air (Products)

$$C_{air,acute} = \max \left(\frac{\sum_{t=t}^{t+15 \text{ min}} C_{i,t} \times \Delta t}{15 \text{ min}} \right)$$

Where:

$C_{air,acute}$	=	Maximum rolling 15-min average exposure concentration in air (mg/m ³)
$C_{i,t}$	=	Concentration in Zone i at time t (mg/m ³)
Δt	=	Time interval (hour)

H.4.1 Model Evaluation

The goodness-of-fit of the model with the final estimated parameters was assessed using several metrics:

- **R²** (coefficient of determination): represents the proportion of variance explained by the model.
- **RMSE** (root mean squared error) and **MAE** (mean absolute error): represents the average magnitude of residuals. Log RMSE and log MAE were also computed as alternative metrics for when residuals are based on the difference in log concentrations, although this option was not exercised as noted previously.
- **AIC** and **BIC**: information criteria penalizing model complexity (lower scores are better when comparing the fit of alternative emission models).
- **SSR**: sum of squared residuals.
- Plots of predicted vs. observed concentrations were generated separately for each replicate to visually assess fit quality.

H.5 Results

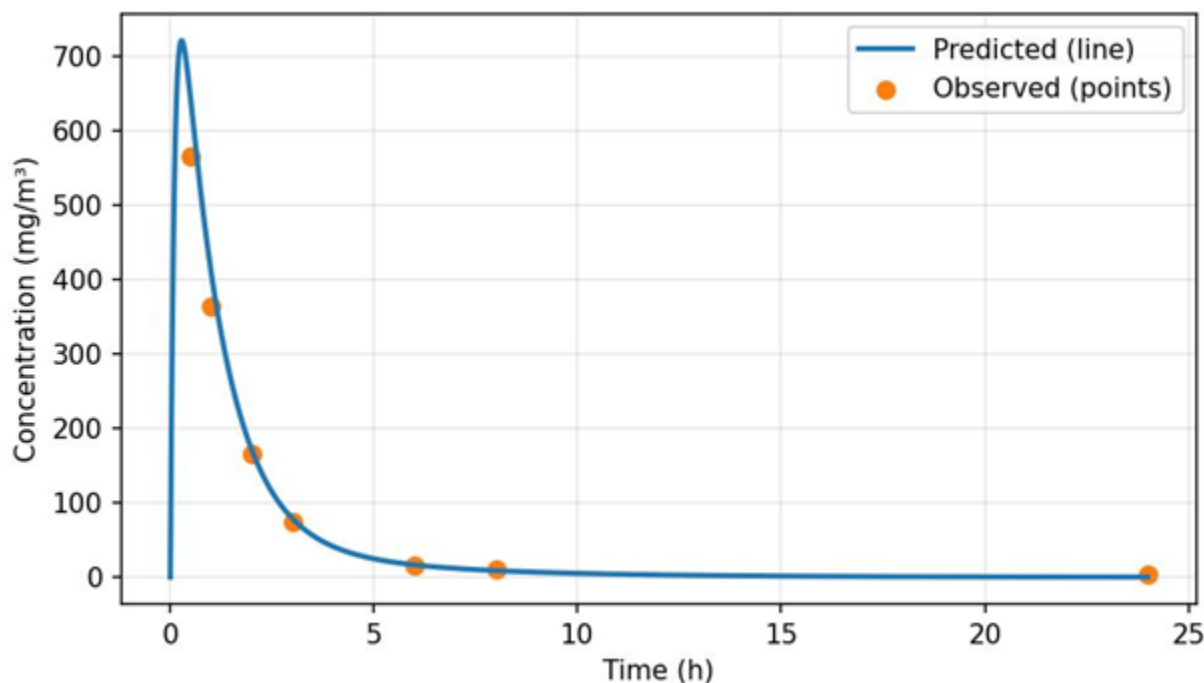
The double exponential emission model provided a very close fit to the chamber data, capturing both the rapid initial rise and decline and the slower tailing of *trans*-1,2-dichloroethylene concentrations. The estimated parameters and goodness of fit statistics are summarized in the table below:

Table_Apx H-4. Estimated Parameters and Goodness of Fit Statistics

Parameter / Goodness of Fit Statistic	Value	Units
Fast Rate Constant, k_1	9.10	h ⁻¹
Slow Rate Constant, k_2	0.26	h ⁻¹
Fast Fraction, f	0.83	—
Emitted Fraction, ρ	0.97	—
Mass inflation factor, m_{inf}	1.59	mg/g
Coefficient of Determination, R^2	0.96	—
Root Mean Squared Error, RMSE	35.4	mg/m ³
Mean Absolute Error, MAE	17.8	mg/m ³
Log RMSE	1.28	—
Log MAE	0.57	—
Akaike Information Criterion, AIC	159.8	—
Bayesian Information Criteria, BIC	165.0	—

Parameter / Goodness of Fit Statistic	Value	Units
Sum of Squared Residuals, SSR	26.292	(mg/m ³) ²
Number of Data Points (all 3 replicates combined)	21	
Maximum Air Concentration (replicate 1)	721.8	mg/m ³
Maximum Air Concentration (replicate 2)	380.5	mg/m ³
Maximum Air Concentration (replicate 3)	453.4	mg/m ³

As an example, Figure_Apx H-1. displays the predicted and observed concentrations for the first replicate in the chamber testing study. Observed measurements occurred at 0.5, 1, 2, 3, 6, 8, and 24 hours.



Figure_Apx H-1. Predicted vs. Observed Concentrations for Replicate 1

H.6 Conclusions

An R^2 value exceeding 96% indicates that the model fits the observed data well. The empirically estimated mass inflation factor required to account for the stated uncertainty in *trans*-1,2-dichloroethylene weight fraction was exactly equal to the average of the estimated excess mass emitted computed from the reported chamber study data. The fitted parameters are physically plausible and consistent with expectations for a double exponential emission process. Visual inspection of the predicted vs. observed plots confirms the model's ability to capture the key features of the emission profile. It is also apparent that this chemical is highly volatile with 97% of the mass released in the first 24 hours, which suggests that the installation phase is likely to account for most of the human exposure and that post-installation emissions are likely to be small.

Appendix I ACUTE AND INTERMEDIATE CONCENTRATION AND DOSE RATE EQUATIONS FOR CONSUMER EXPOSURE

I.1 Intermediate Exposure Concentration – Air

Intermediate exposure concentrations are calculated similarly to the acute exposure concentrations. However, for intermediate concentrations, the maximum 24-hour rolling average is used, rather than the 15-minute average.

Equation_Apx I-1. Acute Exposure Concentration in Air (Products)

$$C_{air,inter} = \max \left(\frac{\sum_t^{t+24 \text{ hour}} C_{i,t} \times \Delta t}{24 \text{ hour}} \right)$$

Where:

$C_{air,inter}$	=	Maximum rolling 24-hour average exposure concentration in air (mg/m ³)
$C_{i,t}$	=	Concentration in Zone i at time t (mg/m ³)
Δt	=	Time interval (hour)

I.2 Intermediate Dose Rate – Dermal

The intermediate dose rate is estimated based on the dermal dose per event average across the number events in a 30-day period, as shown in Equation_Apx I-2.

Equation_Apx I-2. Intermediate Daily Dose Rate for Dermal Exposure to Products

$$IDR_{Dermal} = \frac{DA_{liq} \times FQ_{inter}}{BW \times AT_{inter}}$$

Where:

IDR_{Dermal}	=	Intermediate daily dose rate from dermal contact (mg/kg-day)
DA_{liq}	=	Dermal event dose (mg/event)
FQ_{inter}	=	Number of exposure events per 30-day period
BW	=	Body weight (kg)
AT_{inter}	=	Intermediate averaging time (30 days)