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Draft Chemistry, Fate, Release, and Exposure Assessment for *p*-Dichlorobenzene

Technical Support Document for the Draft Risk Evaluation

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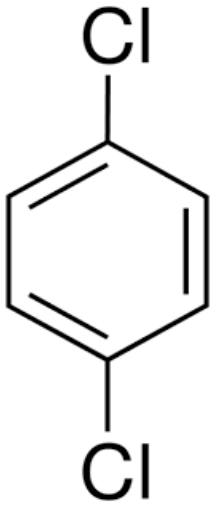

August 2026

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX TABLES

LIST OF APPENDIX FIGURES

KEY ABBREVIATIONS AND ACRONYMS

2-DCP	2,5-Dichlorophenol
7Q10	The lowest 7-day average flow that occurs (on average) once every 10 years
ADME	Absorption, distribution, metabolism, and elimination
APF	Assigned protection factors
BCF	Bioconcentration factor
BAF	Bioaccumulation factor
CADC	Chronic average daily concentrations
CASRN	Chemical Abstract Service registry number
CDR	Chemical Data Reporting
CEHD	Chemical Exposure Health Data
CEM	Consumer Exposure Model
CFR	Code of Federal Regulations
COU	Condition of use
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency (U.S.)
EPCRA	Emergency Planning and Community Right-to-Know Act
ESD	Emission Scenario Document
GS	Generic scenario
HAP	Hazardous Air Pollutant
HLC	Henry's Law constant
IECCU	Indoor Environmental Concentrations in Buildings with Conditioned and Unconditioned Zones
K_{OA}	Octanol:air partition coefficient
K_{OC}	Organic carbon:water partition coefficient
K_{OW}	Octanol:water partition coefficient
LOD	Limit of detection
MDL	Method detection limit
NAICS	North American Industry Classification System
ND	Non-detect
NEI	National Emissions Inventory
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NLM	National Library of Medicine
NPDES	National Pollutant Discharge Elimination System
OECD	Organisation for Economic Cooperation and Development
OEL	Occupational exposure limit
OES	Occupational exposure scenario
ONU	Occupational non-user
OPPT	Office of Pollution Prevention and Toxics (EPA)
OSHA	Occupational Safety and Health Administration (U.S.)
PBZ	Personal breathing zone
PEL	Permissible exposure limit
PESS	Potentially exposed or susceptible subpopulations
POTW	Publicly owned treatment works
PPE	Personal protective equipment
PV	Production volume
RCRA	Resource Conservation and Recovery Act

SDS	Safety data sheet
SLT	State, local, and tribal level
SOC	Standard Occupational Classification
SpERC	Specific Environmental Release Categories
TRI	Toxics Release Inventory
TSCA	Toxic Substance Control Act
TWA	Time-weighted average
U.S.	United States
VP	Vapor pressure
VOC	Volatile organic compound
WQP	Water Quality Portal
WWT	Wastewater treatment
WS	Water solubility

SUMMARY

This draft technical support document (TSD) is part of the Toxic Substances Control Act (TSCA) *Draft Risk Evaluation for p-Dichlorobenzene* (see Appendix C of the draft risk evaluation for a complete list of all TSDs and supplemental files).

The U.S. Environmental Protection Agency (EPA or the Agency) considered all reasonably available information identified through the TSCA systematic review process (U.S. EPA, 2026x) to characterize the physical and chemical properties of *p*-dichlorobenzene as well as the environmental fate and transport of *p*-dichlorobenzene. The following points summarize the chemical properties and expected fate of *p*-dichlorobenzene in the environment.

- ***Chemical Properties:*** *p*-Dichlorobenzene is a white crystalline solid with a pungent odor that sublimes at room temperature. It is poorly soluble in water, though miscible in most organic solvents (solubility = 81.3 mg/L). Partitioning values for *p*-dichlorobenzene indicate low to moderate sorption to soil, sediment, and organic matter (log organic carbon:water partition coefficient [K_{OC}] = 3.0, low octanol:water partition coefficient [K_{OW}] = 3.23). *p*-Dichlorobenzene is a moderately volatile organic compound with a boiling point of 174 °C and a vapor pressure of 1.0 mm Hg. When present in water or soil, volatilization to the surrounding atmosphere is the primary removal mechanism for *p*-dichlorobenzene.
- ***Fate and Transport:*** *p*-Dichlorobenzene has moderate persistence in air ($t_{1/2}$ = ≈30 days), aerobic soils or sediment ($t_{1/2}$ = ≈44 days), and water ($t_{1/2}$ = 5–11 days), with limited partitioning among media once in the environment. It may be persistent in anaerobic environments due to limited biodegradation; however, it is unlikely to be found in such media. There is low potential for *p*-dichlorobenzene to bioaccumulate (log bioconcentration factor [BCF] 1.8) with BCF estimates ranging from 7.1 to 17,000. However, elimination is expected to be rapid (Oliver and Niimi, 1983; Barrows et al., 1980; Veith et al., 1980) limiting any sustained concentrations in organisms within the environment. Furthermore, concentrations of *p*-dichlorobenzene in soil, sediment, and water are negligible and limited environmental exposure is expected. Thus, no trophic transfer is expected.
- ***Environmental Releases:*** According to aggregated Toxics Release Inventory (TRI) and Discharge Monitoring Report (DMR) data (2019–2023), air is expected to be the primary pathway of concern for *p*-dichlorobenzene with 92.9% of *p*-dichlorobenzene released to air (84.8% fugitive and 8.1% stack releases). Other releases include 3.0% released to land, 1.9% released to surface water, and 2.3% transferred for off-site disposal to other locations.

According to these chemical properties and fate assessment, *p*-dichlorobenzene exposure can occur via inhalation, ingestion, or dermal contact. EPA conducted three *p*-dichlorobenzene exposure assessments for the general population, consumers, and occupational workers. Brief summaries are provided below.

General Population Exposure

For general population, the major routes of exposure considered were ambient air inhalation and oral exposure via ingesting drinking water.

- Ambient air concentrations were modeled using the Indoor-Outdoor Air Calculator (IIOAC) based on facility releases reported to TRI between 2019 to 2023.
- The 95th percentile ambient air modeled concentrations across all facilities, reporting years and modeled distances (100, 100–1,000, and 1,000 m) ranged from 0.0 to 47.1 µg/m^3 with the highest concentrations at 100 m from facility releases.

- Acute and chronic margin of exposures (MOEs) were calculated using the 95th percentile modeled concentrations and the respective acute and chronic human equivalent concentrations (HECs) compared to a benchmark of 30.
- All non-cancer, screening-level MOE risk estimates were above the non-cancer benchmark for both acute and chronic exposures. Therefore, there is no expectation of non-cancer risks to the general population from TRI facility releases based on this screening-level assessment.
- Drinking water concentrations were extracted from systematic review, with the highest concentrations reported of 0.056, 4.3, and 169 µg/L in treated drinking water, surface water, and groundwater, respectively.
- Drinking water doses were calculated for adults and infants (birth to <1 month) using the highest concentrations reported from systematic review studies in drinking water, surface water, and groundwater wells along with the EPA *Exposure Factors Handbook* (2011) for drinking water intake and bodyweight.
- Acute and chronic MOEs were calculated using the respective acute and chronic human equivalent doses (HEDs) and compared to the benchmark of 30.
- Both adult and infant acute and chronic MOEs were above the benchmark. Therefore, there is no expectation of non-cancer risks to the general population from treated drinking water or to subpopulations that use untreated surface water or groundwater as a primary source of drinking water.

Consumer Exposure

For consumer uses, *p*-dichlorobenzene is primarily used for air care products (1weight fraction) and foam insulation (0.07 weight fraction). There are also small amounts reported in automotive lubricants/greases and fuels and related products (3.0×10^{-5} to 1.0×10^{-3} weight fraction). This assessment evaluates acute and chronic non-cancer exposures for inhalation and dermal routes of exposure, which are the major routes of exposure. For this assessment, EPA used highest reported weight fractions from safety data sheets (SDS) and representative exposure scenarios of product use for each condition of use (COU) under TSCA. For air care products, the SDS-reported weight fractions ranged from 0.99 to 1 (Willert Home Products, 2019). The inhalation non-cancer chronic MOE for air care products was the only scenario below the benchmark.

Occupational Exposure

EPA evaluated occupational exposures for each occupational exposure scenario (OES), which are developed based on a set of occupational activities and conditions such that similar occupational exposures are expected from the use(s) covered under each OES. EPA used inhalation monitoring data, including directly applicable data obtained through Test Orders under TSCA, to evaluate acute, intermediate, and chronic exposures to workers and ONUs for 8 of the 16 OESs. Data from the Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR Model) was used for one OES (Use of laboratory chemicals). Analogous data from other OESs were used for three OESs (Incorporation into Formulation, Mixture, or Reaction Product; Plastics Converting; and Functional Fluids [closed system]). EPA's Consumer Exposure Model (CEM) was adjusted for occupational use when no monitoring data were available for two OESs (Use in Solid Air Care Products; Use of Adhesives and Sealants). Two OESs were assessed qualitatively due to a lack of evidence that *p*-dichlorobenzene is present at significant amounts (Use of Lubricants and Greases; Use of Fuels and Related Products). Dermal exposure was modeled via a fractional absorption approach using a Monte Carlo simulation with 100,000 iterations for all OESs except Use in Solid Air Care Products. The inputs to this dermal exposure modeling method include dermal loading, chemical concentration, fractional absorption of the chemical into the skin, and the surface area of dermal contact, with the values used for each variable being data driven when possible or assumed defaults when

lacking more specific information. The chemical concentration was either a static value or a distribution depending on the chemical concentration information available about each specific use while fractional absorption of the chemical was a static value for each OES. For the Use in Solid Air Care Products OES, a permeability equation was used to estimate dermal exposure because the chemical is present as a solid puck that does not deposit a defined amount of chemical on skin. See Section 8.2.10.4 and Appendix M for more details on the method and inputs.

Inhalation exposures to *p*-dichlorobenzene are highest during the Repackaging; Incorporation into Air Care Products; Incorporation into Formulation, Mixture, or Reaction Product; and Incorporation into Abrasive Grinding Wheels OESs. Dermal exposures are estimated to be similar among most OESs, with the highest exposure occurring during the Manufacturing and Processing life cycle stages.

The highest expected exposure concentrations across populations, exposure scenarios, and exposure routes are presented in Table S-1.

Table S-1. Key *p*-Dichlorobenzene Exposure Estimates Including Exposed Populations, Exposure Scenarios and Routes, and the Associated Highest Exposure Concentration or Dose

Population (Subpopulation)	Exposure Scenarios	Exposure Route	Highest Estimated Concentration or Dose
General population (Communities within 100–1,000 m from TRI facility releases)	Ambient Air	Inhalation	47.1 µg/m^3
General population (Adult)	Drinking Water – Treated Drinking Water	Oral	2.1E−06 mg/kg-day
General population (Adult) – PESS	Drinking Water – Untreated Surface Water	Oral	1.6E−04 mg/kg-day
General population (Adult) – PESS	Drinking Water – Untreated Groundwater Water	Oral	6.3E−03 mg/kg-day
General population (Infant [birth to <1 month])	Drinking Water – Treated Drinking Water	Oral	3.5E−05 mg/kg-day
General population (Infant [birth to <1 month]) – PESS	Drinking Water – Untreated Surface Water	Oral	2.7E−03 mg/kg-day
General population (Infant [birth to <1 month]) – PESS	Drinking Water – Untreated Groundwater Water	Oral	1.1 E−01 mg/kg-day

Population (Subpopulation)	Exposure Scenarios	Exposure Route	Highest Estimated Concentration or Dose
Consumer (acute exposure; 21+ years old for dermal exposure)	Air Care Products	Inhalation	2.6 mg/m^3
		Dermal	2.91E−01 mg/kg-day
	Lubricants and Greases (Marvel Mystery Oil)	Inhalation	8.4E−06 mg/m^3
		Dermal	2.75E−10 mg/kg-day
	Lubricants and Greases (Marvel Air Tool)	Inhalation	7.4E−05 mg/m^3
		Dermal	9.16E−09 mg/kg-day
	Foam Insulation	Inhalation	1.1E−01 mg/m^3
		Dermal	3.15E−03 mg/kg-day
Occupational workers and Occupational non-users (ONUs)	Manufacturing, Processing, Industrial Use, and Commercial Use life cycle stages	Inhalation, dermal	See Section 8.2
PESS = potentially exposed or susceptible subpopulations; TRI = Toxics Release Inventory			

857

1 INTRODUCTION

This technical document presents the chemistry, fate, release, and exposure assessment (also referred to as the "draft exposure TSD") in support of the TSCA *Draft Risk Evaluation for p-Dichlorobenzene* (also referred to as the "draft risk evaluation") (U.S. EPA, 2026w). 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. The new law 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, COUs and potentially exposed or 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 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. *p*-Dichlorobenzene is one of the chemicals designated as a high priority substance for risk evaluation.

p-Dichlorobenzene is a colorless to white crystalline solid that is poorly soluble in water but miscible in most organic solvents. It has a strong, pungent odor. When the product is unopened, it does not undergo sublimation as the packaging is sealed. When the product is opened at ambient temperature, it undergoes sublimation, passing directly from a solid to a vapor state. *p*-Dichlorobenzene is manufactured in the United States only as a byproduct during the production of vinyl chloride monomer (VCM). It is imported into the country, with an imported volume in the United States ranging between 50 and 100 million pounds (lb). Several industrial and commercial uses were identified, ranging from use in solvents (which become part of product formulation or mixtures) to use in air care products as continuous-action air fresheners. Consumer uses were reported in air care products, lubricants and greases, and building and construction products. The volatilization of *p*-dichlorobenzene from these products has been identified as a potential mechanism of exposure. Exposure to *p*-dichlorobenzene can occur via inhalation of vapors during consumer use and via the dermal route through contact with solids or accidental splashing from liquid consumer products. The primary routes of consumer exposure are inhalation and dermal pathways.

EPA conducted the systematic review (U.S. EPA, 2026x) of gray literature and studies relevant to the physical and chemical properties, fate and transport, environmental release and exposure, and consumer and occupational exposure of *p*-dichlorobenzene. Based on data from studies and grey literature, the Agency conducted exposure assessments for the environment, the general population, consumers, and occupational workers. For more information on the reviewed sources used to build this assessment, as well as the evaluation strategies for these sources, refer to *Data Quality Evaluation and Data Extraction Information for Environmental Release, General Population Exposure, Consumers Exposure, and*

Occupational Exposure for p-Dichlorobenzene (U.S. EPA, 2026g) and EPA's *Draft Systematic Review Protocol for p-Dichlorobenzene* (U.S. EPA, 2026x), respectively.

This draft technical support document (TSD) provides details on the fate and transport, environmental release, environmental exposure assessment, and exposure assessments for the general population, consumers, and occupational workers for *p*-dichlorobenzene. It supports the risk evaluation for *p*-dichlorobenzene. A diagram showing the relationship between assessments/TSDs and risk evaluation is provided in Figure 1-1.

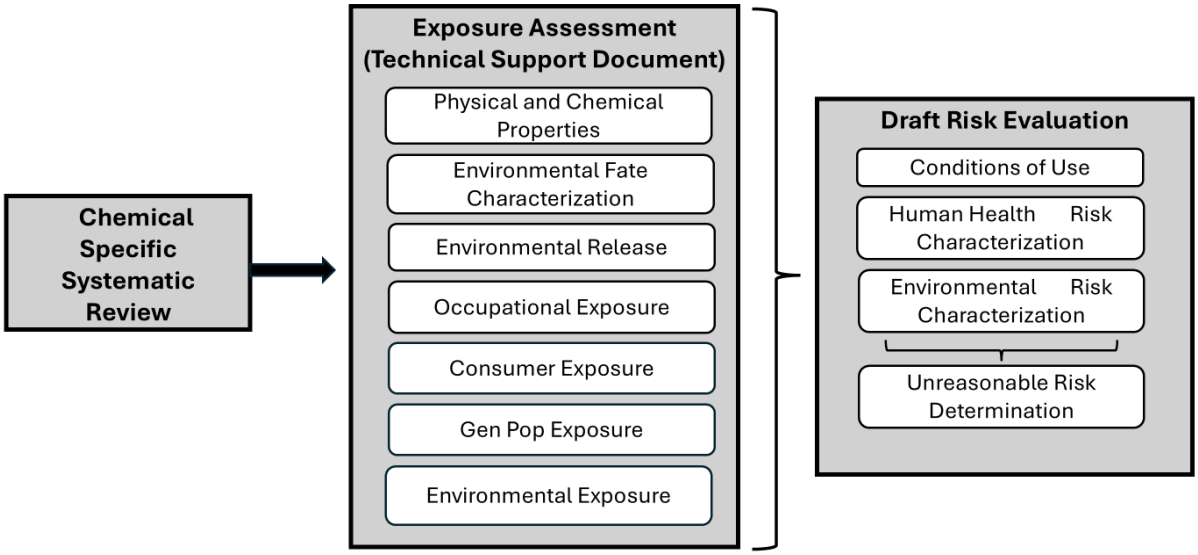

Figure 1-1. Map of *p*-Dichlorobenzene Systematic Review, Exposure Assessment Technical Support Documents, and the Draft Risk Evaluation

2 PHYSICAL AND CHEMICAL PROPERTY ASSESSMENT

2.1 Approach and Methodology for Physical and Chemical Property Assessment

EPA gathered and evaluated physical and chemical property data and information 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, 2021a)). During the evaluation of *p*-dichlorobenzene, EPA considered both measured and estimated physical and chemical property data (Table 2-1).

2.2 Final Selected Physical and Chemical Property Values for *p*-Dichlorobenzene

The systematic review process identified multiple data with high quality ratings for the physical and chemical properties of *p*-dichlorobenzene (U.S. EPA, 2026j). Most of the data were collected under standard environmental conditions (*i.e.,* 20–25 °C and 760 mm Hg). These data are presented in Table 2-1.

Table 2-1. Physical and Chemical Properties of *p*-Dichlorobenzene

Property	Selected Value(s)	Reference	Data Quality Rating
Molecular formula	$C_6H_4Cl_2$	–	–
Molecular weight	147.00 g/mol	–	–
Physical form	Colorless solid; aromatic odor; readily sublimes at room temperature	Rumble (2018c)	High
Melting point	53.1 °C	Rumble (2018c)	High
Boiling point	174 °C	U.S. EPA (2018b)	High
Density	1.46 g/cm^3 at 20 °C	O'Neil et al. (2013)	High
Vapor pressure	1.00 mm Hg	Liu and Dickhut (1994)	High
Vapor density	5.08 (air = 1) (unitless)	NLM (2018)	High
Water solubility	81.3 mg/L	NLM (2018)	High
Octanol:water partition coefficient (log K_{OW})	3.23 (unitless)	Bahadur et al. (1997)	High
Henry's Law constant	2.42E−03 atm·m^3/mol at 25 °C	Rumble (2018a)	High
Flash point	65.56 °C	O'Neil (2013)	High
Autoflammability	>500 °C	NCBI (2020)	High
Viscosity	0.839 centipoise (cP) at 55 °C	NLM (2018)	High
Refractive index	1.529 at 20 °C	Rumble (2018b)	High
Dielectric Constant	2.394 at 55 °C	NLM (2018)	High

To determine specific values for each parameter Table 2-1, priority was given to data from expert-curated, peer-reviewed databases that have been identified as "trusted sources" as detailed in the 2021 Draft Systematic Review Protocol (U.S. EPA, 2021a). Where 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 are conducted according to accepted standard analytical methods, including but not limited to OECD guidelines or other developed standards with sufficient documentation.

2.2.1 Molecular Formula and Weight

The molecular formula of *p*-dichlorobenzene is $C_6H_4Cl_2$. *p*-Dichlorobenzene is defined as having a molecular weight of 147.00 g/mol. This value was not obtained by systematic review but rather was calculated from the known molecular formula. The uncertainty in this value is inherent to molecular weight determination from atomic masses and is negligible.

2.2.2 Physical Form

p-Dichlorobenzene is a crystalline solid at room temperature, which is consistent with the recorded melting and boiling points listed in Table 2-1. The crystals form in a monoclinic crystal system with prismatic or leaf-like crystal habits. Qualitative reports are consistent in describing *p*-dichlorobenzene as clear to white in color and having an aromatic odor. *p*-Dichlorobenzene also readily sublimes at environmentally relevant temperatures and pressures though the rate is variable and depends on exposed surface area, vapor pressure at temperature, and partial pressure of *p*-dichlorobenzene in the surrounding air (Rumble, 2018c).

2.2.3 Melting and Boiling Point

Systematic review identified 21 total melting point data (14 individual data points and 7 data ranges), covering 50 to 57.01 °C. The geometric mean of the 14 values is 53.5 ± 1.4 °C. The seven data ranges collectively span 50 to 56 °C. A final value of 53.1 °C (Rumble, 2018c) was selected because it is rated high quality and aligns with the other data. There is little uncertainty in the value selection for this property.

Systematic review identified 14 total boiling point data (11 individual data points, 2 data ranges, and 1 qualitative observation), covering 173 to 174.6 °C. The geometric mean of the 11 values is 173.9 ± 0.3 °C. The two data ranges collectively span 173 to 174.6 °C. The qualitative observation is that *p*-dichlorobenzene sublimes at room temperatures. The final value selected, 174 °C (Rumble, 2018c; U.S. EPA, 2018b) was selected because it is rated high quality and aligns with the other data. There is little uncertainty in the value selection for this property.

2.2.4 Density

Systematic review identified five total density data (4 values and 1data range), covering 1.2475 to 1.526 g c/cm^3. The geometric mean of the four values is 1.30 ± 0.11 g/cm^3. The data range spans 1.4581 to 1.526 g/cm^3. Density is a temperature-dependent property, and analysis of the data reveals that lower reported density values were collected at temperatures above 25 °C. The final value selected, 1.46 g/cm^3 (O'Neil et al., 2013), was selected because it is rated high quality, was measured at 20 °C, and aligns with the other data. There is little uncertainty in the value selection for this property.

2.2.5 Vapor Density

Systematic review identified 4 total vapor density data. All data measured the vapor density as 5.08 (relative to air = 1). The final value of 5.08 (NLM, 2018) was selected because it is rated high quality. There is little uncertainty in the value selection for this property.

2.2.6 Vapor Pressure

Systematic review identified 12 total vapor pressure data covering 0.04 to 3.39 mm Hg, measured at a variety of temperatures. Vapor pressure increases with increasing temperature, as governed by the

Clausius-Clapeyron relation. Of the 12 data identified, 9 are high quality and are measured at a specific temperature. A plot of log(vapor pressure) as a function of temperature for these data yield a vapor pressure of 0.84 mm Hg at 25 °C. A final value of 1.0 ± 0.02 mm Hg was selected because it aligns with the vapor pressure temperature analysis and is rated high quality (Liu and Dickhut, 1994). Furthermore, while there is a strong correlation between vapor pressure and temperature ($r^2 = 0.95$), a wide range of high-quality data were collected at 25 °C (0.4–1.74 mm Hg) and the propensity for *p*-dichlorobenzene to sublime under standard conditions yields some uncertainty in this value selection.

2.2.7 Water Solubility

Systematic review identified 11 total water solubility data (9 values, 1 data range, and 1 qualitative observation), covering ≈0 to 665 mg/L. The geometric mean of the 9 values is 151 ± 195 mg/L. However, as water solubility is temperature dependent, when only considering the three data that are high quality and collected at 25 °C, the data range spans 30.9 to 117.6 mg/L with a geometric mean of 80.9 ± 0.8 mg/L. The qualitative observation is that *p*-dichlorobenzene is poorly soluble in water. When accounting for the temperature-dependence of water solubility and the quality of collected data, a value of 81.3 mg/L was selected (NLM, 2018). There is little uncertainty in the value selection for this property.

2.2.8 Octanol/Water Partition Coefficient (Log Kow)

Systematic review identified 10 high-quality log K_{OW} data (9 values and 1data range) covering 3.23 to 3.91. The geometric mean of the nine values is 3.47 ± 0.05. The data range spans 3.38 to 3.91. A final value of 3.52 (Rumble et al., 2018) was selected because it aligns with the geometric mean and is from a high-quality study. There is little uncertainty in the value selection for this property.

2.2.9 Henry's Law Constant

Systematic review identified three total Henry's Law constant data. All three data points are high quality and measure the constant as 2.41×10^{-3} (Rumble, 2018a). This was selected as the final value and there is little uncertainty in the value selection for this property.

2.2.10 Flash Point

Systematic review identified 10 total flash point data with a geometric mean of 65.6 ± 0.4 °C. The final value selected was 65.56 °C (O'Neil, 2013) because it is rated high quality and aligns with the other data. There is little uncertainty in the value selection for this property.

2.2.11 Autoflammability

Systematic review identified two total autoflammability data points. Both data points indicated an autoignition temperature greater than 500 °C (NCBI, 2020). There is little uncertainty in the value selection for this property.

2.2.12 Viscosity

Systematic review identified four total high quality viscosity data (1 value and 3 data ranges) covering 0.327 to −913.201 centipoise (cP) over a temperature range of 55 to 622 °C. Viscosity is temperature-dependent and generally decreases as temperature increases. The value 0.839 cP at 55 °C was selected because no data collected under standard conditions were available and 55 °C was the measurement temperature closest to room temperature (*p*-dichlorobenzene is solid at temperatures below 53.5 ± 1.4 °C). Furthermore, the selected value aligns with the other published. There is little uncertainty in the value selection for this property.

2.2.13 Refractive Index

Systematic review identified three total refractive index data, covering 1.5285 to 1.5434 over a temperature range of 20 to 60 °C. The geometric mean of the data is 1.5335 ± 0.0086. The final value, 1.5285 at 20 °C (Rumble, 2018b), was selected because it is rated high quality, was collected near standard conditions, and aligns with the other data. There is little uncertainty in the value selection for this property.

2.2.14 Dielectric Constant

Systematic review identified three dielectric constant data, ranging from 2.394 to 2.533. A final value of 2.394 at 55 °C (NLM, 2018) was selected as the dielectric constant for *p*-dichlorobenzene. There is little uncertainty in the value selection for this property.

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

The general confidence in the physical and chemical properties for *p*-dichlorobenzene is high. Measured data were identified from high-quality studies for all physical and chemical properties. A detailed discussion of strengths, limitations, assumptions, and key sources of uncertainty for the fate and transport assessment is provided below. The physical and chemical property data discussed in this document were the product of a systematic review of reasonably available information (U.S. EPA, 2026x). Overall, there is little uncertainty in the physical and chemical data and analyses presented; as such, there is high confidence in the data. The analyses present the average and standard deviation of all data collected through the systematic review process for each parameter. The standard deviation is reported as uncertainty in the form of tolerance limits (± range) on the average value. Data extracted as a range of values were excluded from the calculations unless expert judgment 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 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

3.1 Approach and Methodology for Fate and Transport Assessment

Reasonably available environmental fate data, including biotic and abiotic biodegradation rates, removal during wastewater treatment, volatilization from lakes and rivers, and organic carbon:water partition coefficient (log K_{OC}), were used to evaluate environmental fate and transport (Table 3-1). In assessing the environmental fate and transport of *p*-dichlorobenzene, EPA considered the full range of results from sources that were rated high- and medium-quality. Details on the rating criteria are contained in the 2021 Draft Systematic Review Protocol (U.S. EPA, 2021a). Information on the full extracted datasets are available in the supplemental file: *Data Quality Evaluation and Data Extraction Information for Environmental Fate and Transport Studies for p-dichlorobenzene* (U.S. EPA, 2026h) and *Data Quality Evaluation and Data Extraction Information for Physical and Chemical Properties for p-dichlorobenzene* (U.S. EPA, 2026i). Fate estimates were also based on modeling results from EPI Suite™ (U.S. EPA, 2012), a predictive tool for physical, chemical, and environmental fate properties. EPI Suite™ was reviewed by the EPA Science Advisory Board (SAB, 2007) and the individual models that comprise EPI Suite™ have been peer reviewed through publication in technical journals. Citations for the supporting manuscripts are available in the help files.

3.1.1 EPI Suite™ Model Inputs and Settings

To parameterize EPI Suite™ for estimating environmental fate properties of *p*-dichlorobenzene, the physical and chemical properties were input based on the values listed in Table 2-1. EPI Suite™ was then run using default settings. Appendix C provides the EPI Suite™ input and output used in this draft assessment.

3.1.2 Evidence Integration for Fate and Transport Properties of *p*-Dichlorobenzene

EPA gathered and evaluated physical and chemical property data and environmental fate information according to the process described in the Draft Systematic Review Protocol (U.S. EPA, 2021a). During the evaluation of *p*-dichlorobenzene, EPA considered both measured and estimated data and information as applicable. Information and full extracted datasets are available in the supplemental file *Data Quality Evaluation and Data Extraction Information for Environmental Fate and Transport Studies for p-Dichlorobenzene* (U.S. EPA, 2026h) and data evaluation information is available in the supplemental file *Data Quality Evaluation and Data Extraction Information for Physical and Chemical Properties for p-Dichlorobenzene* (U.S. EPA, 2026i). The values selected are based on an overall judgement of the strength of the scientific evidence and conclusions regarding the properties and fate of *p*-dichlorobenzene. All judgments about the strength of the evidence are based upon consideration of consistency, study design, study conditions, and uncertainty.

3.2 Selected Fate and Transport Property Values for *p*-Dichlorobenzene

Table 3-1. Final Environmental Fate and Transport Characteristics of *p*-Dichlorobenzene

Property or Endpoint	Selected Value(s)	Reference(s)	Data Quality Rating
Direct photodegradation	Stable; not expected to undergo direct photolysis due to lack of chromophores that absorb at wavelengths >290 nm	HSDB (2018)	High
Indirect photodegradation in air	$t_{1/2}$ (half-life) = 28 ± 8 days ·OH rate constant 3.3E−13 cm^3/s	Wahner and Zetzsch (1981)	High
	$t_{1/2}$ = 20 to 31 days ·OH rate constant 4.3E−13 cm^3/s	Arnts et al. (1989)	High
	$t_{1/2}$ = 24 days ·OH rate constant 4.4E−13 cm^3/s	Klamt (1993)	High
Hydrolysis	Stable; not expected to undergo hydrolysis in the environment due to the lack of hydrolysable functional groups	U.S. EPA (2009)	Medium
Aerobic biodegradation	$t_{1/2}$ = 14 days (contaminated aquifer)	Dermietzel and Vieth (2002)	High
	$t_{1/2}$ = 12–35 days (groundwater and sediment)	Nielsen et al. (1996)	High
	$t_{1/2}$ = 9–16 days (groundwater and sediment)	Nielsen and Christensen (1994)	High
	25–90% removal after 300 days (soil column)	Van Der Meer et al. (1992)	High
Anaerobic biodegradation	$t_{1/2}$ = 365 days (estuarine sediment)	Masunaga et al. (1996)	High
	$t_{1/2}$ = 365 days (sediments and river water)	Susarla et al. (1998)	High
	$t_{1/2}$ = 241 days (soil)	Demirjian et al. (1987)	High
	Very slow, >365 days (contaminated aquifer)	Dermietzel and Vieth (2002)	High
Wastewater treatment	80 to >99% removal efficiency (volatilization and adsorption)	Matter-Müller et al. (1980)	High
	$t_{1/2}$ = 32 days (wastewater sludge in closed system)	Kirk et al. (1989)	High

3.3 Partitioning

Partitioning values (Table 3-2) indicate low to moderate sorption to soil, sediment (log K_{OC} = 3), or organic matter in water (log K_{OW} = 3.23). A Henry's Law constant of 0.00241 atm·m^3/mol at 25 °C indicates volatilization from surface water and soil surfaces. Because *p*-dichlorobenzene sorbs to sediment and soils, it does not strongly partition to water. There is not strong pressure to remove *p*-dichlorobenzene by partitioning, transport, or degradation from the media in which it is released. Thus, air is expected to be the major pathway of concern for *p*-dichlorobenzene; if not routed to underground

injection wells or Resource Conservation and Recovery Act (RCRA) landfills, all *p*-dichlorobenzene is released to air.

Table 3-2. Partitioning Coefficients for *p*-Dichlorobenzene

Parameter	Value	Log Value	Source	Predominant Phase
Octanol:Water (K_{OW})	1,698	3.23	Bahadur et al. (1997)	Organic carbon
	2,754	3.44	Poole and Poole (1999)	
	2,398	3.38	Rumble et al. (2018)	
	2,344	3.37	Wasik et al. (1983)	
	1,905–2,754	3.28–3.44	U.S. EPA (2019b)	
Organic Carbon:Water (K_{OC})	813	2.91	Djohan et al. (2017)	Organic carbon
	794	2.9	Djohan et al. (2005)	
	21,380–37,154	4.33–4.57	Kleineidam et al. (2002)	
	794-2,884	2.90–3.46	Lee et al. (2003)	
	832	2.92	Sacan and Balcioglu (1996)	
	5,278–21,380	3.72–4.33	Sun and Zhou (2010)	
	550	2.74	Valsaraj et al. (1999)	
	389–2,042	2.59–3.31	Gao et al. (1996)	
	776	2.89	Cornelissen et al. (1997)	
Octanol:Air (K_{OA})	27,542	4.44	U.S. EPA (2019b)	Organic carbon
	28,183	4.45	U.S. EPA (2010)	
Air:Water (K_{AW})	1.16	0.07	Sproule et al. (1991)	Water
	0.09	−1.01	U.S. EPA (2010)	

Partitioning coefficients were measured across variable temperatures. The K_{OC} had the widest range of reported measurements (550–37,154). There is likely some partitioning from surface water to sediment but migration to groundwater is also possible though likely negligible given competing volatilization. The K_{OW} and K_{OC} suggest that *p*-dichlorobenzene will partition to organic matter in the environment but could still be mobile in aquatic environments. The octanol:air partition coefficient (K_{OA}) suggests that some *p*-dichlorobenzene will minimally partition to air. The K_{AW} indicates that there is not a strong tendency of *p*-dichlorobenzene to partition out of air to water or vice versa.

3.3.1 Fugacity Modeling

EPA ran the level III fugacity model in EPI Suite™ (U.S. EPA, 2012) to predict how environmental releases of *p*-dichlorobenzene partition between environmental compartments (air, water, soil, sediment). The model predicts the partitioning of a substance released to air, water, soil, and sediment and identifies important partitioning processes. The Level III Fugacity model is a steady-state, non-equilibrium model that includes the processes of degradation, advection (flow out of the evaluative environment) and intermedia transfer. Physical and chemical properties used as input to the model are described in Section 2 and summarized in Table 2-1. Additionally, environmental fate properties from Table 3-1 were used as inputs to the model, which was run holding the environmental release steady at a default rate of 1,000 kg/hour but varying the receiving media (*i.e.,* air, water, soil). Releases were modeled for 1,000 kg/hour simultaneously to air, soil, and water (33% of release each) and 1,000

kg/hour released only to air, soil, or water (100% of release each). TRI releases for 2023 (95.2% of release to air, 5.7% release to land, and <1% release to water) were also modeled (Figure 3-1).
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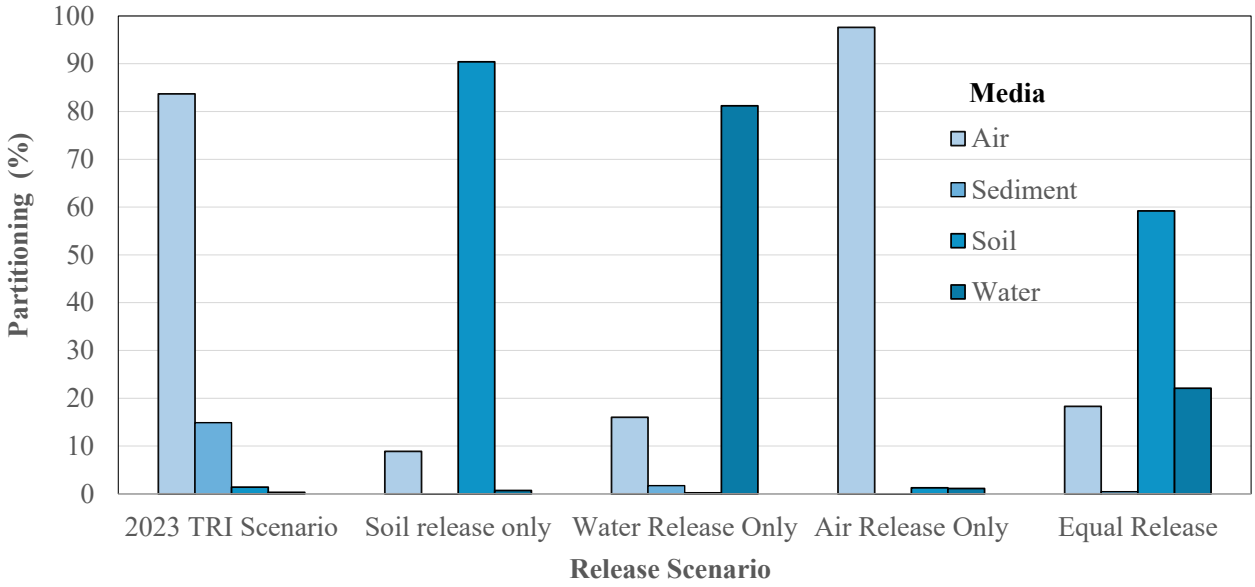

Figure 3-1. EPI Suite™ Level III Fugacity Modeling for *p*-Dichlorobenzene Showing Partitioning from Different Media Release Scenarios Assuming Constant Release
Modeling used half-life (t½) values of 30 days in air, 22 days in water, and 44 days in soil.

Fugacity modeling supports that *p*-dichlorobenzene will minimally partition out of release media. If released as air emissions, *p*-dichlorobenzene will predominantly stay in air; if *p*-dichlorobenzene is released to water or soil, *p*-dichlorobenzene will predominantly stay in water or soil, respectively (assuming constant release). Thus, minimal partitioning among media is expected. Based on the releases outlined in this document (Section 3), approximately 93% of *p*-dichlorobenzene is released to air, approximately 3% is released to land, and approximately 2% releases to surface water. However, *p*-dichlorobenzene is highly volatile and low soluble in water; as a result, it tends to volatilize to air rather than accumulate in the water. Therefore, *p*-dichlorobenzene would be expected to primarily be in air. However, release to soil (*i.e.,* land) is through landfills which are assumed to be impermeable. There are no direct releases to land. The fugacity modeling from EPI Suite™ supports the classification of air as the major compartment for *p*-dichlorobenzene given the disposal pattern documented by TRI (Section 3). Although air deposition to soil and water might occur, it is not expected to be significant (Section 4).

Once in the environment, *p*-dichlorobenzene is not expected to undergo rapid (*i.e.,* within hours) degradation in air, water, soil, or sediment. Based on results from EPI Suite™ BIOWIN, little biodegradation in aerobic or anaerobic sediments and soils is expected (not readily biodegradable). Further, there is relatively slow reaction with hydroxyl radicals ($t_{1/2}$ = 32.33 days, AOPWIN) and no hydrolysable functional groups. These metrics indicate *p*-dichlorobenzene may be persistent in the environment. Due to the physical and chemical properties of *p*-dichlorobenzene (Table 2-1), it is expected to volatilize from soil and other surfaces. Further, there is low to moderate potential for sorption to organic matter (log K_{OC} = 3.0). There is some potential for long-range transport in air given the limited degradation pathways and persistence in air. The characteristic travel distance (CTD) informs the potential for long-range transport. The CTD was calculated at 16,376 km using the Level III Fugacity Model in EPI Suite™. *p*-Dichlorobenzene is expected to remain largely in the vapor phase.

3.4 Transformation Processes

p-Dichlorobenzene can undergo various transformation processes in environmental media that affect persistence and retention within the environment. Transformation processes include biodegradation, photolysis, and hydrolysis. Potential anaerobic transformation products include chlorobenzene and benzene; potential aerobic transformation products include dichlorocatechols, chloroacids, and simple acids.

3.4.1 Biodegradation

Biodegradation can be an important transformation process in aerobic conditions, but not anaerobic conditions—though volatilization is a competing process. Specifically, some biodegradation of *p*-dichlorobenzene will occur under aerobic conditions with measured half-life ranging from 9 to 35 days (Dermietzel and Vieth, 2002; Nielsen et al., 1996; Nielsen and Christensen, 1994). Specifically, biodegradation rates measured *in situ* for *p*-dichlorobenzene in an aerobic aquifer yielded a rate constant of 0.06 day^{-1} ($t_{1/2}$ = 12–35 days) with a lag time of 0 to 20 days under an observed two-stage degradation (Nielsen et al., 1996). Aerobic degradation rates in groundwater and sediment laboratory experiments also yielded two-stage degradation with 0 to 7 days lag and measured half-life of 9 to 16 days (Nielsen and Christensen, 1994).

Negligible biodegradation of *p*-dichlorobenzene is expected under anaerobic conditions. In anaerobic sediment and groundwater, half-life of *p*-dichlorobenzene is up to 365 days (Dermietzel and Vieth, 2002; Susarla et al., 1998; Masunaga et al., 1996). Similarly, in anaerobic soils, *p*-dichlorobenzene biodegradation ranges from undetectable (Brunsbach and Reineke, 1994) to approximately 38% in 241 days (Demirjian et al., 1987). However, if acclimated, *p*-dichlorobenzene degrading cultures have been found to decrease concentrations by up to 61% (Lee et al., 2003).

3.4.2 Photolysis and Hydrolysis

p-Dichlorobenzene is not expected to undergo extensive transformation processes in the environment. Direct photolysis and hydrolysis are not expected due to a lack of chromophores that absorb at wavelengths exceeding 290 nm or hydrolysable functional groups, respectively. Limited data suggest that indirect photolysis of *p*-dichlorobenzene in air and water is possible though not a significant transport pathway (Kochany and Bolton, 1992; Wahner and Zetzsch, 1981), with a half-life of approximately 1 month for both processes. *p*-Dichlorobenzene quantitative structure-activity relationship (QSAR) models have estimated rate constants for ·OH reaction at 3.3×10^{-12}, though reactions with ozone and nitrates were found to be negligible indicating that *p*-dichlorobenzene is minimally reactive in air (Grosjean, 1990; Wahner and Zetzsch, 1981).

Indirect photolysis of *p*-dichlorobenzene in surface waters is also expected to be an insignificant pathway (Howard et al., 1991).

3.5 Media Assessments

3.5.1 Air and Atmosphere

Chemical reactions important to atmospheric degradation of chemicals include reaction with hydroxyl (·OH), nitrate (NO_3), and ozone (O_3) radicals as well as photolysis. Reactions with ozone or other common atmospheric species are not expected to be significant. Additionally, direct photodegradation is not expected to occur due to a lack of chromophores and hydrolysis will not occur due to the lack of hydrolysable functional groups. The main degradation pathway for *p*-dichlorobenzene in air is via photochemically generated hydroxyl radicals. *p*-Dichlorobenzene QSAR models have estimated rate

constants for ·OH reaction at 3.3×10^{-12} and reactions with ozone and nitrates were found to be negligible indicating that *p*-dichlorobenzene is minimally reactive in air (half-life ≈30 days, range 20–31 days) (Grosjean, 1990).

Releases of *p*-dichlorobenzene to air are detailed in Section 3 and measured concentrations of *p*-dichlorobenzene in air across the United States from monitoring databases and systematic review are detailed in Section 5.2.

3.5.2 Aquatic Environments

p-Dichlorobenzene does not undergo hydrolysis because it does not contain hydrolysable functional groups (NLM, 2014; Lyman et al., 1990).

Photolysis of nitrate and nitrite in surface water can lead to the formation of hydroxyl radicals, which can, in turn, react with *p*-dichlorobenzene. However, there is some uncertainty as to the likelihood of these reactions due to the volatility of *p*-dichlorobenzene. Limited data suggest that indirect photolysis of *p*-dichlorobenzene in air and water is possible, though not a significant transport pathway (Kochany and Bolton, 1992; Wahner and Zetzsch, 1981), with a half-life of approximately 1 month for both processes.

p-Dichlorobenzene in surface water is expected to volatilize given its physical and chemical properties (Table 2-1). EPI Suite™ estimated volatilization half-life from water ranged from 1.53 hours in a model river to 4.93 days in a model lake. These volatilization half-lives are based on a depth of 1 m, wind velocity of 5 m/s, and current velocity of 1 m/s for the model river, and a depth of 1 m, wind velocity of 0.5 m/s, and current velocity of 0.05 m/s for the model lake. Other inputs to EPI Suite™ are listed in (Table 2-1).

Biodegradation may be an important transformation process in aerobic conditions, but not anaerobic conditions, though volatilization is a competing process. Specifically, some biodegradation of *p*-dichlorobenzene will occur under aerobic conditions with measured half-life ranging from 9 to 35 days (Dermietzel and Vieth, 2002; Nielsen et al., 1996; Nielsen and Christensen, 1994) depending on conditions. Specifically, biodegradation rates measured *in situ* for *p*-dichlorobenzene in an aerobic aquifer yielded a rate constant of 0.06 day^{-1} ($t_{1/2}$ = 12–35 days) with a lag time of 0 to 20 days under an observed two-stage degradation (Nielsen et al., 1996). Aerobic degradation rates in groundwater and sediment laboratory experiments also yielded two-stage degradation with 0 to 7 days lag and measured half-life of 9 to 16 days (Nielsen and Christensen, 1994). Negligible biodegradation of *p*-dichlorobenzene is expected under anaerobic conditions. In anaerobic sediment and groundwater, half-life of *p*-dichlorobenzene is 365 days or more (Dermietzel and Vieth, 2002; Susarla et al., 1998; Masunaga et al., 1996).

Releases of *p*-dichlorobenzene to water are detailed in Section 3 and measured concentrations of *p*-dichlorobenzene in water across the United States from monitoring databases and systematic review are detailed in Section 5.3.

3.5.3 Terrestrial Environments

p-Dichlorobenzene is expected to have low to medium mobility in soil (log K_{OC} = 3.0) with volatilization being the primary transport mechanism for *p*-dichlorobenzene in soils (OECD, 2001). *p*-Dichlorobenzene is not expected to undergo indirect photodegradation in soil. Further, no significant biodegradation is expected, particularly under anaerobic conditions (Brunsbach and Reineke, 1994; Kirk et al., 1989; Kuhn et al., 1985; Tabak et al., 1964).

Although air deposition to soil may occur, it is not expected to be significant (Section 4). Due to the physical and chemical properties of *p*-dichlorobenzene (Table 2-1), it is expected to volatilize from soil and other surfaces. Additionally, there is low-to-moderate potential for sorption to organic matter (log K_{OC} = 3.0).

Releases of *p*-dichlorobenzene to land are detailed in Section 3, whereas measured concentrations of *p*-dichlorobenzene in soils and groundwater across the United States from monitoring databases and systematic review are detailed in Section 5.3.

3.6 Persistence Potential of *p*-Dichlorobenzene

p-Dichlorobenzene may persist in the environment though it volatilizes from water and land and has low degradation in all environmental media. Based on results from BIOWIN™, which is an EPI Suite™ sub-model that estimates the probability of rapid aerobic and anaerobic biodegradation of an organic compound in the presence of mixed populations of environmental microorganisms, low rates of biodegradation are expected in aerobic environments but no significant biodegradation is expected in anaerobic environments. Volatilization half-life from water is estimated to range from 1 hour in rivers to 5 days in lakes. In the atmosphere, there is reaction with hydroxyl radicals ($t_{1/2}$ = 26.7 days, AOPWIN™). These metrics suggest *p*-dichlorobenzene may be persistent in the environment.

3.6.1 Destruction and Removal Efficiency

The Clean Air Act 40CFR part 63, subpart EEE—National Emission Standards for Hazardous Air Pollutants from Hazardous Waste Combustors—requires all hazardous waste combustors, hazardous waste incinerators, hazardous waste cement kilns, hazardous waste lightweight aggregate kilns, hazardous waste solid fuel boilers, hazardous waste liquid fuel boilers, and hazardous waste hydrochloric acid production furnaces to achieve a destruction and removal efficiency (DRE) of 99.99% for each principle organic hazardous constituent (POHC)—including *p*-dichlorobenzene. Although no DRE values for *p*-dichlorobenzene were identified, it is expected to be 99.99%.

3.6.2 Removal in Wastewater Treatment

Due to the volatility of *p*-dichlorobenzene, only small amounts are expected to enter wastewater treatment plants (WWTPs). The small amounts that enter WWTPs are expected to be removed primarily by volatilization and possibly some biodegradation. Direct assessments of wastewater treatment have shown a majority of *p*-dichlorobenzene (80–99%) is removed via volatilization and adsorption (Matter-Müller et al., 1980) with a half-life of 32 days (Kirk et al., 1989).

The EPI Suite™ (U.S. EPA, 2012) STPWIN sub-model was run using default settings (biodegradation half-life was set to 10,000 hours to evaluate degradation based on abiotic processes alone) and *p*-dichlorobenzene physical and chemical properties outlined in Table 2-1 to evaluate its potential to volatilize to air or adsorb to sludge during wastewater treatment. EPI Suite™ STPWIN modeling estimated 52.1% removal with 6.1% sludge adsorption further highlighting that volatilization is a primary pathway for environmental fate of *p*-dichlorobenzene.

3.7 Bioaccumulation Potential of *p*-Dichlorobenzene

Measured BCF values ranged across several orders of magnitude from 7.1 in bluegill adult fish to 17,000 in rainbow trout eggs (Table 3-3). Thus, estimates were dependent on organism life stage as well as species, taxonomic group, and exposure conditions. An invertebrate study (*Chironomid*) under steady-state conditions measured a BCF of 159 after 5.25 hours *p*-dichlorobenzene exposure that

increased to a BCF of 270 after 16.25 hours of exposure (Mcintyre, 1988). Similarly, in rainbow trout, BCF increased with exposure time under steady-state conditions (Oliver and Niimi, 1983).

p-Dichlorobenzene has low potential to bioaccumulate in organisms based on these measured BCF values. However, depuration of *p*-dichlorobenzene from organisms is known to be rapid and limits any sustained bioaccumulation within an organism, or biomagnification across organisms (Barrows et al., 1980; Veith et al., 1980). Thus, any bioaccumulation of *p*-dichlorobenzene upon exposure is not retained within the organism (elimination <5 days, (Oliver and Niimi, 1983; Veith et al., 1980)).

The EPI Suite™ (U.S. EPA, 2012) BCFBAF sub-model (formerly known as BCFWIN) indicated low potential for *p*-dichlorobenzene bioaccumulation in the environment with an estimated log BCF of 1.8 (BCF = 62.8 L/kg wet-wt). The bioconcentration factor regression-based estimate was 62.83 L/kg wet-weight and the biotransformation half-life normalized to 10 g fish was 2.97 days.

Table 3-3. Bioconcentration Values for *p*-Dichlorobenzene

Endpoint	Organism	Value(s)	Reference(s)	Data Quality Ranking
Bioconcentration factor (BCF, whole organism)	Fish, Bluegill	60	Barrows et al. (1980)	High
	Fish, Rainbow trout	85–112	Calamari et al. (1982)	High
	Fish, Fathead minnow	110	Carlson and Kosian (1987)	High
	Fish, Mosquito fish	78	Chaisusant et al. (1997)	High
	Fish, Bluegill	7.1–11.7	Dow Chemical (1982)	High
	Fish, Rainbow trout (eggs)	3,000–17,000	Kurosu and Crick (2009)	High
	Fish, Rainbow trout	370–720	Oliver and Niimi (1983)	High
	Invertebrate, *Chironomid* (midges)	159–270	Mcintyre (1988)	High

3.8 Overall Fate and Transport of *p*-Dichlorobenzene

Air is expected to be the primary major environmental compartment for *p*-dichlorobenzene due to releases patterns (Section 3) and physical and chemical properties (Section 2) (Figure 3-2). It is minimally degraded via abiotic and biotic processes once in the environment. Half-life in the atmosphere by reaction with photochemically-produced hydroxyl radicals is approximately one month. Based on an estimated octanol-air partition coefficient (K_{OA}) of 4.44 to 4.45, *p*-dichlorobenzene is not expected to associate strongly with airborne particulates; hence, it is not expected to undergo significant deposition to water or land (Section 4). It is expected to remain largely in the vapor phase where it will undergo degradation.

There is some potential for long-range transport of *p*-dichlorobenzene in air given the limited degradation pathways and persistence in air. Specifically, the characteristic travel distance (CTD) informs potential for long range transport. The CTD was calculated using the Level III Fugacity Model in EPI Suite™ at 16,376 km. Overall, *p*-dichlorobenzene is primarily released to air and will generally remain in air with limited partitioning or transformation though volatilization from water and soil will occur.

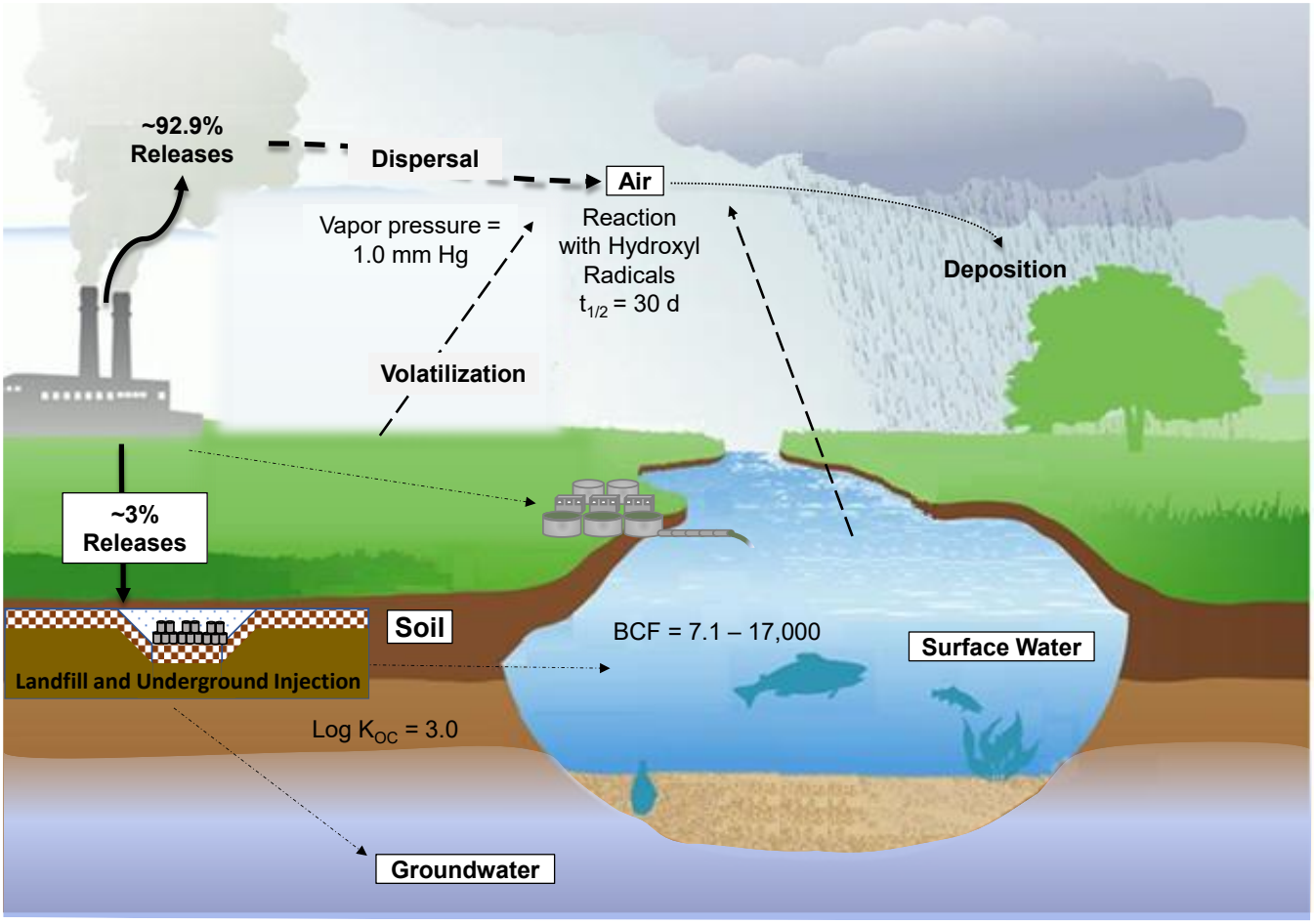

Figure 3-2. Transport, Partitioning and Degradation of *p*-Dichlorobenzene in the Environment. The diagram depicts the release, distribution, transport and partitioning of *p*-dichlorobenzene in the environment. The width of the arrow is a qualitative indication of relative amounts of movement (*i.e.,* wider arrows indicate more likely partitioning).

Based on the release of *p*-dichlorobenzene to the atmosphere, air is expected to be primary pathway of exposure. Low release amounts to water as well as volatility means the water pathway is not expected to be a significant pathway of exposure. Sediments and soil are also not expected to be major pathways for *p*-dichlorobenzene based on low partition coefficients to organic matter. There is some potential for bioaccumulation of *p*-dichlorobenzene in biota though depuration is rapid and no trophic transfer is expected.

3.9 Weight of Scientific Evidence Conclusions for Fate and Transport

Evaluation of the Weight of the Scientific Evidence for the fate and transport of *p*-dichlorobenzene is shown below and is based on categorization described in the 2021 *Draft Systematic Review Protocol Supporting TSCA Risk Evaluations* (U.S. EPA, 2021a). There is robust evidence showing that *p*-dichlorobenzene will

- volatilize from soil and water surfaces;
- not hydrolyze significantly in water; and
- minimally partition to soil, sediment, or organic matter.

There is moderate evidence showing that *p*-dichlorobenzene will

- undergo indirect photodegradation in air;

- biodegrade in aerobic conditions;
- not biodegrade in anaerobic conditions; and
- have low bioaccumulation potential.

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

There is generally limited evidence on the fate of *p*-dichlorobenzene in the environment. This lack of data creates some uncertainty. Nevertheless, EPA has high confidence in our assumptions about the fate of *p*-dichlorobenzene in the environment based on its physical and chemical properties, environmental release data, and monitoring data.

Half-lives of *p*-dichlorobenzene in air can vary significantly under different environmental conditions, which result in spatio-temporal variation in degradation rates that contribute to uncertainty. For instance, greater residence times of *p*-dichlorobenzene are expected in colder, cloudy conditions.

The fate assessment of *p*-dichlorobenzene in aquatic environments was based mainly on physical and chemical data as well as estimated properties and release data. Volatilization and biodegradation are key processes in the fate of *p*-dichlorobenzene in water; however, no available data was found measuring the direct volatilization of *p*-dichlorobenzene from water and sediments. Estimations of volatilization using EPI Suite™ are based on a shallow model river and lake; volatilization may be much lower for deeper water bodies.

Estimated and measured data of potential bioaccumulation of *p*-dichlorobenzene varied several orders of magnitude due to the physical and chemical conditions as well as the differences among organisms. No studies were available for potential bioaccumulation of *p*-dichlorobenzene by terrestrial organisms. Exposure is not expected to be significant in aquatic ecosystems, but there is potential exposure to terrestrial organisms via ambient air. Therefore, there is some uncertainty around bioaccumulation in terrestrial organisms. Furthermore, there is limited data on depuration of *p*-dichlorobenzene though we have high confidence in the assumption that bioaccumulation potential is low for aquatic species due to low exposure.

4 RELEASE ASSESSMENT

4.1 Occupational Exposure Scenarios

EPA assessed environmental releases and occupational exposures for the COUs as described in Table 2-1 of the *Draft Risk Evaluation for p-Dichlorobenzene* (U.S. EPA, 2026w). These COUs are also listed in Table 4-1 below. 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." EPA identifies COUs for chemicals during the scoping phase and presents them in the *Final Scope of the Risk Evaluation for p-Dichlorobenzene* (U.S. EPA, 2020c), though the COUs presented may change between the scope document and the risk evaluation itself as the assessment is conducted and more information about the chemical is gathered. Each COU is a unique combination of Lifecycle Stage, Category(ies), and Subcategory(ies) that describes the chemical's use. As shown in Table 4-1, EPA has identified a total of 23 COUs for *p*-dichlorobenzene under TSCA.

Each COU for *p*-dichlorobenzene was assigned an OES that characterizes its release and exposure potential. although named for their utility when assessing occupational exposure, these scenarios are also used when assessing environmental releases from industrial and commercial facilities. "OES" is a term that describes the grouping or segmenting of COUs for assessment of releases and exposures. For example, EPA may assess a group of multiple COUs together as one OES due to similarities in release and exposure sources, worker activities, and use patterns. Alternatively, the Agency may assess multiple OESs for one COU because there are different release and exposure potentials within a given COU. OES determinations are largely driven by the availability of data and available 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, EPA would not group them into the same OES. For each OES, environmental releases and occupational exposure results are provided and are expected to be representative of the sites and population of workers for the given OES in the United States. Figure 4-1 depicts the ways that COUs may be mapped to OESs.

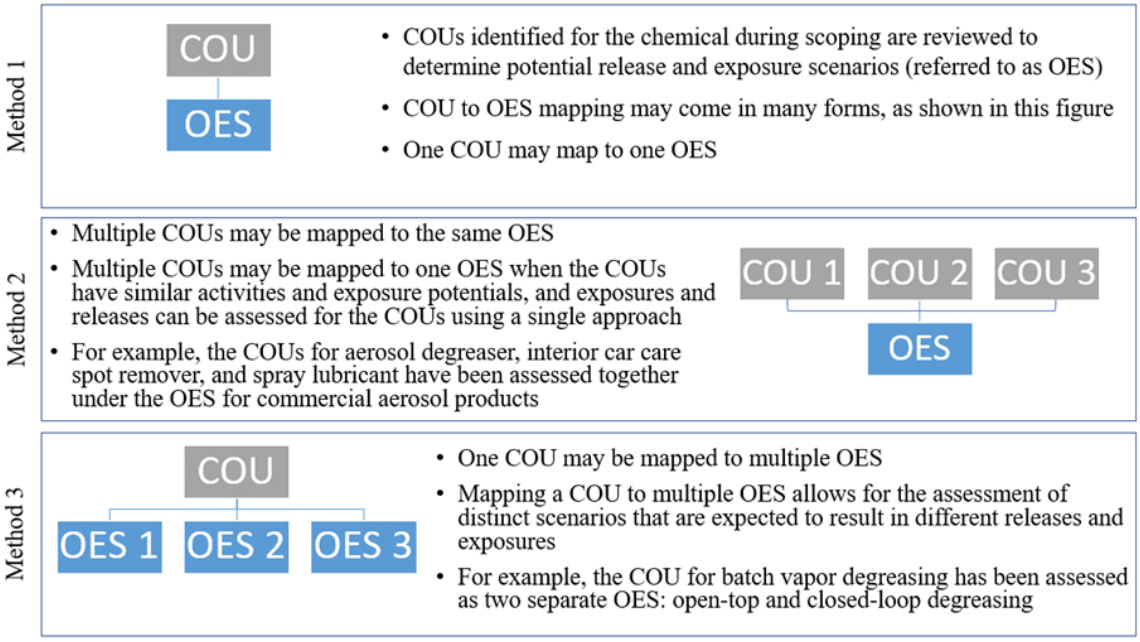

Figure 4-1. Conditions of Use to Occupational Exposure Scenario Mapping

Table 4-1 shows the mapping between the COUs in Table 2-1 of the *Draft Risk Evaluation for p-Dichlorobenzene* (U.S. EPA, 2026w) to the OESs assessed in this document. For *p*-dichlorobenzene, EPA mapped OESs to COUs based on information gathered during systematic review, test orders collected under TSCA section 4, industry outreach, and public comments. Several of the COU categories and subcategories were grouped and assessed together in a single OES due to similarities in the processes or lack of data to differentiate between them. For example, the COUs with subcategories of "Importing" and "Repackaging" are both assessed under the Repackaging OES. This grouping minimized repetitive assessments. A total of 16 unique OESs were identified. Table 4-1 lists each COU (defined by its unique combination of a life cycle stage, category, and subcategory) and its corresponding OES(s) for *p*-dichlorobenzene.

Table 4-1. Crosswalk of *p*-Dichlorobenzene Conditions of Use (COUs) to Occupational Exposure Scenarios (OESs) Assessed

Life Cycle Stage[a]	Category[b]	Subcategory[c]	Occupational Exposure Scenario
Manufacturing	Manufacture	Domestic manufacture	Manufacturing
	Import	Import	Repackaging
Processing	Processing as a reactant	Processing as a reactant	Processing as a Reactant
	Processing – Incorporation into formulation, mixture or reaction product	Solvents (which become part of product formulation or mixture)	Incorporation into Formulation, Mixture, Or Reaction Product
		Plastics compounding	Plastic Compounding
		Soap, cleaning compound, and toilet preparation manufacturing	Incorporation into Air Care Products
	Processing – Incorporation into article	Plastic product manufacturing	Plastic Converting
		Other	Incorporation into Grinding Wheels
	Recycling	Recycling	Processing as a Reactant
	Repackaging	Repackaging	Repackaging
Distribution in commerce	Distribution in commerce	Distribution in commerce	Distribution in Commerce[d]
Industrial use	Solvents (which become part of product formulation or mixture)	Synthetic dye and pigment manufacturing	Processing as a Reactant
	Functional fluids (closed system)	All other basic organic chemical manufacturing	Use in Functional Fluids
Commercial use	Air care products	Continuous action air fresheners	Use in Air Care Products
	Lubricants and greases	Lubricants and greases	Application of Lubricants And Greases[e]

Life Cycle Stage[a]	Category[b]	Subcategory[c]	Occupational Exposure Scenario
	Fuels and related products	Fuel additive	Use as Fuel Additive[e]
	Other use	Laboratory chemicals	Use as Laboratory Chemical
	Building and construction products	Sealant	Application of Sealant
Consumer use	Building and construction products	Sealant	Not Applicable[f]
	Air care products	Continuous action air fresheners	
	Lubricants and greases	Lubricants and greases	
	Fuels and related products	Fuel additive	
Disposal	Disposal	Disposal	Waste Handling, Treatment, and Disposal

[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 COU appear in the life cycle diagram, reflect CDR codes, and broadly represent COUs of *p*-dichlorobenzene in industrial and/or commercial settings.

[c] These subcategories reflect more specific COUs of *p*-dichlorobenzene.

[d]. For the purpose of this risk evaluation, distribution in commerce is the transportation of *p*-dichlorobenzene and *p*-dichlorobenzene-containing products between sites at which *p*-dichlorobenzene manufacturing, processing, and use occurs or the transportation of *p*-dichlorobenzene -containing wastes for recycling or disposal. EPA expects all of the above mentioned materials to be transported in closed system or otherwise to be transported in a form (*e.g.,* articles containing *p*-dichlorobenzene) such that there is negligible potential for occupational exposure except during an incident

[e] Although these uses were identified during scoping, upon further investigation EPA made the decision to not quantitatively assess these uses of *p*-dichlorobenzene due to low expected exposure and releases. For a description of the rationale for not performing a quantitative assessment, and details for each decision, see Section 4.3.15.

[f] Consumer uses are not assigned to an OES as they are not part of the occupational assessment. See Section 7 for information on the consumer exposure assessment.

After identifying those OESs that will be assessed, the next step was to describe the function of *p*-dichlorobenzene within each OES. This information is utilized in mapping release and exposure data to an OES as well as applying modeling approaches. Table 4-2 is a summary; for more information on each OES see the corresponding process descriptions in Section 4.3.

Table 4-2. Description of the Function of *p*-Dichlorobenzene for Each OES

OES	Role/Function of *p*-Dichlorobenzene
Manufacturing	This OES captures the Manufacturing COU category. *p*-Dichlorobenzene is manufactured as a byproduct during the production of other chemicals such as vinyl chloride monomer (VCM). EPA is not aware of any facility in the United States that intentionally manufactures this chemical. *p*-Dichlorobenzene byproduct manufacturing was evaluated in the context of domestic VCM production {Exponent Inc, 2024, 13170985}. In this process, *p*-dichlorobenzene is separated from the intended product and managed as waste via incineration.
Repackaging	This OES captures the Import and Repackaging COU categories. Import and repackaging sites are expected to distribute *p*-dichlorobenzene to various downstream uses. *p*-Dichlorobenzene is shipped either in molten form in heated, insulated steel tank cars or in flake or granular solid form in sealed containers such as paper bags, fiber packs, or drums.
Processing as a Reactant	This OES captures the Processing as a reactant and Recycling COU categories and the Synthetic dye and pigment manufacturing COU subcategory. *p*-Dichlorobenzene is used as a feedstock in the manufacture of several products such as the high-performance thermoplastic polyphenylene sulfide (PPS), 1,2,4-trichlorobenzene, and insecticide intermediates. *p*-Dichlorobenzene was also once used as an intermediate in the manufacture of certain dyes. This OES also encompasses when *p*-dichlorobenzene is recovered from a generated waste stream and recycled back into the feedstock, an activity that often occurs in scenarios like processing as a reactant.
Incorporation into Formulation	This OES captures the Solvents (which become part of product formulation of mixture) COU subcategory within the processing life cycle stage. *p-D*ichlorobenzene is incorporated into formulations to create products such as functional fluids, fuels, laboratory standards, and sealants.
Plastic Compounding	This OES captures part of the Plastics compounding COU subcategory within the processing life cycle stage. *p*-Dichlorobenzene is used to make PPS resin, which may contain residual *p*-dichlorobenzene as it is used in the plastic compounding process.
Incorporation into Air Care Products	This OES captures the Soap, cleaning compound, and toilet preparation manufacturing COU subcategory. *p*-Dichlorobenzene is present in some space, toilet bowl, and garbage deodorants at concentrations up to 100% by weight. Due to its volatility, density, pleasant odor, and solid nature at room temperature, it is used alone or in combination with disinfectant substances to produce deodorants in a variety of continuous evaporation forms, most commonly solid air deodorizers and toilet blocks.

OES	Role/Function of *p*-Dichlorobenzene
Plastic Converting	This OES captures part of the Plastic product manufacturing COU sub-category. *p*-Dichlorobenzene is used to make PPS resin that is compounded and then converted to plastic products. Residual *p*-dichlorobenzene may be present throughout this process.
Incorporation into Grinding Wheels	This OES captures part of the Other sub-category within the Processing – incorporation into article COU category. *p*-Dichlorobenzene is used as a temporary pore producing material in resin-bonded abrasive grinding wheel manufacturing plants, where it may be present during the manufacturing of the wheel and in the product as a residual.
Distribution in Commerce	This OES captures the Distribution in commerce COU category. *p*-Dichlorobenzene is expected to be distributed in commerce for the purposes of each processing, industrial, and commercial use of the chemical. EPA expects *p*-Dichlorobenzene to be transported from manufacturing sites to downstream processing and repackaging sites.
Use in Functional Fluids	This OES captures the Function fluids (closed system) COU category. *p*-Dichlorobenzene is used in a mixture with *o*-dichlorobenzene as a coolant in a closed system in the manufacture of some organic chemicals.
Use in Air Care Products	This OES captures the Air care products COU category within the commercial use life cycle stage. *p*-Dichlorobenzene is used in air car products such as antimicrobial products, bathroom cleaners, urinal and toilet deodorants, and deodorizing wall blocks. In several cases such as in use in toilet and urinal products *p*-dichlorobenzene is an active ingredient and may be present in a nearly pure form.
Application of Lubricants and Greases	This OES captures the Lubricants and greases COU category within the commercial use life cycle stage. *p*-Dichlorobenzene has been reported as a component of automotive engine oils, and oils used to maintain tools. A single relevant product was identified, and although *p*-dichlorobenzene is indicated to be present in amounts less than 0.1%, the company informed EPA in a public comment that the *p*-dichlorobenzene within these products exists only as a contaminant of *o*-dichlorobenzene, which is present in the products at 0.12% (EPA-HQ-OPPT-2018-0446-0028). Due to these low expected amounts of *p*-dichlorobenzene in the product, EPA expects that exposures via this OES are negligible compared to hazard thresholds and thus did not quantitatively assess this use.
Use as Fuel Additive	This OES captures the Fuel additive COU category within the commercial use life cycle stage. *p*-Dichlorobenzene was also indicated to be present in some fuel additive products that are marketed to the aerospace community but not widely used. A single relevant product was identified, and although *p*-dichlorobenzene is indicated to be

OES	Role/Function of *p*-Dichlorobenzene
	present in amounts less than 0.1%, the company informed EPA in a public comment that the *p*-dichlorobenzene within these products exists only as a contaminant of *o*-dichlorobenzene, which is present in the products at 0.12% (EPA-HQ-OPPT-2018-0446-0028). Due to these low expected amounts of *p*-dichlorobenzene, EPA expects that exposures via this OES are negligible compared to hazard thresholds and thus did not quantitatively assess this use.
Use as Commercial Laboratory Chemical	This OES captures the laboratory chemicals COU category within the commercial use life cycle stage. EPA has identified several cases of *p*-dichlorobenzene in use as a laboratory chemical. One commenter provided descriptions of their use of *p*-dichlorobenzene as a reference sample for analysis of terrestrial and extraterrestrial material samples and in laboratory applications for analytical standards, research, equipment calibration and sample preparation. Several products intended for laboratory use were also found, indicating *p*-dichlorobenzene present in both neat form (Sigma-Aldrich, 2024) and within a formulation at up to 1% (Supelco, 2025).
Application of Sealants	This OES captures the Sealant COU category within the commercial use life cycle stage. *p*-Dichlorobenzene was identified in several building sealant products, which are in the form of spray-foam sealants that fill gaps for the purposes of pest control and reducing drafts in the home.
Disposal	This OES captures the Disposal COU category within the commercial use life cycle stage. Each of the OESs may generate waste streams of *p*-dichlorobenzene that are collected and transported to third-party sites for disposal or treatment, and these cases are assessed under this OES.

EPA reviewed release data from TRI from 2019 to 2023 (U.S. EPA, 2023e), NEI from 2017 and 2020 (U.S. EPA, 2020d), and DMR from 2019 to 2023 (U.S. EPA, 2023c) to identify relevant releases of *p*-dichlorobenzene to the environment. One more recent year of TRI data has become available since the completion of this analysis—the data for year 2024. EPA reviewed the total TRI air releases from this year and found that the releases from 2024 fell within the range of releases that occurred from 2019 to 2023. Although these databases sufficiently informed industrial and processing COUs, the databases are limited in data on environmental releases for commercial COUs. These databases may not identify all *p*-dichlorobenzene releases as some facilities may not be required to report due to reporting thresholds.

EPA's assessment of releases includes quantifying annual and daily releases of *p*-dichlorobenzene to air, water, and land. Releases to air include both fugitive and stack air emissions and emissions resulting from on-site waste treatment equipment, such as incinerators. Releases to water include both direct discharges from industrial facilities to surface water and indirect discharges to publicly owned treatment works (POTW) or non-POTW wastewater treatment (WWT). Note that indirect discharges are not released directly into the environment but instead transported to wastewater treatment plants. Releases to land include any disposal of liquid or solids wastes containing *p*-dichlorobenzene into landfills, land treatment, surface impoundments, or other land applications. Read more about *p*-dichlorobenzene's fate in each release medium in Section 3.

The purpose of this section is to quantify releases. Environmental fate and transport of *p*-dichlorobenzene is discussed in the Section 3, and exposure estimates to the general population and ecological species are discussed in Section 6.

Note that in this assessment EPA used a screening approach, where first releases from TRI, the highest release from DMR, and the highest release from NEI were assessed. If the MOEs calculated from these releases were above the benchmark MOE for the environment and general population, EPA did not seek to estimate releases further. Because all MOEs were above the benchmark MOE as a result of this assessment, some OESs did not receive comprehensive release estimates since EPA expects the releases in these cases to be lower than those releases that reported to the databases, and thus no MOEs below the benchmark would be expected.

4.2 Approach and Methodology

An environmental release assessment was conducted for each OES specified in Table 4-1 and are presented in Section 4.3. Each section contains the following components:

- ***Process Description:*** A description of the OES, including (as available) the function of the chemical in the OES; physical forms and weight fractions of the chemical throughout the process; the total production volume (PV) associated with the OES; per site throughputs/use rates of the chemical; operating schedules; and process vessels, equipment, and tools used during the COU.
- ***Estimates of Number of Facilities and Release Days:*** An estimate of the number of sites that use *p*-dichlorobenzene and an estimate of the number of days per year a release of the chemical may occur for the given OES.
- ***Environmental Release Sources:*** A description of each of the potential sources of environmental releases to air in the process for the given OES.
- ***Environmental Release Assessment Results:*** Estimates of chemical released into each environmental media (surface water, POTW, non-POTW WWT, fugitive air, stack air, and land disposal).

For those OESs that were not quantitatively assessed, the relevant discussions can be found in Section 4.3.15. For the remainder of this section, the approach and methodology for completing each of the above listed components is described in more detail.

4.2.1 Process Descriptions

EPA performed a literature search to find descriptions of processes involved in each OES. When data were available to do so, the Agency included the following information in each process description:

- total PV associated with the OES;
- facility operating schedules (*e.g.,* year-round, 5 days/week, batch process, continuous process, multiple shifts)
- key process steps;
- physical form and weight fraction of the chemical throughout the process steps;
- information on receiving and shipping containers; and
- ultimate destination of chemical leaving the facility.

Where *p*-dichlorobenzene-specific process descriptions were unclear or not available, EPA referenced generic process descriptions from literature, including relevant emission scenario documents (ESDs) or generic scenarios (GSs). Process descriptions for each OES can be found in Section 4.3.

4.2.2 Number of Facilities

To estimate the number of facilities within each OES, the Agency used a combination of bottom-up analyses of EPA-reporting programs and top-down analyses of U.S. economic data and industry-specific data. Generally, the Agency used the following steps to develop facility estimates:

1. Identify or "map" each facility reporting for *p*-dichlorobenzene in the 2016 and 2020 CDR (U.S. EPA, 2020a, b, 2019a), 2019 to 2023 TRI (U.S. EPA, 2026a, t), 2019 to 2023 DMR (U.S. EPA, 2026z), and 2017 and 2020 NEI (U.S. EPA, 2026a) to an OES. The full details of the methodology for mapping facilities from EPA reporting programs is described in Appendix D. In brief, mapping consists of using facility reported industry sectors (typically reported as either North American Industry Classification System (NAICS) or Standard Industrial Classification (SIC) codes), and chemical activity, processing, and use information to assign the most likely OES to each facility.

   Note that facilities may report to multiple databases under different names, and in these cases, EPA used reported addresses and company information to match facilities with their equivalents across databases but there may be uncertainty to the facility estimates due to this. Another source of uncertainty is that facilities that produce or handle *p*-dichlorobenzene may have several uses for the chemical on-site, however for the purposes of this assessment each site can only be assigned one OES.

2. Based on the reporting thresholds and requirements of each dataset, evaluate whether the data in the reporting programs are expected to cover most or all the facilities within the OES. If so, no further action was required, and EPA assessed the total number of facilities in the OES as equal to the count of facilities mapped to the OES from each dataset. If not, EPA proceeded to Step 3. OESs with quantified releases and exposures obtained the number of facilities solely from reporting programs. For ten OESs, there were no reporting sites in the databases, so EPA proceeded to Step 3 and 4.

3. Supplement the available reporting data with U.S. economic and market data using the following method:
   a. Identify the NAICS codes for the industry sectors associated with the OES.
   b. Estimate total number of facilities using the U.S. Census' Statistics of US Businesses (SUSB) data on total establishments by 6-digit NAICS.
   c. Use market penetration data to estimate the percentage of establishments likely to be using *p*-dichlorobenzene instead of other chemicals.
   d. Combine the data generated in Steps 3.a through 3.c to produce an estimate of the number of facilities using *p*-dichlorobenzene in each 6-digit NAICS code and sum across all applicable NAICS codes for the OES to arrive at a total estimate of the number of facilities within the OES. Typically, EPA assumed this estimate encompasses the facilities identified in Step 1; therefore, EPA assessed the total number of facilities for the OES as the total generated from this analysis.

4. If market penetration data required for Step 3.c. are not available, use generic industry data from GSs, ESDs, and other literature sources on typical throughputs/use rates, operating schedules, and the *p*-dichlorobenzene PV used within the OES to estimate the number of facilities. In cases where EPA identified a range of operating data in the literature for an OES, EPA used stochastic modeling to provide a range of estimates for the number of facilities within an OES. EPA provided the details of the approaches, equations, and input parameters used in stochastic modeling in the relevant OES sections throughout this draft TSD.

4.2.3 Annual Release Estimates

Releases to the environment are a component of potential exposure and may be derived from reported data that are obtained through direct measurement via monitoring, calculations based on empirical data, and/or assumptions and models. For each OES, EPA, where applicable, provided annual releases, daily releases, and the number of release days per year for each media of release (air, water, and land). Annual and daily releases are provided as central tendency and high-end estimates, which are typically estimated for datasets with six or more data points, by taking the 50th and 95th percentiles respectively of release data from all facilities within the OES. For datasets with three to five data points, EPA estimated central tendency exposure using the 50th percentile and the maximum as the high-end release point. For datasets with two data points, the Agency estimated the central tendency using the midpoint value and the higher of the two values as the high-end. Finally, for datasets with only one data point, EPA presented the single release value. The Agency notes in the relevant tables each case when these release datasets contain less than six points.

EPA used the following hierarchy in selecting data and approaches for assessing environmental releases:

1. Monitoring and measured data:
    a. Releases calculated from site-specific concentration in medium and flow rate data
    b. Releases calculated from mass balances or emission factor methods using site-specific measured data
2. Modeling approaches
3. Release limits (company specific limits, regulatory limits, etc.)

As indicated in the list above, EPA's preference was to rely on facility-specific release data reported in TRI (U.S. EPA, 2026a, t, z), NEI (U.S. EPA, 2026a), and DMR (U.S. EPA, 2026z) where available, and in the case of this risk evaluation EPA used only this monitoring and measured data. No modeling approaches or release limits were used.

For the *p*-dichlorobenzene release assessment, EPA used a tiered approach for assessing environmental releases. The first tier of this approach included an assessment of the risk to the general population and the environment from all releases reported to TRI. The highest releasing facilities from the NEI database (Forton Industries LLC, which uses *p*-dichlorobenzene to manufacture polyphenylene sulfide [PPS]), and the DMR database (Gulf Coast Waste Disposal Authority – Bayport, which disposes of *p*-dichlorobenzene) were also considered. Both releases, along with releases reported to TRI, are expected to be the largest sources of *p*-dichlorobenzene in the environment.

If the releases from TRI, DMR, or NEI resulted in MOEs below the benchmark MOE for the environment and general population, EPA would have continued to the next tier in the assessment. This would have included the use of modeling to obtain release estimates for each OES not represented in the release databases.

In the case of *p*-dichlorobenzene, MOEs were not below benchmarks for the environment or the general population due to the releases reported to TRI, or the highest releases reported to DMR and NEI. For this reason, EPA did not estimate releases from other OESs as they are expected to have lower releases of *p*-dichlorobenzene than releases that would be required to report to TRI. Release data collected from TRI can be found summarized for each OES in Section 4.3. Releases from DMR and NEI can be found summarized in *Draft Water Release Summary for DMR and TRI for p-Dichlorobenzene* (U.S. EPA, 2026z) and *Draft Air Release Summary and Statistics for NEI and TRI for p-Dichlorobenzene* (U.S. EPA, 2026a).

4.2.3.1 Introduction to the Data Reported to EPA

Generally, EPA used the facility-specific release data reported in TRI, DMR, and NEI as annual releases in each dataset for each site and estimated the daily release by averaging the annual release over the expected release days per year. EPA's approach to estimating release days per year is described in Section 4.2.5. The relevant supplemental files contain the calculations of the central tendency and high-end annual and daily releases for each OES where EPA databases were to estimate releases. Land release calculations are in *Draft Land Release Summary for TRI for p-Dichlorobenzene* (U.S. EPA, 2026t). Water release calculations are in *Draft Water Release Summary for DMR and TRI for p-Dichlorobenzene* (U.S. EPA, 2026z). Air release calculations are in *Draft Air Release Summary and Statistics for NEI and TRI for p-Dichlorobenzene* (U.S. EPA, 2026a).

Toxics Release Inventory (TRI)

Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) established the TRI, which tracks the waste management of designated toxic chemicals from facilities within specified industry sectors. Facilities are required to report to TRI if the facility has 10 or more full-time employees; is included in an applicable NAICS code; and manufactures, processes, or uses the chemical in quantities greater than a certain threshold (25,000 lb for manufacturers and processors and 10,000 lb for users of *p*-dichlorobenzene). 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. EPA makes the reported information publicly available through TRI.

Each facility subject to the rule must report either using a Form R or a Form A. Facilities reporting using a Form R must report annually the volume of chemical released to the environment (*i.e.,* surface water, air, or land) and/or managed through recycling, energy recovery, and treatment (*e.g.,* incineration) from the facility. Facilities may submit a Form A if the volume of chemical manufactured, processed, or otherwise used does not exceed 1,000,000 lb/year and the total annual reportable releases do not exceed 500 lb/year. Facilities reporting using Form A are not required to submit annual release and waste management volumes or use/sub-use information for the chemical. Due to reporting limitations, some sites that manufacture, process, or use *p*-dichlorobenzene may not report to TRI and are therefore not included in this draft assessment.

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.[1] Additional details on the basis for the reported release estimate (*e.g.,* calculations, underlying assumptions) are not reported in TRI.

EPA included only TRI Form R submissions in the analysis of environmental releases. For Form Rs, the Agency assessed releases using the reported annual release volumes from each media. Only one facility that reported *p*-dichlorobenzene releases to TRI submitted as Form A, and it was not included in this risk evaluation. EPA used TRI data from reporting years 2019 to 2023 to provide a basis for estimating

[1] 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).

releases (U.S. EPA, 2023e). Further details on the Agency's approach to using TRI data for estimating releases are described in the following subsections, Appendix D and Appendix F.

EPA obtained 2019 to 2023 TRI data for *p*-dichlorobenzene from EPA's Basic Plus Data Files. The Agency followed a similar approach to estimate air, water, and land releases. The Agency used the reported annual releases directly as reported in TRI and then divided the annual releases over the number of estimated operating days to obtain daily average release estimates. EPA presents the release data as central tendency and high-end estimates by calculating the 50th and 95th percentiles of the releases, respectively, from all facilities mapped to a given OES. Release estimates are separated where relevant by stack and fugitive air emissions, surface water discharges, POTWs, non-POTW WWT, and land releases.

- Air emissions in TRI are reported separately for stack air and fugitive air and occur on-site at the facility. From 2019 to 2023, 22 facilities reported air emissions of *p*-dichlorobenzene, and there were 78 total reports.
- 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. A total of 0 facilities reported non-zero water releases of *p*-dichlorobenzene.
- 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. A total of 9 facilities reported non-zero land releases of *p*-dichlorobenzene with a total of 19 reports.

NEI

The NEI was established to track emissions of Criteria Air Pollutants (CAPs) and CAP precursors and assist with National Ambient Air Quality Standard (NAAQS) compliance under the CAA. Air emissions data for the NEI are collected at the state, local, and tribal (SLT) level. SLT air agencies then submit these data to EPA through the Emissions Inventory System (EIS). In addition to CAP data, many SLT air agencies voluntarily submit data for pollutants on EPA's list of hazardous air pollutants (HAPs). EPA uses the data collected from SLT air agencies, in conjunction with supplemental HAP data, to build the NEI. The Agency makes an updated NEI publicly available every three years. For this risk evaluation, EPA used NEI data for reporting years 2017 and 2020 to provide a basis for estimating releases.

NEI emissions data are categorized into (1) point source data, (2) area or nonpoint source data, (3) onroad mobile source data, and (4) nonroad mobile source data. EPA included only point source data categories in this assessment of environmental releases. See Appendix F for more information on area or nonpoint and onroad mobile sources. Point sources are stationary sources of air emissions from facilities with operating permits under Title V of the CAA, also called "major sources." Major sources are defined as having actual or potential emissions at or above the major source thresholds. While thresholds can vary for certain chemicals in NAAQS non-attainment areas, the default threshold is 100 tons/year for non-HAPs, 10 tons per year for a single HAP, or 25 tons per year for any combination of HAPs. Point source facilities include large energy and industrial sites and are reported at the emission unit- and release point-level. Further details on EPA's approach to using NEI data for estimating releases are described in Section 4.2.3.3, 0, and Appendix F.

EPA does not summarize NEI data for *p*-dichlorobenzene in this document, but a summary of releases can be found in *Draft Air Release Summary and Statistics for NEI and TRI for p-Dichlorobenzene* (U.S. EPA, 2026a).

Discharge Monitoring Report

Under the Clean Water Act, EPA regulates the discharge of pollutants into receiving waters through National Pollution Discharge Elimination System (NPDES) permits. A NPDES permit authorizes discharging facilities to discharge pollutants to specified effluent limits. There are two types of effluent limits: (1) technology-based, and (2) water quality-based. Although the technology-based effluent limits are uniform across the nation, the water quality-based effluent limits vary and are more stringent in certain areas. NPDES permits may also contain requirements for sewage sludge management.

NPDES permits apply pollutant discharge limits to each outfall at a facility. For TSCA risk evaluation purposes, EPA was interested only in the outfalls to surface water bodies. NPDES permits also include internal outfalls, but they are not included in this analysis. This is because these outfalls are internal monitoring points within the facility wastewater collection or treatment system and do not represent discharges from the facility. NPDES permits require facilities to monitor their discharges and report the results to EPA and the state regulatory agency. Facilities report these results in DMRs. EPA makes these reported data publicly available via the Agency's Enforcement and Compliance History Online (ECHO) system and Water Pollutant Loading Tool (also referred to as "Loading Tool"). The latter is a web-based tool that obtains DMR data through ECHO, presents data summaries and calculates pollutant loading (mass of pollutant discharged).

For this draft risk evaluation/assessment, EPA queried DMRs for all *p*-dichlorobenzene point source water discharges available for 2019 to 2023 (U.S. EPA, 2026z). While only the highest reported discharge was used in this assessment, a summary of all release data considered from DMR can be found in *Draft Water Release Summary for DMR and TRI for p-Dichlorobenzene* (U.S. EPA, 2026z). Further details on EPA's approach to using DMR data for estimating releases are described in Section 4.2.3.2 and Appendix E.

4.2.3.2 Approach for Estimating Water Releases from TRI and DMR

Where available, EPA used TRI and DMR to estimate annual wastewater discharges, average daily wastewater discharges, and high-end daily wastewater discharges. Water releases in TRI include both reports of annual direct discharges to surface water and annual indirect discharges to off-site POTWs and WWT facilities. Water releases in DMR considered in this assessment only include direct discharge to surface water. Direct surface water discharges are released to the environment, discharges to POTWs and WWT facilities are not directly released into the environment, but to treatment facilities.
As stated in Section 3.6.2, due to the volatility of *p*-dichlorobenzene, only small amounts are expected to enter wastewater treatment facilities. The small amounts that do enter are expected to be removed primarily by volatilization and possibly some biodegradation. Direct assessments of wastewater treatment have shown that a majority of *p*-dichlorobenzene (80–99%) is removed via volatilization and adsorption.

Annual Wastewater Discharges

For TRI, annual discharges are reported directly by facilities. 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. In instances where a facility reports a period's monitoring results as below the limit of detection (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.

Average Daily Wastewater Discharges

To estimate average daily discharges, EPA used the following steps:

1. Obtained total annual loads calculated from the DMR Loading Tool and reported annual direct surface water discharges and indirect discharges to POTW and non-POTW WWT in TRI.
2. Any TRI reporters using Form A were removed as they were not included in the assessment.
3. Determined if any of the facilities receiving indirect discharges reported in TRI have reported DMRs for the corresponding TRI reporting year. This indicates that the indirect discharge from TRI enter the facility that reported to DMR, and so the release to surface water reported from the DMR report captures the actual amount that is released to the environment, and the TRI indirect release can be excluded.
4. Divided the annual discharges over the number of estimated operating days (estimated as described in Section 4.2.5).
5. Estimated a release duration using facility-specific data available in models and/or literature sources. If no data was available, listed as "unknown".

The results of these calculations for DMR releases can be found in the *Draft Water Release Summary for DMR and TRI for p-Dichlorobenzene* supplemental file (U.S. EPA, 2026z). TRI reported no non-zero water releases during the timeframe assessed. Only the highest annual DMR release was used to estimate risk in this assessment.

4.2.3.3 Approach for Estimating Air Releases from TRI and NEI

Where available, EPA used TRI to estimate annual and average daily fugitive and stack air emissions. For air emissions, EPA estimated both release patterns (*i.e.,* days per year of release) and release durations (*i.e.,* hours per day the release occurs). NEI releases for 2017 and 2020 (the 2 most recent years available) were compared to TRI releases (2019–2023), and the highest releasing facility in NEI had a lower release than the highest TRI facility release. For this reason, EPA did not use NEI releases to estimate risk in the evaluation. The NEI releases considered are available for review in the *Draft Air Release Summary and Statistics for NEI and TRI for p-Dichlorobenzene Release* supplemental file (U.S. EPA, 2026a).

Annual Emissions

Facility-level annual emissions are available for TRI reporters and major sources in NEI. EPA considered the reported annual emissions directly as reported in TRI and NEI for major sources. Only emissions from TRI are summarized in this section.

Average Daily Emissions

To estimate average daily emissions for TRI reporters, EPA used the following steps:

1. Obtain total annual fugitive and stack emissions for each TRI reporter.
2. Any TRI reporters using Form A were removed, as they were not included in the assessment.
3. Divide the annual stack and fugitive emissions over the number of estimated operating days.
4. Estimate a release duration using facility-specific data available in NEI, models, and/or literature sources. If no data are available, list as "unknown."

4.2.3.4 Approach for Estimating Land Releases from TRI

Where available, EPA used TRI data to estimate annual and average daily land disposal volumes. TRI includes reporting of disposal volumes for a variety of land disposal methods, including underground injection, RCRA Subtitle C landfills, land treatment, RCRA Subtitle C surface impoundments, other surface impoundments, and other land disposal. TRI also provides the type of release media for a

particular facility, as well as how the chemical is managed through recycling, energy recovery, or treatment. EPA provided estimates for the total aggregated land disposal volume. Read more about *p*-dichlorobenzene's fate in land releases in Section 3.

Annual Land Disposal

Facility-level annual disposal volumes are available directly for TRI reporters. EPA used the reported annual land disposal volumes directly as reported in TRI for each land disposal method. The Agency combined totals from all land disposal methods from each facility to estimate a total annual aggregate disposal volume to land.

Average Daily Land Disposal

To estimate average daily disposal volumes, EPA used the following steps:

1. Obtain total annual disposal volumes for each land disposal method for each TRI reporter.
2. Any TRI reporters using Form A were removed, as they were not included in the assessment.
3. Divide the annual disposal volumes for each land disposal method over the number of estimated operating days.

4.2.4 Approach for Identifying Release Sources

EPA performed a literature search to identify process operations that could potentially result in releases of *p*-dichlorobenzene to air, water, or land from each OES. For each OES, EPA identified the release sources and the associated media of release. Where *p*-dichlorobenzene release sources were unclear or not available, EPA referenced relevant ESDs or GSs. Descriptions of release sources for each OES can be found in Section 4.3.

4.2.5 Approach for Estimating Number of Release Days

EPA typically assumed the number of release days per year from any release source will be equal to the number of operating days at the facility unless information is available to indicate otherwise. To estimate the number of operating days, the Agency used the following hierarchy:

1. ***Facility-Specific Data:*** EPA used facility-specific operating days per year data if available. If facility-specific data was not available for one facility of interest but was available for other facilities within the same OES, EPA estimated the operating days per year using one of the following approaches:
    a. If other facilities have known or estimated average daily use rates, EPA calculated the days per year as: Days/year = estimated annual use rate for the facility (kg/year) / average daily use rate from facilities with available data (kg/day).
    b. If facilities with days per year data do not have known or estimate average daily use rates, EPA used the average number of days per year from the facilities with such data available.
2. ***Industry-Specific Data:*** EPA used industry-specific data available from GSs, ESDs, trade publications, or other relevant literature.
3. ***Manufacture of Large-PV Commodity Chemicals***: Commodity chemicals are basic and relatively inexpensive compounds that are often produced in large quantities at plants built specifically to make one chemical. These plants are often run continuously, typically only shutting down for a few weeks a year for maintenance. Because of this, for the manufacture of the large-PV commodity chemicals, EPA used a value of 350 days per year. This assumes the

plant runs 7 days per week and 50 weeks per year (with 2 weeks down for turnaround) and assumes that the plant is always producing the chemical.

4. ***Manufacture of Lower-PV Specialty Chemicals:*** Specialty chemicals are often more expensive and are produced less frequently, at smaller quantities, and on an "as needed" basis. Because of this, for the manufacture of lower-PV specialty chemicals, it is unlikely the chemical is being manufactured continuously throughout the year. Therefore, EPA used a value of 250 days per year. This assumes the plant manufactures the chemical 5 days per week and 50 weeks per year (with 2 weeks down for turnaround).

5. ***Processing as Reactant (Intermediate Use) in the Manufacture of Commodity Chemicals:*** Similar to #3, EPA assumed the manufacture of commodity chemicals occurs 350 days per year such that the use of a chemical as a reactant to manufacture a commodity chemical would also occur 350 days per 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, EPA used a value of 250 days per year.

7. ***Other Chemical Plant OESs (e.g., Processing into Formulation and Use of Industrial Processing Aids):*** For these OESs, EPA assumed that the chemical of interest is not always in use at the facility, even if the facility operates 24 hours/7 days. Therefore, in general, EPA used a value of 300 days/year based on the "[Specific Environmental Release Categories] 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 (ESIG, 2012). However, in instances where the OES uses a low volume of the chemical of interest, EPA used 250 days per year as a lower estimate.

8. ***POTWs:*** Although EPA expects POTWs to operate continuously over 365 days per 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. However, there can be multiple upstream facilities (possibly with different OESs) 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, EPA could not determine an exact number of days per year the chemical of interest is discharged from the POTW and used a value of 365 days per year.

9. ***All Other OESs****:* Regardless of what the facility operating schedule is, other OESs are unlikely to use the chemical of interest every day. Therefore, EPA used a value of 250 days per year for these OESs.

4.2.6 Evidence Integration for Environmental Releases

Evidence integration for the environmental release assessment includes analysis, synthesis, and integration of information and data to produce estimates of environmental releases and occupational inhalation exposures. During evidence integration, EPA considered the likely location, duration, intensity, frequency, and quantity of releases and exposures while also considering factors that increase or decrease the strength of evidence when analyzing and integrating the data. Key factors the Agency considered when integrating evidence include 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 in exposure evidence integration. 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 data set 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 environmental releases and occupational exposures resulting directly from a specific source, medium, or product. If available, measured release and 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. For example, the Agency may have given preference to high quality modeled data directly applicable to the OES being assessed over low-quality measured data that is not specific to the OES. The final integration of the environmental release and occupational exposure evidence combined decisions regarding the strength of the available information, including information on plausibility and coherence across each evidence stream.

4.3 Industrial and Commercial Release Assessment

The following sections contain process descriptions and specific details (release sources, media of release, and release assessment approach and results) for the assessment of each OES. Only TRI releases are summarized in this section, as they were the primary data used in the assessment. Releases from DMR and NEI are referenced if applicable in each OES' section.

Refer to Table 4-1 to see how each OES described below pairs with the COUs stated in the *Draft Risk Evaluation for p-Dichlorobenzene* (U.S. EPA, 2026w).

A summary of the release data collected from the databases, and the data itself, can be found in the following supplemental files:

- For water releases from TRI and DMR, see *Draft Water Releases Summary for DMR and TRI p-Dichlorobenzene* (U.S. EPA, 2026z).
- For stack and fugitive air releases from TRI and NEI, see *Draft Air Releases Summary for NEI and TRI p-Dichlorobenzene* (U.S. EPA, 2026a).
- For land releases, see *Draft Land Releases for TRI p-Dichlorobenzene* (U.S. EPA, 2026t).

4.3.1 Manufacturing

EPA identified cases where *p*-dichlorobenzene is manufactured as a byproduct during the production of vinyl chloride monomer (VCM) (Exponent, 2024).

As listed in Table 4-1, this OES addresses the Manufacturing COU category.

4.3.1.1 Process Description

Westlake reported that *p*-dichlorobenzene is manufactured as a byproduct during the production of VCM (Exponent, 2024). In the VCM unit, ethylene dichloride (EDC) is thermally cracked in vinyl furnaces to produce VCM in a continuous, semi-automatic process. Side reactions can form benzene, which may chlorinate to chlorobenzenes, including *p*-dichlorobenzene. These byproducts are mixed with an intermediate feedstock (IFS) stream that comes into the facility from other plants and then routed to the waste treatment unit (WTU) for separation. In the WTU, recoverable organics (derivatives) and non-recoverable organics are separated. The recoverable organics are collected in product tanks and routed to

an outdoor Per-Tri unit for processing. The Per-Tri unit converts process derivatives to perchloroethylene (Per) and trichloroethylene (Tri) via reactors and distillation columns. *p*-Dichlorobenzene may also be generated as a byproduct within this unit; however, during the process it is expected to be consumed. The WTU non-recoverable organic mixture stream, containing a 2% composition of *p*-dichlorobenzene, is sent to waste storage and then incinerated in a halogen acid furnace (HAF) unit. Using this composition value, *p*-dichlorobenzene production was estimated to average 374,258 lb per year over 2017 through 2024. "Laboratory technicians analyze daily samples from the VCM and WTU units for parameters such as water content, pH, product purity, and color. Because *p*-dichlorobenzene is present at very low concentrations, it is not included in routine analyses.

4.3.1.2 Number of Facilities and Release Days

EPA used TRI, NEI, DMR, and CDR data between 2019 and 2023 to identify seven facilities that potentially produce *p*-dichlorobenzene as a byproduct in their chemical manufacturing process. Facilities that indicated a release of *p*-dichlorobenzene and produce VCM, or indicate in TRI that the chemical's presence is due to its manufacture as a byproduct, were categorized into this OES.

Note that facilities may report to multiple databases under different names, and in these cases, EPA used reported addresses and company information to match facilities with their equivalents across databases but there is some uncertainty to the facility estimate due to this.

Due to the uncertainty associated with reporting limits in the release databases, which may result in an underestimate of releasing facilities, EPA also considered the estimation approach of using data from CDR (U.S. EPA, 2020c). *p*-Dichlorobenzene is manufactured in the United States as a byproduct of VCM production (Exponent, 2024). Therefore, EPA assumes there could be up to 14 *p*-dichlorobenzene manufacturing sites, which is equal to the number of VCM manufacturers that reported to CDR in 2020 (U.S. EPA, 2020c).

For facility operating schedules, *p*-dichlorobenzene is a byproduct in the manufacture of VCM, which is a large-PV commodity chemical most commonly used to manufacture other chemicals, so as described in Section 4.2.5, the Agency assumes that the facility operates 7 days per week, 50 weeks per year (with 2 weeks down for turnaround) and that the facility is producing and releasing the chemical daily during operation. This results in an estimated 350 days/yr of operation. Without additional information, EPA assumes that number of release days per year is equivalent to the number of operating days per year.

4.3.1.3 Release Points

In general, potential sources of water releases in the chemical industry may include equipment cleaning operations, transport container cleaning, aqueous wastes from scrubbers/decanters, reaction water, process water from washing intermediate products, and trace water settled in storage tanks. Sources specific to *p*-dichlorobenzene may include cleaning of the waste storage tanks or transport containers holding the *p*-dichlorobenzene-containing IFS stream.

Sources of stack air releases are expected from vented losses to air during process operations and incineration of waste, as well as fugitive air releases from leakage of pipes (including equipment such as valves, pumps, and connectors), flanges, loading racks, and during container filling from equipment leaks and displaced vapor as containers are filled. Releases may also occur during sampling of the process.

4.3.1.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the manufacture of *p*-dichlorobenzene. A summary of all releases can be found in the supplemental files referenced at the beginning of Section 4.3. A summary of releases reported to TRI is presented in Table 4-3. TRI releases are summarized here because the release data from TRI are the primary data used in this assessment, as the highest releases to the environmental are reported from TRI. According to reported data, *p*-dichlorobenzene is released through the following environmental media: surface water, fugitive air, and stack air. EPA does not expect significant releases to water or land from this OES.

Table 4-3. Summary of Environmental Releases During the Manufacture of *p*-Dichlorobenzene

Media	Estimated Annual Release Range Across Sites (kg/yr)		Number of Release Days	Estimated Daily Release Range Across Sites (kg/day)		Number of Facilities	Source
	Central Tendency	High-End		Central Tendency	High-End		
Air (fugitive) [a]	35.67	41.93	350	1.02E−01	1.20E−01	2	TRI
Air (stack)	18.77	33.48	350	5.36E−02	9.56E−02	3	TRI
Water (surface)	23.83	26.09	350	6.81E−02	7.45E−02	1	DMR

[a] Two sites reported fugitive releases at least one year during the timeframe of this assessment, with three total entries. As described in Section 4.2.3, the median (the middle number) is presented as the central tendency, and the maximum is presented as the high-end.

4.3.2 Repackaging

p-Dichlorobenzene is repackaged when it is prepared for distribution in commerce in a different form, state, or quantity than originally received or stored, including when it is imported from outside of the United States. EPA identified Repackaging as an OES for *p*-dichlorobenzene based on CDR data (U.S. EPA, 2020a), which reports two importers of record that import *p*-dichlorobenzene directly to their sites for on-site processing or use and three importers of record that import *p*-dichlorobenzene directly to other sites for processing or use (the importing sites of record do not directly handle or store the imported *p*-dichlorobenzene). This OES also includes the loading, unloading, and repackaging of *p*-dichlorobenzene associated with facilities that primarily conduct these repackaging activities.

In general, EPA assessed the transport activities resulting in releases (*e.g.,* loading, unloading) throughout the relevant life cycle stages and COUs rather than a single distribution and transport scenario. While this description includes general language about the transport and storage of *p*-dichlorobenzene that may be relevant to transport activities within facilities that are mapped to other OESs as well, this section addresses releases that may occur at facilities that primarily import or repackage *p*-dichlorobenzene. Data for assessing releases that occur during transportation of *p*-dichlorobenzene, such as releases from accidental spills that occur during transport, are presented in Section 4.3.9, which discusses distribution in commerce.

As listed in Table 4-1, this OES addresses the Import and Repackaging COU categories.

4.3.2.1 Process Description

In general, chemicals 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. Domestically, *p*-dichlorobenzene is shipped either in molten form in heated, insulated steel tank cars or in flake or granular solid form in sealed containers such as paper bags, fiber packs, or drums (Krishnamurti, 2001).

At facilities where *p*-dichlorobenzene is used in the production of polyphenylene sulfide (PPS), *p*-dichlorobenzene is transported and stored in liquid form. During loading and unloading of the material, hoses and transfer lines will be connected and disconnected between storage tanks and trucks, tanker cars, tanker trailers, and ISO containers. It was reported that trailer and railcar unloading may occur 25 times per week, with examples given of one company that reported four railcars unloaded over 2 days, and a second company that reported 8 trucks unloaded over 2 days.

p-Dichlorobenzene may be imported or repackaged neat or as a component in a formulation. Figure 4-2 provides both typical release and occupational exposure points during the repackaging of *p*-dichlorobenzene.

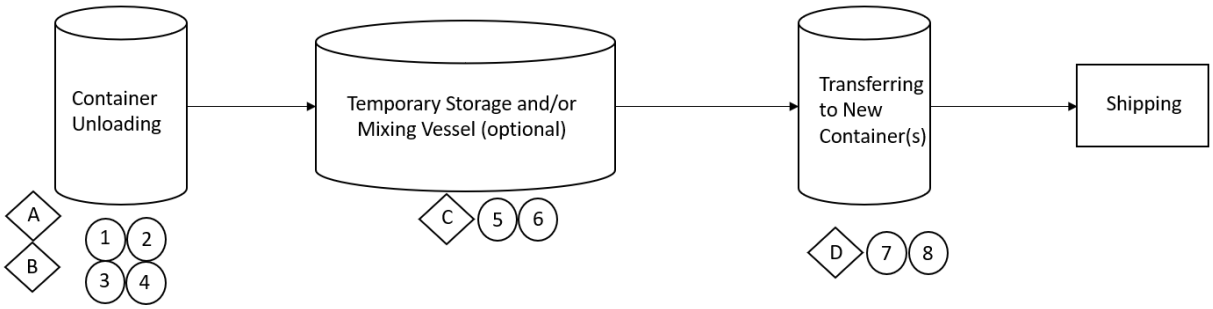

Figure 4-2. Typical Release and Exposure Points During the Repackaging of *p*-Dichlorobenzene
Source: (U.S. EPA, 2022c)

Environmental Releases:

1. Releases to air from unloading volatile chemicals from transport containers.
2. Releases to air, water, incineration, or landfill from unloading solids from transport containers.
3. Releases to water, incineration or land from transport container residue (via container cleaning or direct disposal of empty containers).
4. Releases to air from cleaning transport containers containing volatile chemicals
5. Releases to water, incineration or land from cleaning of storage/mixing vessels and other equipment.
6. Releases to air from cleaning equipment used to process volatile chemicals.
7. Releases to air from loading volatile chemicals into transport containers.
8. Releases to air, water, incineration, or landfill from loading solids into transport containers.

Occupational Exposures:

A. Inhalation exposures to volatile liquids and dust from unloading transport containers.
B. Inhalation exposures to volatile liquids from transport container cleaning.
C. Inhalation exposures to volatile liquids from equipment cleaning.
D. Inhalation exposures to volatile liquids from loading transport containers.

4.3.2.2 Number of Facilities and Release Days

EPA identified only two facilities associated with this OES that reported to TRI, NEI, DMR, or CDR data between 2019 and 2023. As this is believed to be an underestimation, EPA used an alternate method to identify number of facilities associated with this OES. EPA assessed a bounding estimate of 21,286 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a

bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this OES. EPA assigned the following NAICS codes for this OES:

- 325211 – Plastics Material and Resin Manufacturing
- 325130 – Synthetic Dye and Pigment Manufacturing
- 325991 – Custom Compounding of Purchased Resins
- 325199 – All Other Basic Organic Chemical Manufacturing
- 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)

EPA did not identify data on facility operating schedules; therefore, the Agency assumes repackaging occurs 7 days/week and 50 weeks/yr (with 2 weeks down for turnaround), which results in an estimate of 350 days/yr of operation (Section 4.2.5). Without additional information, EPA assumes that number of release days per year is equivalent to the number of operating days per year.

4.3.2.3 Release Points

Potential releases to air, water, or land may occur from loading and unloading of *p*-dichlorobenzene from transport containers, cleaning transport containers, cleaning of storage or mixing vessels and other equipment, cleaning equipment used to process the chemical, and loading into transport containers.

4.3.2.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the repackaging of *p*-dichlorobenzene. A summary of releases can be found in the supplemental files referenced at the beginning of Section 4.3. Because there are few reported releases of *p*-dichlorobenzene found associated with this OES, EPA does not expect significant releases to air, water, or land from this OES.

4.3.3 Processing as a Reactant

p-Dichlorobenzene is used as a feedstock in the manufacture of several products such as the high-performance thermoplastic polyphenylene sulfide (PPS), 1,2,4-trichlorobenzene, and insecticide intermediates (Krishnamurti, 2001). *p*-Dichlorobenzene is used predominantly in the manufacture of PPS, and in 1988 PPS manufacturing consumed 22% of all *p*-dichlorobenzene manufactured that year (U.S. EPA, 1994b).

It was reported that *p*-dichlorobenzene was used in industry as an intermediate in the production of dyes, in particular *p*-dichlorobenzene was used in the production of the dye intermediate 2,5-dichloroaniline (Fishbein, 1979). The Ecological and Toxicological Association of Dyes and Organic Pigments Manufacturers (ETAD) reported that in the 1960 and 1970s, *p*-dichlorobenzene was available in large quantities due to its use in the manufacture of dichlorodiphenyltrichloroethane (DDT), and so it was used in the manufacturing process for certain dyes, such as use as a starting material in the manufacture of Pigment Red 88. However, these uses were phased out after DDT was banned in 1972, and *p*-dichlorobenzene is not associated with any current or recent use or application in dye manufacturing. To the best of ETAD's knowledge it is not present even in trace quantities as an impurity in any commercial dye (see EPA-HQ-OPPT-2018-0446-0035 and EPA-HQ-OPPT-2018-0446-0039). EPA has not found other evidence of *p*-dichlorobenzene currently being used for this purpose, but as *p*-dichlorobenzene is a reactant in this process, the Agency assumes this use is most relevant to the Processing as a Reactant OES.

This OES also encompasses the recycling of *p*-dichlorobenzene. Recycling does not involve a reaction of the chemical that would usually cause an activity to fall under this OES, however most cases EPA found of *p*-dichlorobenzene recycling occur after *p*-dichlorobenzene is processed as a reactant, when it is recovered from a generated waste stream and recycled back into the feedstock. Therefore, it is expected that releases and exposures related to Processing as a Reactant could also represent releases and exposures during recycling.

As listed in Table 4-1, this OES includes the Processing as a reactant, Synthetic dye and pigment manufacturing, and Recycling COU categories.

4.3.3.1 Process Description

During the manufacture of PPS, *p*-dichlorobenzene arrives at a site in liquid form from a tank truck or rail car where it is unloaded into site storage tanks (ACC, 2023). PPS is formed by a reaction of *p*-dichlorobenzene and sodium sulfide in a polar solvent. The first step is to prepare sodium sulfide from aqueous caustic and aqueous sodium hydrosulfide in a polar solvent, and then the feedstock is distilled by dehydration. Next the polymer is formed from the reaction of the sodium sulfide stream and *p*-dichlorobenzene at an elevated temperature in a polar solvent. Next is polymer recovery, then removal of the byproduct sodium chloride by washing, drying of the product, optional curing, and packaging.

PPS produced by this process can be used in coating applications by slurry-coating procedures, however it is most often used as a feedstock in the production of molding-grade resins. These resins are produced by a curing process where the polymer, which can be in either a solid state or in a melt, is exposed to a small amount of air at high temperature, and higher molecular weight resin is produced while lower molecular weight polymers are volatilized. Several changes in the polymer take place during curing: toughness increases, melt viscosity increases, rate and extent of crystallization decrease, and color changes from white to tan/brown/black. The extent to which these changes occur depends on the extent of cure, which is a function of both the time and temperature of curing. Residence time, reaction temperature, and melt viscosity are important in the formation of various grades of PPS. Once cured, the polymer is cooled, combined with fillers, pelletized, and then packaged (Geibel and Leland, 2000; U.S. EPA, 1994b). See Figure 4-3 for a process flow diagram of this process.

p-Dichlorobenzene monomer is completely consumed in the process, and since the final plastic product has no chlorine in it, it cannot decompose or react to release *p*-dichlorobenzene (EPA-HQ-OPPT-2018-0446-0034). The process is a closed system and the two facilities discussed by ACC are reported to be open to the air, and the manufacturing units operated year-round, 24 hours a day, 7 days a week. The concentrations of *p*-dichlorobenzene at the facilities range from 100% in the *p*-dichlorobenzene storage tanks to less than 100 ppm in the final solid polymer. These two facilities are reported to be the only two in the United States that manufacturing PPS (ACC, 2023).

Following the initial creation of the PPS polymer, the material may then be transported to a compounding facility, discussed further in Section 4.3.5.

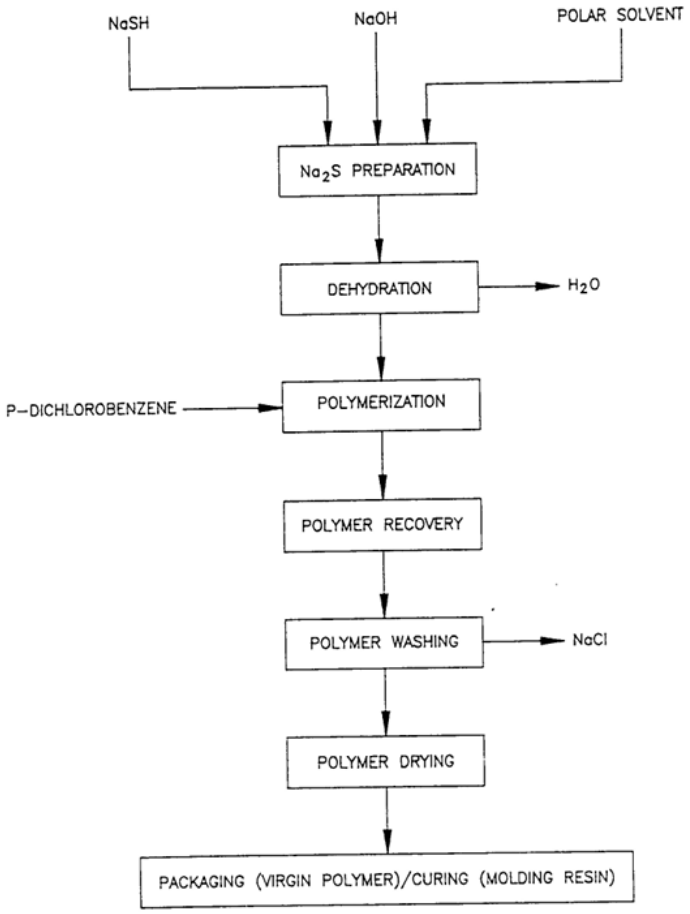

Figure 4-3. Process Flow Diagram of PPS Manufacturing (U.S. EPA, 1994b)

Environmental Releases (not labeled on figure):

1. Transfer operations losses to air, water, incineration, or landfill from loading, unloading, and transfers activities
2. Transport vessels and transport equipment residue cleaning/disposal losses to water, landfill, or incineration
3. Vapor emissions from reactor to fugitive or stack air (liquid additives only)
4. Equipment cleaning residue losses to water, landfill, or incineration
5. Direct contact cooling water releases to water
6. Transfer operations losses to air, water, incineration, or landfill from loading polymer into final containers (only applicable to pellets, granules, flakes, and other similar shapes)

Occupational Exposure (not labeled on figure):

A. Inhalation and dermal exposure to liquids and solids during unloading of chemicals
B. Inhalation and dermal exposure to liquids and solids during container cleaning
C. Inhalation exposure to vapors and dusts generated during reaction process operations
D. Dermal exposure to liquids and solids during equipment cleaning
E. Inhalation exposures to vapors and solids during packaging of polymer (only applicable to pellets, granules, flakes, and other similar shapes)

p-Dichlorobenzene is also used to manufacture 1,2,4-trichorobenzene which is primarily used in pesticide formulation. The most common process for forming this chemical is the catalytic chlorination of *o*- and *p*-dichlorobenzene at 20 to 30 °C in the presence of ferric chloride. The reaction is allowed to proceed until a density of 1.4 grams per mL is obtained, at which time the acid is neutralized and the product are fractionally distilled to yield 1,2,4-trichlorobenzene as well as the 1,2,3-isomer (U.S. EPA, 1994b).

4.3.3.2 Number of Facilities and Release Days

EPA used TRI, NEI, DMR, and CDR data between 2019 and 2023 to identify 14 facilities that potentially process *p*-dichlorobenzene as a reactant. Facilities that indicated release of *p*-dichlorobenzene and were reported to use *p*-dichlorobenzene as a reactant, or that are indicated to produce PPS or other intermediate chemical where *p*-dichlorobenzene is a known reactant, were categorized into this OES.

Note that facilities may report to multiple databases under different names, and in these cases, EPA used reported addresses and company information to match facilities with their equivalents across databases but there is some uncertainty to the facility estimate due to this.

Facilities that manufacture PPS were reported to operate 24 hours a day, 7 days per week, year-round. (ACC, 2023). EPA typically assumes a facility may be down 2 weeks per year for turnaround operations (Section 4.2.5). This results in an estimate of 350 days per year of operation for this OES. Without additional information, EPA assumes that number of release days per year is equivalent to the number of operating days per year.

4.3.3.3 Release Points

EPA expects releases to occur during container and equipment cleaning, maintenance, and sampling. Environmental releases may also occur during the unloading of *p*-dichlorobenzene from transport containers into intermediate storage tanks and process vessels. Equipment leaks may occur while connecting and disconnecting hoses and transfer lines. Additionally, EPA expects stack air releases from vented losses to air during process operations, and fugitive air releases from leakage of pipes, flanges, and accessories used for transport.

4.3.3.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the processing of *p*-dichlorobenzene as a reactant. A summary of releases can be found in the supplemental files referenced at the beginning of Section 4.3. A summary of releases from TRI is presented in Table 4-4. TRI releases are summarized here because the release data from TRI are the primary data used in this assessment, as the highest releases to the environmental are reported from TRI. According to reported data, *p*-dichlorobenzene is released through the following environmental media: surface water, fugitive air, stack air, and land.

Table 4-4. Summary of Environmental Releases During the Processing of *p*-Dichlorobenzene as a Reactant

Media	Estimated Annual Release Range Across Sites (kg/yr)		Number of Release Days	Estimated Daily Release Range Across Sites (kg/day)		Number of Facilities	Source
	Central Tendency	High-End		Central Tendency	High-End		
Surface Water[a]	2.3		350	6.6E−03		1	TRI
Air (Fugitive)	5.7E03	9.5E03	350	16	27	2	TRI
Air (Stack)	4.2E02	1.1E03	350	1.2	3.1	2	TRI
Land[b]	65	189	350	0.19	0.54	2	TRI

[a] One facility reported this release amount to surface water per year.
[b] One facility's land releases were to an on-site underground injection well (class I), but 1 year some releases from the facility were also sent to an off-site unspecified landfill. The other facility reported off-site disposal via transfer to a waste broker.

4.3.4 Incorporation into Formulation, Mixture, or Reaction Product

Incorporation into a formulation, mixture or reaction product refers to the process of mixing or blending of several raw materials to obtain a single product or preparation. EPA identified Incorporation into formulation, mixture, or reaction product as a use of *p*-dichlorobenzene due to *p*-dichlorobenzene's presence in products such as functional fluids, laboratory standards, and sealants (EPA-HQ-OPPT-2018-0446-0037; DAP Products, 2026; Supelco, 2025). This OES encompasses the releases and exposures that may occur during the formulation of these products.

p-Dichlorobenzene may also be present as a residual in the *o*-dichlorobenzene component of petroleum lubricating oils and fuel additives. *o*-Dichlorobenzene is present in concentrations up to 0.12%, with no test results on the products indicating the presence of *p*-dichlorobenzene in the formulations at a quantifiable concentration (EPA-HQ-OPPT-2018-0446-0028).

As listed in Table 4-1, this OES includes the Solvents (which become part of product formulation of mixture) COU subcategory within the processing life cycle stage.

4.3.4.1 Process Description

In the formulation of sealant polyurethane foams, *p*-dichlorobenzene was identified at concentrations of 3 to 7% in one product that is used to spray a foam seal in gaps and cracks in buildings. *p*-Dichlorobenzene is present as a pest repellant function in the product and may act as an olfactory deterrent (DAP Products, 2026). EPA did not have information about the process for producing the specific *p*-dichlorobenzene sealant identified. However, the following is a generic process for producing polyurethane foam sealants. Foam manufacturers typically receive formulations containing the polymerization raw materials required to manufacture their foams (*e.g.,* pre-polymers and other reactants), which may contain other additives that enhance the properties of the final polymer. The additives may serve many functions including acting as flame retardants, fillers, and colorants (or in *p*-dichlorobenzene's case, a pest deterrent). All polyurethane foams are made by way of a reaction between polyols, diisocyanates, and water. The reaction between the polyols and isocyanate creates the polyurethane polymer matrix. The reaction between the isocyanate and water generates carbon dioxide, which acts as an "*in situ*" blowing agent. In some applications, an auxiliary blowing agent (ABA) is added to the process (*e.g.,* additional carbon dioxide, acetone, methylene chloride (in limited applications)).

Polyurethane foams are produced in one of two forms: flexible foam and rigid foam. The foam sealant that contains *p*-dichlorobenzene dries into a rigid foam, which is a closed-cell foam and produced from high functionality polyols (with molecular weights of approximately 500) and poly(methylene)-poly(phenyl isocyanate). Other additives include blowing agents, catalysts, and foam stabilizers. Rigid foams are often produced in slabs that are cut into panels, but they can also be sprayed (*e.g.,* onto structural components as building insulation) or poured/pumped into molds (similar to that described for molded flexible polyurethane foams). Rigid polyurethane foams may also be poured/sprayed into a permanent space to be filled (*e.g.,* insulation for refrigerators, boat hulls), as is the case with the foam sealant containing *p*-dichlorobenzene (U.S. EPA, 2004b).

p-Dichlorobenzene is also formulated into liquid products such as functional fluids at a concentration of up to 25% (EPA-HQ-OPPT-2018-0446-0037), and laboratory standards at concentrations in a mixture of up to 1% (Supelco, 2025). Note that some products intended for laboratory use contain *p*-dichlorobenzene in its neat form. Since these products are not formulated, the releases and exposures due to their preparation are assessed in the Repackaging OES.

4.3.4.2 Number of Facilities and Release Days

EPA used TRI, NEI, DMR, and CDR data between 2019 and 2023 to identify 106 facilities that potentially incorporate *p*-dichlorobenzene into a formulation. Facilities that indicated a release of *p*-dichlorobenzene and were reported to incorporate *p*-dichlorobenzene into a formulation, or that are indicated to manufacture sealants, functional fluids, or laboratory chemicals, were categorized into this OES.

Note that facilities may report to multiple databases under different names, and in these cases, EPA used reported addresses and company information to match facilities with their equivalents across databases but there is some uncertainty to the facility estimate due to this.

EPA did not identify data on facility operating schedules; therefore, EPA assumes that the chemical of interest is not always in use at the facility, even if the facility operates 24/7. Therefore, EPA assumes 300 days/year 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 (ESIG, 2012). See Section 4.2.5 for more information. Without additional information, EPA assumes that number of release days per year is equivalent to the number of operating days per year.

4.3.4.3 Release Points

EPA expects releases to occur to water, incineration, or landfill due to container residue in transport containers, product sample wastes, and equipment cleaning. Due to the chemical's volatility EPA also expects losses to air during container and equipment cleaning, transfer operations such as loading and unloading, product sampling, and mixing operations. EPA also expects stack air releases from vented losses during process operations and packaging into transport containers.

4.3.4.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the incorporation of *p*-dichlorobenzene into formulation. A summary of releases can be found in the supplemental files referenced at the beginning of Section 4.3. A summary of releases from TRI is presented in Table 4-5. TRI releases are summarized here because the release data from TRI are the primary data used in this assessment, as the highest releases to the environmental are reported from TRI. According to reported data, *p*-dichlorobenzene is released through the following environmental

media: surface water, fugitive air, and stack air. However, EPA does not expect significant releases to stack air, water, or land from this OES.

Table 4-5. Summary of Environmental Releases During the Incorporation of *p*-Dichlorobenzene into a Formulation

Media	Estimated Annual Release Range Across Sites (kg/yr)		Number of Release Days	Estimated Daily Release Range Across Sites (kg/day)		Number of Facilities	Source
	Central Tendency	High-End		Central Tendency	High-End		
Air (fugitive) [a]	68		300	0.23		1	TRI
[a] Central tendency and high-end are the same in this case because only 1 facility, for 1 year (2023), reported an annual release of this chemical to TRI for this OES.							

4.3.5 Plastic Compounding

EPA identified Incorporation into formulation, mixture, or reaction product as a use of *p*-dichlorobenzene. *p*-Dichlorobenzene is used to make PPS resin (Section 4.3.3), which contains less than 100 ppm of residual *p*-dichlorobenzene (ACC, 2023). This residual *p*-dichlorobenzene is then incorporated into the downstream product during plastic compounding.

As listed in Table 4-1, this OES includes the Plastics compounding COU subcategory within the processing life cycle stage.

4.3.5.1 Process Description

After the manufacture of the PPS resin described in Section 4.3.3, the resin may be transported to another facility for compounding. Compounding consists of blending polymers with plastics additives to form a masterbatch, which is a mixture of polymers and additives, for further converting into finished articles. Additives, which can be comprised of one or more distinct chemicals, can be added during the resin manufacturing process as well as during the converting process described in Section 4.3.7, however additives are commonly added during compounding in order to impart the desired properties into the masterbatch. In the compounding facilities, PPS polymer is blended with other additives and extruded into pellets. Extruders have individual exhaust ventilation over the die heads that are used to shape the plastic material into the desired pellets (ACC, 2023). One facility that compounds PPS reports having three compounding machines that are run 24 hours a day, 7 days a week.

Figure 4-4 below illustrates the general compounding processes and their associated environmental release sources and occupational exposure activities.

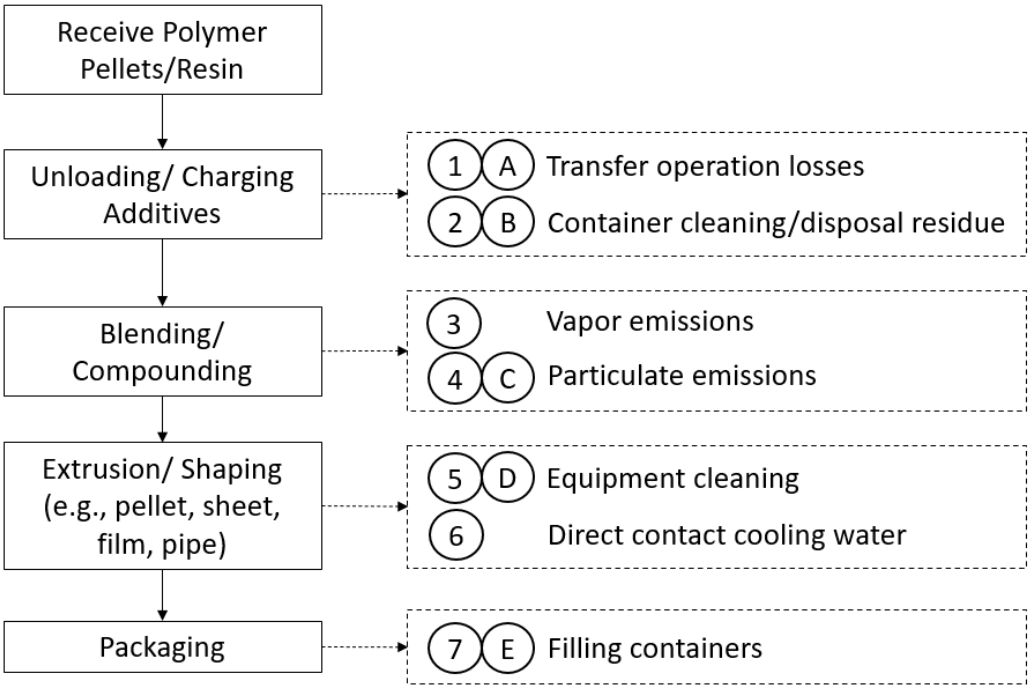

Figure 4-4. Typical Release and Exposure Points During Plastic Compounding (U.S. EPA, 2021c)

Environmental Releases:

1. Transfer operations losses to air, water, incineration, or landfill from container transfers of additives
2. Container residue cleaning/disposal losses to water, landfill, or incineration
3. Vapor emissions from blending/compounding to fugitive or stack air (liquid additives only)
4. Particulate emissions from blending/compounding to air, water, incineration, or landfill (solid additives only)
5. Equipment cleaning residue losses to water, landfill, or incineration
6. Direct contact cooling water releases to water
7. Transfer operations losses to air, water, incineration, or landfill from loading compounded plastics into final containers (only applicable to pellets, granules, flakes, and other similar shapes)

Occupational Exposure:

A. Inhalation exposure to solids and dermal exposure to liquids and solids during unloading of additive chemicals
B. Inhalation exposure to solids and dermal exposure to liquids and solids during container cleaning
C. Inhalation exposure to dusts generated during blending/compounding process operations
D. Dermal exposure to liquids during equipment cleaning
E. Inhalation exposures to solids during packaging of compounded plastics containing additive chemical (only applicable to pellets, granules, flakes, and other similar shapes)

4.3.5.2 Number of Facilities and Release Days

EPA did not find information from TRI, NEI, DMR, or CDR data between 2019 and 2023 to identify number of facilities associated with this OES. Therefore, EPA assessed a bounding estimate of 1,527 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this OES. EPA assigned the following NAICS codes for this OES:

- 325211 – Plastics Material and Resin Manufacturing; and
- 325991 – Custom Compounding of Purchased Resins.

EPA did not identify data on facility operating schedules. The ESD on Plastic Additives references European technical guidance, which estimates up to 300 operating days/yr for the polymers industry

(OECD, 2009). EPA assumes 300 days/yr of operation. Without additional information, the Agency assumes that number of release days per year is equivalent to the number of operating days per year.

4.3.5.3 Release Points

EPA expects releases to occur to air, water, landfill, or incineration from container transfers of compounded resin, container residue cleaning/disposal, vapor emissions from compounding and converting, and equipment cleaning. EPA also expects releases to wastewater from direct contact cooling and incineration, and landfill releases from solid waste trimming.

4.3.5.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the plastic compounding of *p*-dichlorobenzene. A summary of releases can be found in the supplemental files referenced at the beginning of Section 4.3. Because there are low reported releases of *p*-dichlorobenzene found from the facilities associated with this OES, EPA does not expect significant releases to air, water, or land from this OES.

4.3.6 Incorporation into Air Care Products

EPA identified Incorporation into formulation, mixture, or reaction product as a use of *p*-dichlorobenzene, particularly in the production of air care products. *p*-Dichlorobenzene is in air care product within space, toilet bowl, and garbage deodorants at concentrations up to 100% by weight (EPA-HQ-OPPT-2018-0446-0011; EPA-HQ-OPPT-2018-0446-0004; Home Depot, 2019; Willert Home Products, 2019; Hospeco, 2018). Due to its volatility, density, pleasant odor, and solid nature at room temperature, it is used alone or in combination with disinfectant substances to produce deodorants in a variety of continuous evaporation forms, most commonly solid air deodorizers and toilet blocks (U.S. EPA, 1994b).

As listed in Table 4-1, this OES includes the Soap, cleaning compound, and toilet preparation manufacturing COU subcategory.

4.3.6.1 Process Description

According to one facility, raw *p*-dichlorobenzene may be delivered to the facility in bags where it is stored until used for production of air care products. Once needed, the *p*-dichlorobenzene is moved to the production line using pallet jack or follies. The bag is then emptied into a chute that leads to a grinder and then a hopper that feeds into the production line at the facility. Fragrance is added to the raw *p*-dichlorobenzene, and then it is added to machines which produce the solid product. Although more specific details about the manufacture of these products is not known, most solid block deodorants are formed by combining the active ingredients such as *p*-dichlorobenzene with a carrier substance. Water is the most common carrier substance, however process soils, solvents, and various petroleum products may also be employed depending on the form of the deodorant (U.S. EPA, 1994b). The product tablets contain *p*-dichlorobenzene in tablet form at concentrations equal to or greater than 99.8%. These tablets are then attached to a hanging device so to be hung onto a toilet bowl or garbage can. After it is manufactured the product is packaged and distributed immediately. The finish product is not stored for any significant amount of time (EPA-HQ-OPPT-2018-0446-0011).

One facility reported processing approximately 10,000,000 lb of *p*-dichlorobenzene per year (SCI Engineering, 2024). In 1988, it was reported that 16% of *p*-dichlorobenzene produced in the United States is used in the production of space deodorants (U.S. EPA, 1994b).

4.3.6.2 Number of Facilities and Release Days

EPA used TRI, NEI, DMR, and CDR data between 2019 and 2023 to identify two facilities that potentially incorporate *p*-dichlorobenzene into air care products. Facilities that indicated a release of *p*-dichlorobenzene and were reported to conduct incorporation into formulation, or a facility where the presence of deodorizers or other cleaning products were present, were categorized into this OES.

Note that facilities may report to multiple databases under different names, and in these cases, EPA used reported addresses and company information to match facilities with their equivalents across databases but there is some uncertainty to the facility estimate for this reason.

Due to the uncertainty associated with reporting limits in the release databases, which may result in an underestimate of releasing facilities, EPA also considered the approach of estimating number of facilities using relevant NAICS codes for the OES. Therefore, EPA considered a bounding estimate of 1,442 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this OES. EPA assigned the following NAICS codes for this OES:

- 325612 – Polish and Other Sanitation Good Manufacturing; and
- 325620 – Toilet Preparation Manufacturing.

EPA did not identify data on facility operating schedules, however due to industry communication indicating frequent use of the chemical, the Agency assumes Incorporation into air care products occurs 7 days/week and 50 weeks/yr (with 2 weeks down for turnaround), which results in an estimate of 350 days/yr of operation (Section 4.2.5). Without additional information, EPA assumes that number of release days per year is equivalent to the number of operating days per year.

4.3.6.3 Release Points

EPA expects releases to occur to water, incineration, or landfill due to container residue in transport containers, product sample wastes, and equipment cleaning. Due to the chemical's volatility, the EPA also expects losses to air during container and equipment cleaning, transfer operations such as loading and unloading, product sampling, and mixing operations. The Agency further expects stack air releases from vented losses during process operations and packaging into transport containers.

4.3.6.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the incorporation of *p*-dichlorobenzene into air care products. A summary of releases can be found in the supplemental files referenced at the beginning of Section 4.3. A summary of releases from TRI is presented in Table 4-6. TRI releases are summarized here because the release data from TRI are the primary data used in this assessment because the highest releases to the environmental are reported from TRI. According to reported data, *p*-dichlorobenzene is released through the following environmental media—fugitive air. EPA does not expect significant releases to water or land from this OES. One of the three TRI sites for this OES was a Form A site, which the Agency assumes has a release of 227 kg per year to one media (Section 4.2.3.1). EPA has chosen to attribute this release to the fugitive air medium at this facility, to match the tendency of release for other facilities of this OES.

Table 4-6. Summary of Environmental Releases of *p*-Dichlorobenzene during Incorporation into Air Care Products

Media	Estimated Annual Release Range Across Sites (kg/yr)		Number of Release Days	Estimated Daily Release Range Across Sites (kg/day)		Number of Facilities	Source
	Central Tendency	High-End		Central Tendency	High-End		
Air (fugitive) [a]	113		350	0.32		2	TRI
Air (stack) [b]	29		350	8.3E−02		1	TRI

[a] Although this dataset includes 6 release points, 5 of the 6 are the same number displayed in the table, so this number represents both the 50th and 95th percentiles.
[b] Central tendency and high-end are the same in this case because only 1 facility, for 1 year (2023), reported an annual release to this medium to TRI for this OES.

4.3.7 Plastic Converting

EPA identified Incorporation into an article as a use of *p*-dichlorobenzene, which encompasses plastic converting. *p*-Dichlorobenzene is used to make PPS resin (Section 4.3.3), which contains less than 100 ppm of residual *p*-dichlorobenzene (ACC, 2023). This residual *p*-dichlorobenzene was then incorporated into the downstream product during plastic compounding, presented in Section 4.3.5, and then converted, described within this section.

As listed in Table 4-1, this OES includes the Plastic product manufacturing subcategory within the Processing – Incorporation into article COU category.

4.3.7.1 Process Description

After the compounding process described in Section 4.3.5, compounded plastic and rubber resins are converted into solid articles. EPA did not find a process description specific to *p*-dichlorobenzene-containing plastic resin that would be converted but presents here a general process description of plastic converting, which is expected to be applicable.

Common converting processes include injection molding, extrusion, calendering, blow molding, and thermoforming. In injection molding, heated resin is injected into a cold mold where the plastic takes the shape of the mold as it solidifies. In extrusion, heated resin is forced through a die and then quenched to form products such as pipe, profiles, sheets, and wire coating. In calendaring, heated resin is fed onto rolls that compress the material into a thin layer to form sheets and films (OECD, 2009). There are two types of blow molding that plastic and rubber producers use: extrusion and injection blow molding. In extrusion blow molding, an extruder delivers a tubular extrudate (parison) between two halves of a mold which are brought together around the hot extrudate, closing its top and bottom. Air is blown into the parison, forcing the polymer melt against the sides of the mold. In injection blow molding, the parison, usually in a preform shape, is formed by injection molding. The parison is normally transferred directly to a blow molding unit, or it may be cooled and stored as a preform. In thermoforming, a plastic sheet is locked in a frame and is heated to the forming temperature when it is brought into contact with a mold whose shape it assumes. In some cases, the process is assisted by drawing the sheet on to the form using vacuum, in others, pressure is applied. For all methods, in some cases the plastic product may undergo subsequent trimming to remove excess material. Other finishing operations, such as paint, coating, and bonding may occur (these are covered under other COUs) (OECD, 2009). Figure 4-5 highlights typical release and exposure points during plastics converting.

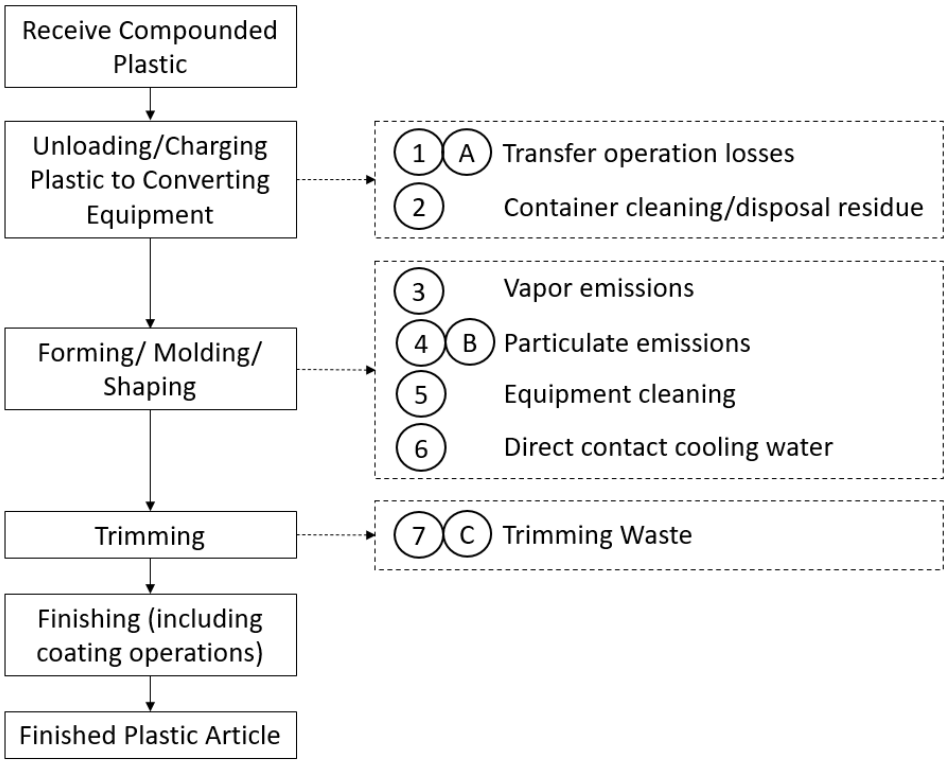

Figure 4-5. Typical Release and Exposure Points During Plastics Converting
Source: (U.S. EPA, 2004a)
Environmental Releases:

1. Transfer operation losses to air, water, landfill or incineration from container transfers of compounded resin
2. Container residue cleaning/disposal losses to water, landfill, or incineration
3. Vapor emissions from converting to stack or fugitive air (liquid additives only)
4. Particulate emissions from converting to air, water, incineration, or landfill (all additive types)
5. Equipment cleaning losses to water, landfill, or incineration
6. Direct contact cooling water released to water
7. Solid waste from trimming operations to landfill or incineration

Occupational Exposure:

A. Inhalation exposures to solids during unloading of compounded resins
B. Inhalation exposure to dusts generated during converting processes
C. Inhalation exposure to solids during trimming activities

4.3.7.2 Number of Facilities and Release Days

EPA used TRI, NEI, DMR, and CDR data between 2019 and 2023 to identify 12 facilities that potentially incorporate *p*-dichlorobenzene into articles via plastic converting. Facilities that indicated a release of *p*-dichlorobenzene and were reported to conduct plastic converting activities with evidence of the presence of PPS resin were categorized into this OES.

Note that facilities may report to multiple databases under different names, and in these cases, EPA used reported addresses and company information to match facilities with their equivalents across databases but there is some uncertainty to the facility estimate due to this.

Due to the uncertainty associated with reporting limits in the release databases, which may result in an underestimate of releasing facilities, EPA also considered the approach of estimating number of facilities using relevant NAICS codes for the OES. This approach involved first identifying the relevant

NAICS codes for the OES. EPA assessed a bounding estimate of 11,194 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this OES. EPA assigned the following NAICS codes for this OES:

- 326100 – Plastics Product Manufacturing; and
- 325199 – All Other Basic Organic Chemical Manufacturing.

EPA did not identify data on facility operating schedules. The ESD on Plastic Additives references European technical guidance, which estimates up to 300 operating days/yr for the polymers industry (OECD, 2009). EPA assumes 300 days/yr of operation. Without additional information, EPA further assumes that number of release days per year is equivalent to the number of operating days per year.

4.3.7.3 Release Points

EPA expects releases to occur to air, water, landfill, or incineration from feedstock container transfers of compounded PPS resins (*p*-dichlorobenzene is an impurity), container residue cleaning/disposal, vapor emissions from converting process steps, and converting equipment cleaning. EPA also expects releases to wastewater from direct contact cooling and incineration, and solid waste transferred to landfill or incineration for energy recovery generated from trimming operations.

4.3.7.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the plastic converting of *p*-dichlorobenzene. A summary of releases can be found in the supplemental files referenced at the beginning of Section 4.3. According to reported data, *p*-dichlorobenzene is released through the following environmental media: stack air. However, EPA does not expect significant releases to air, water, or land from this OES.

4.3.8 Incorporation into Abrasive Grinding Wheels

EPA identified Incorporation into an article as a use of *p*-dichlorobenzene, including the use of *p*-dichlorobenzene as a temporary pore producing material in resin-bonded abrasive grinding wheel manufacturing plants (ECHA, 2004), where it may be present during the manufacturing of the wheel and in the product as a residual.

As listed in Table 4-1 this OES includes the Other subcategory within the Processing – Incorporation into article COU category.

4.3.8.1 Process Description

For the production of porous grinding material, *p*-dichlorobenzene may be mixed with the grinding material at a volume percent between 3.5 and 20%.[2] After mixing and shaping, the grinding wheels are dried and heated to high temperatures. *p*-Dichlorobenzene can be recovered during the drying process or thermally destroyed during the heating process. As *p*-dichlorobenzene vaporizes it leaves pores and wider grain spacing. The European consumption is estimated to be 100 tonnes per year (ECHA, 2004).

4.3.8.2 Number of Facilities and Release Days

EPA did not find information from TRI, NEI, DMR, or CDR data between 2019 and 2023 to identify number of facilities associated with this OES. Therefore, EPA assessed a bounding estimate of 3,894 sites for this OES based on the number of sites listed under the identified NAICS codes, representing a maximum number of theoretical sites using *p*-dichlorobenzene. Using a bounding estimate will

[2] https://patents.google.com/patent/US4786292A/en; accessed June 17, 2026)

overestimate the true number of sites that use *p*-dichlorobenzene for this OES. EPA assigned the following NAICS codes for this OES:

- 327910 – Abrasive Product Manufacturing; and
- 332999 – All Other Miscellaneous Fabricated Metal Product Manufacturing.

EPA did not identify data on facility operating schedules; therefore, the Agency assumes that the chemical of interest is not always in use at the facility—even if the facility operates 24/7. Thus, the Agency assumes 300 days/year based on the "SpERC fact sheet – Formulation & (re)packing of substances and mixtures – Industrial (Solvent-borne)" that uses a default of 300 days/year for the chemical industry (ESIG, 2012). See Section 4.2.5 for more information. Without additional information, EPA assumes that number of release days per year is equivalent to the number of operating days per year.

4.3.8.3 Release Points

EPA expects releases to occur to water, incineration, or landfill due to container residue in transport containers, product sample wastes, and equipment cleaning. Due to the chemical's volatility, the Agency also expects losses to air during container and equipment cleaning, transfer operations such as loading and unloading, product sampling, and mixing operations. EPA further expects stack air releases from vented losses during process operations and packaging into transport containers.

4.3.8.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the incorporation of *p*-dichlorobenzene into abrasive grinding wheels. A summary of releases can be found in the supplemental files referenced at the beginning of Section 4.3. Because there are no reported releases of *p*-dichlorobenzene found associated with this OES, EPA does not expect significant releases to air, water, or land from this OES.

4.3.9 Distribution in Commerce

For purposes of assessment in this risk evaluation, distribution in commerce consists of the transportation associated with the moving of *p*-dichlorobenzene or *p*-dichlorobenzene-containing products and/or articles between sites manufacturing, processing, and use COUs, or the transportation of *p*-dichlorobenzene-containing wastes to recycling sites or for final disposal. EPA expects all the *p*-dichlorobenzene or *p*-dichlorobenzene-containing products and/or articles to be transported in closed system or otherwise to be transported in a form (*e.g.,* articles containing *p*-dichlorobenzene) such that there is negligible potential for releases except during an incident. Therefore, no occupational exposures are reasonably expected to occur, and no separate assessment was performed for estimating releases and exposures from distribution in commerce.

4.3.10 Functional Fluids

It was reported to EPA that *p*-dichlorobenzene is used in a mixture with *o*-dichlorobenzene as a coolant in a closed system in the manufacture of organic chemicals.

As listed in Table 4-1 this OES includes the Function fluids (closed system) COU category.

4.3.10.1 Process Description

The *p*-dichlorobenzene in this process is used as a non-contact cooling medium. It is contained in a closed heat transfer system that recirculates within an organic chemical manufacturing process unit. The heat transfer fluid is a mixture of 25% *p*-dichlorobenzene and 75% *o*-dichlorobenzene. The *p*-

dichlorobenzene is removed from the system only during maintenance, which occurs every 3 to 5 years (EPA-HQ-OPPT-2018-0446-0037).

4.3.10.2 Number of Facilities and Release Days

EPA used TRI, NEI, DMR, and CDR data between 2019 and 2023 to identify one facility that potentially use *p*-dichlorobenzene as a functional fluid. Facilities that indicated a release of *p*-dichlorobenzene and were reported to use *p*-dichlorobenzene as a functional fluid were categorized into this OES.

Note that facilities may report to multiple databases under different names, and in these cases, EPA used reported addresses and company information to match facilities with their equivalents across databases but there is some uncertainty to the facility estimate due to this.

Due to the uncertainty associated with reporting limits in the release databases, which may result in an underestimate of releasing facilities, EPA also considered the approach of estimating number of facilities using relevant NAICS codes for the OES. This approach involved first identifying the relevant NAICS codes for the OES. EPA then considered a bounding estimate of 841 sites for this OES based on the number of sites listed under the identified NAICS code. Using a bounding estimate will likely overestimate the true number of sites that use *p*-dichlorobenzene for this OES. EPA assigned the following NAICS codes for this OES:

- 333415 – Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing.

EPA did not identify data on facility operating schedules, so the Agency assumed that the chemical of interest is not always in use at the facility—even if the facility operates 24/7. For these cases in general EPA may use a value of 300 days/year based on the "SpERC fact sheet – Formulation & (re)packing of substances and mixtures – Industrial (Solvent-borne)" that uses a default of 300 days/year for the chemical industry (ESIG, 2012). However, in instances such as Use in Functional Fluids, where the OES uses a low volume of the chemical of interest, EPA assumes 250 days per year as a lower estimate. See Section 4.2.5. Without additional information, EPA also assumes that number of release days per year is equivalent to the number of operating days per year.

4.3.10.3 Release Points

EPA expects releases to occur to water, incineration, or landfill due to container residue in transport containers, product sample wastes, and equipment cleaning. Due to the chemical's volatility, the Agency also expects losses to air during container and equipment cleaning, transfer operations such as loading and unloading, and product sampling. EPA further expects stack air releases from vented losses during packaging into transport containers. Most release points would occur during the transport of the material to and from the process because the process is a closed system in which the chemical is rarely removed, and so releases to the environment due to the process itself are expected to be minimal.

4.3.10.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the use of *p*-dichlorobenzene in functional fluids. A summary of releases can be found in the supplemental files referenced at the beginning of Section 4.3. According to reported data, *p*-dichlorobenzene is released through the following environmental media: surface water. However, EPA does not expect significant releases to air, water, or land from this OES.

4.3.11 Use of Air Care Products

p-Dichlorobenzene is used in air car products such as antimicrobial products, bathroom cleaners, urinal and toilet deodorants, and deodorizing wall blocks. In several cases such as in use in toilet and urinal products *p*-dichlorobenzene is an active ingredient and may be present in a nearly pure form (>99%) (EPA-HQ-OPPT-2018-0446-0011; EPA-HQ-OPPT-2018-0446-0004; Home Depot, 2019; Willert Home Products, 2019; Hospeco, 2018). While available in the consumer market, toilet and urinal deodorizers and fresheners are routinely used in marketplaces, households, and businesses such as restaurants and hotels. One manufacturer reported that most of their toilet deodorizer product is used for toilet bowls, with 0.5% used for garbage cans or in clothes closets (EPA-HQ-OPPT-2018-0446-0011).

As listed in Table 4-1 this OES includes the Air care products COU category within the commercial use life cycle stage.

4.3.11.1 Process Description

p-Dichlorobenzene may be present in multiple air care products. In the case of toilet deodorizers, these products are manufactured in tablet form, and each tablet it attached to a hanging device and hung on a toilet bowl or garbage can. The product is expected to slowly evaporate when exposed to air (EPA-HQ-OPPT-2018-0446-0011).

4.3.11.2 Number of Facilities and Release Days

EPA did not find information from TRI, NEI, DMR, or CDR data between 2019 and 2023 to identify number of facilities associated with this OES. Therefore, EPA assessed a bounding estimate of 69,698 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this OES. EPA assigned the following NAICS codes for this OES:

- 561720 – Janitorial Services; and
- 424690 – Other Chemical and Allied Products Merchant Wholesalers.

EPA did not identify data on facility operating schedules, however as these products may be attached to a toilet or garbage can and released continuously, the Agency assumes 365 days/yr of release (Section 4.2.5).

4.3.11.3 Release Points

EPA expects releases to occur to water during the transport, installation, and use of this product. Releases to air are expected through the product's lifecycle due to the chemical's volatility and releases due to incineration and landfill as expected during the disposal of the product.

4.3.11.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the use of *p*-dichlorobenzene in air care products. A summary of releases can be found in the supplemental files referenced at the beginning of Section 4.3. Because there are no reported releases of *p*-dichlorobenzene found associated with this OES, EPA does not expect significant releases to air, water, or land from this OES.

4.3.12 Use as Commercial Laboratory Chemical

EPA has identified several cases of *p*-dichlorobenzene in use as a laboratory chemical. A commenter (EPA-HQ-OPPT-2018-0446-0036) provided descriptions of their use of *p*-dichlorobenzene as a critical use as a reference sample for analysis of terrestrial and extraterrestrial material samples and in laboratory applications for analytical standards, research, equipment calibration and sample preparation.

Several products intended for laboratory use were also found, indicating *p*-dichlorobenzene present in both neat form (Sigma-Aldrich, 2024) and within a formulation at up to 1% (Supelco, 2025).

As listed in Table 4-1 this OES includes the Other Use COU within the commercial use life cycle stage

4.3.12.1 Process Description

p-Dichlorobenzene may be involved in various processes as a laboratory chemical. Some applications listed by providers for neat *p*-dichlorobenzene include the use as a reactant in the synthesize nitro-aromatics via electrophilic nitration and polyarylbenzenes through C-C cross coupling with arylboronic acids using imidazolium salt as a catalyst. It can also be used in the Pd-catalyzed Mizoroki-Heck coupling reaction with alkenes (Sigma-Aldrich, 2024). EPA has observed reports of solid *p*-dichlorobenzene transported in 100 gram or 3 kilogram containers. *p*-Dichlorobenzene was also reported within a volatile organic calibration mix, transported within a 1 mL ampule that has been used as a standard in the analysis of contaminants like VOCs in food product samples by using gas chromatography coupled with mass spectrometry (GC-MS) (Supelco, 2025).

p-Dichlorobenzene is expected to be used in these laboratory procedures and then disposed of with other laboratory wastes. Figure 4-6 highlights the typical release and exposure points during the use of *p*-dichlorobenzene.

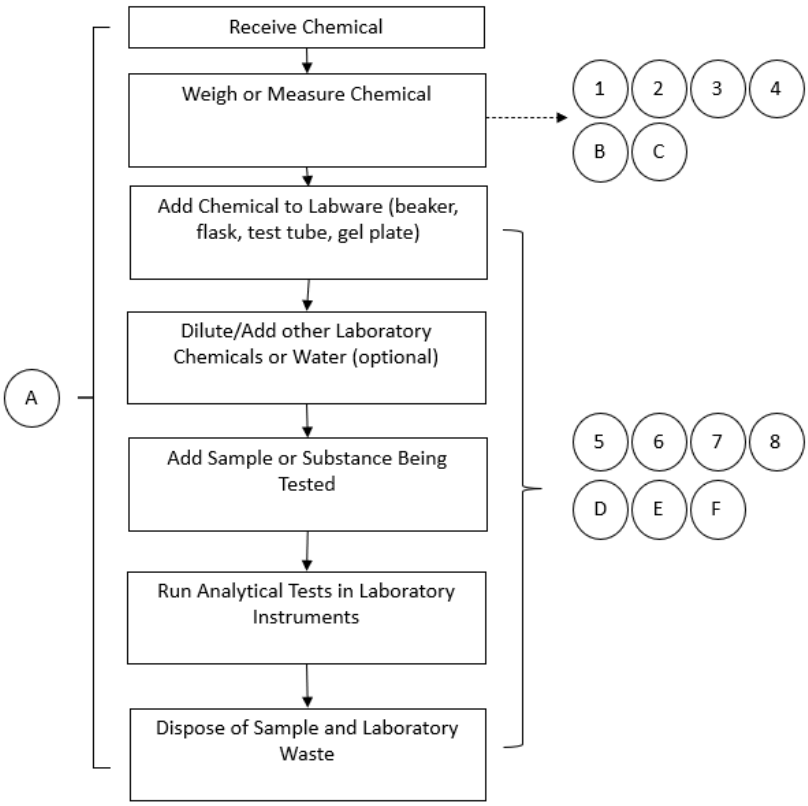

Figure 4-6. Typical Release and Exposure Points During the Laboratory Use of *p*-Dichlorobenzene
Source: (U.S. EPA, 2023g)

Environmental Releases:

1. Release to air from transferring volatile chemicals from transport containers.
2. Release to air, water, incineration, or landfill from transferring solid powders.
3. Release to water, incineration, or land from cleaning or disposal of transport containers.
4. Release to air from cleaning containers used for volatile chemicals.
5. Labware equipment cleaning residuals released to water, incineration, or landfill.

6. Release to air during labware equipment cleaning for volatile chemicals.
7. Release to air from laboratory analyses for volatile chemicals.
8. Release to water, incineration, or landfill from laboratory waste disposal.

Occupational Exposures:

A. Full-shift inhalation exposure from all activities.
B. Inhalation exposure from unloading chemicals from transport containers (if full-shift estimates are not used).
C. Inhalation exposure during container cleaning throughout sample preparation and testing activities (if full-shift estimates are not used).
D. Inhalation exposure during equipment cleaning (if full-shift estimates are not used).
E. Inhalation exposure during laboratory analyses (if full-shift estimates are not used).
F. Inhalation exposure during disposal of laboratory chemicals (non-quantifiable).

4.3.12.2 Number of Facilities and Release Days

EPA reviewed information from TRI, NEI, DMR, or CDR data between 2019 and 2023 to identify number of facilities associated with this OES and found two facilities. Due to the low number of facilities, EPA used an alternative method to estimate number of facilities. EPA assessed a bounding estimate of 10,490 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this OES. EPA assigned the following NAICS codes for this OES:

- 541380 – Testing Laboratories; and
- 541714 – Research and Development in Biotechnology (except Nanobiotechnology).

EPA did not identify data on facility operating schedules; therefore, the Agency assumes operation 5 days/week for 50 weeks/yr. This results in 250 days/yr of operation (Section 4.2.5). Without additional information, EPA further assumes that number of release days per year is equivalent to the number of operating days per year.

4.3.12.3 Release Points

EPA expects releases to air, water, incineration, or landfill from transferring volatile chemicals from transport containers, cleaning or disposal of transport containers, cleaning containers used for volatile chemicals, labware equipment cleaning residuals, labware equipment cleaning, laboratory analyses, and laboratory waste disposal.

4.3.12.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the use of *p*-dichlorobenzene as a commercial laboratory chemical. A summary of releases can be found in the supplemental files referenced at the beginning of Section 4.3. Because there are only two reported releasing facilities of *p*-dichlorobenzene found associated with this OES, EPA does not expect significant releases to air, water, or land from this OES.

4.3.13 Application of Sealants

p-Dichlorobenzene was identified in several building sealant products, including one that indicates the presence of *p*-dichlorobenzene at concentrations of 5 to 10% (Convenience Products, 2016). Although these products are available in the consumer market, they may also be used in a commercial setting in the construction, home repair, and pest control industries.

As listed in Table 4-1 this OES captures the Building and construction products COU category within the commercial use life cycle stage.

4.3.13.1 Process Description

The following is obtained from the instructions of DAP Mouse Shield Pest Block Foam Sealant, which contains *p*-dichlorobenzene at concentrations between 5 and 10% (Convenience Products, 2016). To use the sealant, the can is held upside-down and slowly activated to fill the gap that requires filling. It is advised to keep the mechanism tip moving to reduce the possibility of overfilling, as the product expands after it is dispensed. The product advises filling no more than one-third of the gap to allow for expansion of the product. The foam may continue dispensing for a few seconds after the trigger is released. The foam is dried into a solid state in 30 minutes and fully cured in 4 hours. Once dried the foam can be trimmed, sanded, caulked, plastered, or painted.

The product is described as a sealant for gaps and crevices, forms a guard against unwanted pests and drafts, and crafted to repel mice, birds, bats, and a variety of insects and spiders. It is sold in 12-ounce cans.

4.3.13.2 Number of Facilities and Release Days

EPA did not find information from TRI, NEI, DMR, or CDR data between 2019 and 2023 to identify number of facilities associated with this OES. Therefore, the Agency assessed a bounding estimate of 2,023 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this OES. EPA assigned the following NAICS codes for this OES:

- 335300 – Electrical Equipment Manufacturing.

EPA did not identify data on operating schedules; therefore, the Agency assumes the relevant products may not be used every day of the year, and so an estimate of 250 days/yr of release is used in the assessment (Section 4.2.5).

4.3.13.3 Release Points

EPA expects releases to occur to air, water, and land during the transport and use of this product. Releases to air during initial application—and to a lesser degree through the product's life, even following application—are expected due to the chemical's volatility. Releases due to incineration and landfill as expected during the disposal of the product.

4.3.13.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the application of *p*-dichlorobenzene in a sealant. A summary of releases can be found in the supplemental files referenced at the beginning of Section 4.3. Because there are no reported releases of *p*-dichlorobenzene found associated with this OES, EPA does not expect significant releases to air, water, or land from this OES.

4.3.14 Waste Handling, Treatment, and Disposal

As listed in Table 4-1 this OES captures the Disposal COU category.

4.3.14.1 Process Description

Each of the COUs of *p*-dichlorobenzene may generate waste streams of the chemical that are collected and transported to third-party sites for disposal or treatment (see Figure 4-7). Industrial sites that treat and/or dispose of onsite wastes that they themselves generate are assessed within the relevant COU. Wastes of *p*-dichlorobenzene that are generated during a COU and sent to a third-party site for treatment, disposal, or recycling may include the following:

- ***Wastewater:*** *p*-dichlorobenzene may be contained in wastewater discharged to POTW or other, non-public treatment works for treatment. Off-site transfers may include aqueous streams that were collected and destined for off-site treatments. These include particulate matter collected in air pollution control devices, wastewater and slurries from equipment cleaning, plastic pellet spills, and container residue (OECD, 2005). Industrial wastewater containing *p*-dichlorobenzene 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 *p*-dichlorobenzene is included in each of the COU assessments in Sections 4.3.1 through Sections 4.3.13.
- ***Solid Wastes:*** Non-hazardous solid wastes are managed under Subtitle D and, if land disposed, go to Subtitle D (non-hazardous) landfills per state requirements. However, solid wastes are hazardous if they are listed at 40 CFR 261.30 to 261.35 or exhibit a characteristic under 40 CFR 261.20 to 261.24. Hazardous waste must be managed under RCRA Subtitle C at permitted treatment, storage, and disposal facilities (TSDFs) and if land disposed, must meet land disposal restrictions and be placed in a Subtitle C (hazardous) landfill. Off-site transfers from plastic compounding/converting may include solids sent for treatment or disposal consistent with their non-hazardous/ hazardous status (OECD, 2005).
- ***p-Dichlorobenzene Is a U-Listed Hazardous Waste Under Code U072 Under RCRA:*** therefore, discarded, unused pure and commercial grades of *p*-dichlorobenzene are regulated as a hazardous waste under RCRA (40 CFR 261.33(f)).
- ***Wastes Exempted as Solid Wastes Under RCRA:*** Certain COUs of *p*-dichlorobenzene may generate wastes of *p*-dichlorobenzene that are exempted as solid wastes under 40 CFR 261.4(a). For example, the generation and legitimate reclamation of hazardous secondary materials of *p*-dichlorobenzene may be exempt as a solid waste.

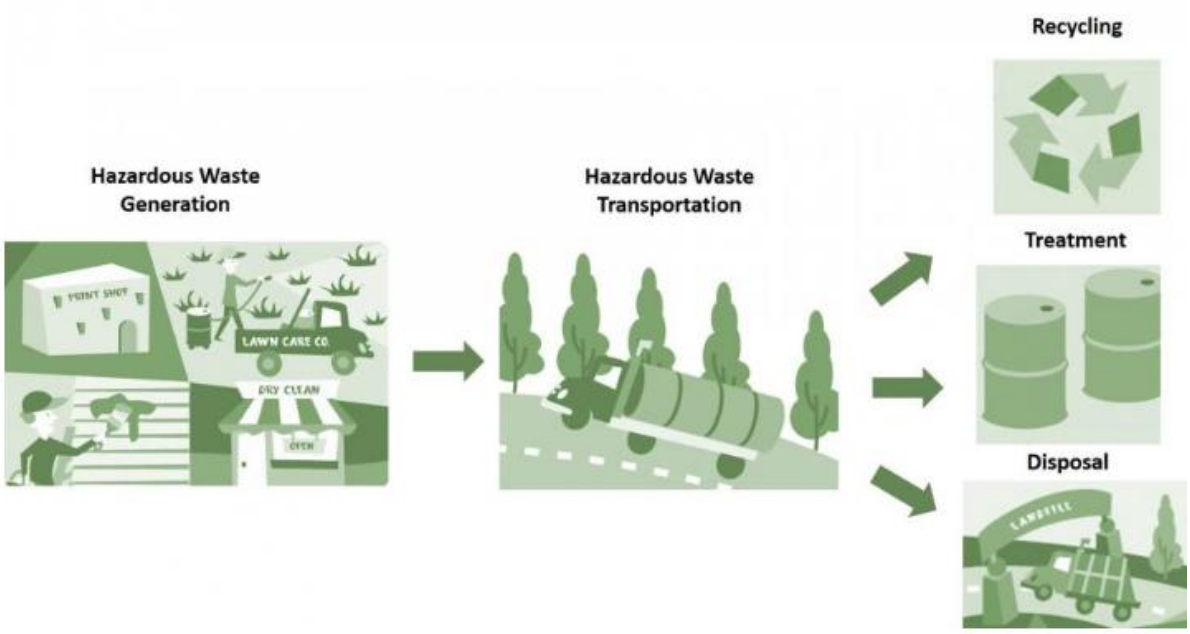

Figure 4-7. Typical Waste Disposal Process (U.S. EPA, 2019d)

Municipal Waste Incineration

Municipal waste combustors (MWCs) that recover energy are generally located at large facilities comprising an enclosed tipping floor and a deep waste storage pit. Typical large MWCs may range in capacity from 250 to over 1,000 tons per day. At facilities of this scale, waste materials are not generally

handled directly by workers. Trucks may dump the waste directly into the pit, or waste may be tipped to the floor and later pushed into the pit by a worker operating a front-end loader. A large grapple from an overhead crane is used to grab waste from the pit and drop it into a hopper, where hydraulic rams feed the material continuously into the combustion unit at a controlled rate. The crane operator also uses the grapple to mix the waste within the pit, to provide a fuel consistent in composition and heating value, and to pick out hazardous or problematic waste.

Facilities burning refuse-derived fuel (RDF) conduct on-site sorting, shredding, and inspection of the waste prior to incineration to recover recyclables and remove hazardous waste or other unwanted materials. Sorting is usually an automated process that uses mechanical separation methods, such as trommel screens, disk screens, and magnetic separators. Once processed, the waste material may be transferred to a storage pit, or it may be conveyed directly to the hopper for combustion.

Tipping floor operations may generate dust. Air from the enclosed tipping floor, however, is continuously drawn into the combustion unit via one or more forced air fans to serve as the primary combustion air and minimize odors. Dust and lint present in the air is typically captured in filters or other cleaning devices in order to prevent the clogging of steam coils, which are used to heat the combustion air and help dry higher-moisture inputs (Kitto and Stultz, 1992).

Hazardous Waste Incineration

A typical industrial incineration process is illustrated in Figure 4-8. Commercial scale hazardous waste incinerators are generally two-chamber units, a rotary kiln followed by an afterburner, that accept both solid and liquid waste. Liquid wastes are pumped through pipes and are fed to the unit through nozzles that atomize the liquid for optimal combustion. Solids may be fed to the kiln as loose solids gravity fed to a hopper, or in drums or containers using a conveyor (Center, 2018; Heritage, 2018).

Incoming hazardous waste is usually received by truck or rail, and an inspection is required for all waste received. Receiving areas for liquid waste generally consist of a docking area, pumphouse, and storage facilities. For solids, conveyor devices are typically used to transport incoming waste (Center, 2018; Kitto and Stultz, 1992)

Smaller scale units that burn municipal solid waste or hazardous waste (such as infectious and hazardous waste incinerators at hospitals) may require more direct handling of the materials by facility personnel. Units that are batch-loaded require the waste to be placed on the grate prior to operation and may involve manually dumping waste from a container or shoveling waste from a container onto the grate.

The concentration of *p*-dichlorobenzene in hazardous waste entering incineration facilities is not reported, but the mass of *p*-dichlorobenzene disposed of in ash and released with stack emissions is reported in TRI.

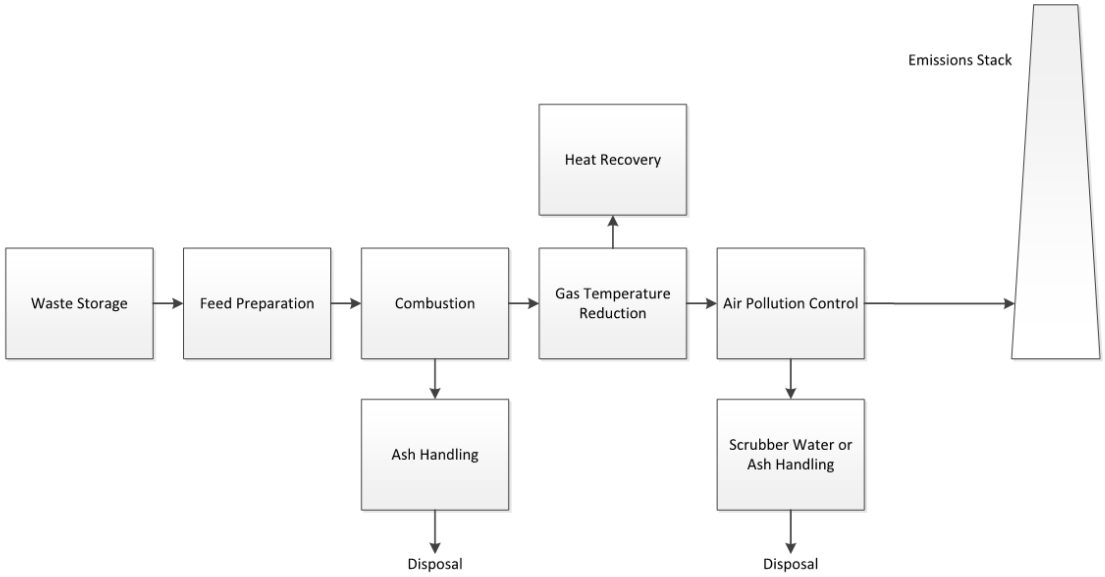

Figure 4-8. Typical Industrial Incineration Process

Municipal Waste Landfill

Municipal solid waste landfills are discrete areas of land or excavated sites that receive household wastes and other types of non-hazardous wastes (*e.g.,* industrial and commercial solid wastes). Standards and requirements for municipal waste landfills include location restrictions, composite liner requirements, leachate collection and removal system, operating practices, groundwater monitoring requirements, closure-and post-closure care requirements, corrective action provisions, and financial assurance. Non-hazardous solid wastes are regulated under RCRA Subtitle D, but states may impose more stringent requirements. Municipal solid wastes may be first unloaded at waste transfer stations for temporary storage, prior to being transported to the landfill or other treatment or disposal facilities. There are pathways for substances that are listed as hazardous wastes to be properly disposed of in non-Hazardous Waste landfills (non-subtitle C landfills) if certain criteria are met or if they are a part of certain exempt categories.

Hazardous Waste Landfill

Hazardous waste landfills are excavated or engineered sites specifically designed for the final disposal of non-liquid hazardous wastes. Design standards for these landfills require double liner, double leachate collection and removal systems, leak detection system, run on, runoff and wind dispersal controls, and construction quality assurance program (U.S. EPA, 2018c). There are also requirements for closure and post-closure, such as the addition of a final cover over the landfill and continued monitoring and maintenance. These standards and requirements prevent potential contamination of groundwater and nearby surface water resources. Hazardous waste landfills are regulated under CFR part 264/265, subpart N. The exact concentration of *p*-dichlorobenzene in landfilled hazardous waste is not reported.

4.3.14.2 Number of Facilities and Release Days

EPA used TRI, NEI, DMR, and CDR data between 2019 and 2023 to identify facilities that potentially conduct waste handling, treatment, and disposal of *p*-dichlorobenzene. Facilities that indicated a release of *p*-dichlorobenzene, and that appeared to conduct waste handling activities were categorized into this OES.

Note that facilities may report to multiple databases under different names, and in these cases, EPA used reported addresses and company information to match facilities with their equivalents across databases but there is some uncertainty to the facility estimate due to this.

EPA did not identify data on facility operating schedules; therefore, EPA assumes waste handling occurs 7 days/week and 50 weeks/year (with 2 weeks down for turnaround), which results in an estimate of 350 days/yr of operation (Section 4.2.5). Without additional information, EPA assumes that number of release days per year is equivalent to the number of operating days per year.

4.3.14.3 Release Points

Sources of potential environmental release include the unloading of solid or liquid waste containers. Releases may occur while connecting and disconnecting transfer lines and hoses, and during the treatment of waste. EPA expects releases to air of volatile *p*-dichlorobenzene during waste handling, treatment, and disposal. Additionally, the Agency expects releases of solid or liquid waste to land.

4.3.14.4 Release Assessment

EPA used 2019 to 2023 TRI, 2017 and 2020 NEI, and 2019 to 2023 DMR to estimate environmental releases during the waste handling, treatment, and disposal of *p*-dichlorobenzene. A summary of releases can be found in the supplemental files referenced at the beginning of Section 4.3; a summary of releases from TRI is presented in Table 4-7. TRI releases are summarized herein because the release data from TRI are the primary data used in this draft assessment because the highest releases to the environment are reported from TRI. According to reported data, *p*-dichlorobenzene is released through the following environmental media: surface water, fugitive air, stack air, and land. However, EPA does not expect significant releases to water from this OES.

Table 4-7. Summary of Environmental Releases of *p*-Dichlorobenzene During Waste Handling, Treatment, and Disposal

Media	Estimated Annual Release Range Across Sites (kg/yr)		Number of Release Days	Estimated Daily Release Range Across Sites (kg/day)		Number of Facilities	Source
	Central Tendency	High-End		Central Tendency	High-End		
Air (fugitive)	4.5E−02	5.6	350	1.3E−04	1.7E−02	11	TRI
Air (stack)	4.5E−02	42	350	7.8E−04	0.12	9	TRI
Land[a]	11	307	350	3.2E−02	0.88	7	TRI

[a] A majority of sites reported off-site disposal to RCRA subtitle C landfills, while 1 reported unspecified on-site disposal, another reported some release to an off-site underground injection well (class 1), and another reported off-site land release to unspecified landfills.

4.3.15 Uses Identified During Scoping but Not Quantitatively Assessed

As the risk evaluation process moved past scoping and a deeper understanding of each COU was developed, it was at times determined that a use identified during scoping and presented in the COU table would not be assessed quantitatively. In the case of *p*-dichlorobenzene, the following is a list of factors that contributed to these determinations:

1. ***Lack of Reasonably Available Information:*** EPA used systematic review to gather reasonably available information and conducted targeted searches when systematic review left gaps in the Agency's understanding of a given COU. If EPA was unable to find evidence of a use occuring,

and further investigation into the rationale for the use's inclusion in the scope did not indicate a true use of the chemical, the Agency decided not to assess the use.

2. ***Industry Comments and Outreach:*** In some cases, EPA received comments or contacted industry to request further information on certain uses. The industries contacted were chosen for a variety of reasons, including if they left a public comment that was relevant to the use in question and the Agency needed more clarification, or if it was indicated in a database, company website, or SDSs that a particular entity may have knowledge of the suspected use. These communications sometimes led to the decision to not assess a use in cases where more information from industry indicated that the suspected use is not relevant to the chemical.
3. ***Increased Understanding of p-Dichlorobenzene's Place in the Use:*** Although *p*-dichlorobenzene may have been reported as being present in a particular use, there were cases when it was found upon further investigation that *p*-dichlorobenzene was only present in "up-stream" steps of the processing, and by the time in a product's life cycle it reached the reported COU, *p*-dichlorobenzene was no longer a component, or present only in residual amounts.

The following sections describe each use that was not assessed and detail the specific rationale for why the use was included in the scope but was ultimately excluded from the risk evaluation.

4.3.15.1 Use in Lubricants and Greases, and Use in Engine Additive

This section includes a discussion on two OESs. The first is Use in Lubricants and Greases, which covers the COU subcategory of Lubricants and greases. The second OES is Use in Engine Additives, which covers the COU subcategory of Fuel additive. Both OESs are discussed together due to the similarity of the relevant products that come from the same manufacturer.

p-Dichlorobenzene has been reported as a constituent within products or formulations for the manufacture, operation, and maintenance of automotive and aerospace products. More specifically it was reported as a component of automotive engine oils, and oils used to maintain tools (EPA-HQ-OPPT-2018-0446-0007). *p*-Dichlorobenzene was also indicated to be present in some fuel additive products that are marketed to the aerospace community but not widely used (EPA-HQ-OPPT-2018-0444-0016).

EPA has identified a single fuel additive product that contains *p*-dichlorobenzene, and it contains less than 0.01% *p*-dichlorobenzene, as per its SDS (Marvel Oil Company, 2024b). The product is a multipurpose lubricant for use in a variety of engine types and is also registered fuel additive for use in unleaded gasoline and diesel. It is designed to be used in automobiles as an engine oil additive and as a fuel additive and is sold into the consumer market in 16-, 32-, and 128-ounce sizes.

The same manufacturer as the fuel additive also produces a lubricant product that is only for pneumatic tools. It is designed to be used to lubricate air-driven motors in tools such as impact wrenches and other tools with high-speed motors that are air-driven. This product is used throughout commercial manufacturing and maintenance operations nationwide and is sold in 4- and 32-ounce sizes.

Both products are used in industrial, commercial, and consumer settings and are sold online, in stores, auto supply stores, and in other settings.

Although *p*-dichlorobenzene is indicated to be present in amount less than 0.1%, the company informed EPA in a public comment that the *p*-dichlorobenzene within these products exists only as a contaminant of *o*-dichlorobenzene, which is present in the products at 0.12%. The comment expresses that there are

no test results that indicate the presence of *p*-dichlorobenzene in the products, and it is included as a possible component out of an abundance of caution (EPA-HQ-OPPT-2018-0446-0028).

EPA found no additional evidence of these uses for *p*-dichlorobenzene and so has determined that releases and exposures due to this use are negligible.

4.4 Weight of Scientific Evidence Conclusions for Release Assessment

EPA considered the assessment approach, the quality of the data, and the strengths, limitations, assumptions, and key sources of uncertainties in the assessment results to determine a weight of scientific evidence (WOSE) rating. EPA considered factors that increase or decrease the strength of the evidence supporting the release estimate—including quality of the data/information, applicability of the release or exposure data to the OES (including considerations of temporal relevance, locational relevance) and the representativeness of the estimate for the whole industry. The best professional judgment is summarized using the descriptors of robust, moderate, slight, or indeterminant, according to EPA's 2021 Draft Systematic Review Protocol (U.S. EPA, 2021a). For example, a conclusion of moderate is appropriate where there is measured release data from a limited number of sources such that there is a limited number of data points that may not cover most or all the 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 Protocol (U.S. EPA, 2021a) for additional information on weight of scientific evidence conclusions.

WOSE ratings for the environmental release and 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.

4.4.1 Overall Confidence in Release Estimates by OES

EPA considered release data from TRI, DMR, and NEI to estimate releases for this chemical. In a screening-level approach, EPA investigated the MOEs below the benchmark MOE for the general population and the environment associated with all releases from TRI, and the highest release from DMR. NEI was compared to TRI, and the highest facility release in NEI was found to be less than the highest facility release in TRI. No MOEs were below the benchmark for the general population or the environment due to these releases. Since releases greater than those that report to TRI, DMR, and NEI are not expected, EPA did not take further steps to model OESs that had limited release data.

Water releases are assessed using reported releases from 2019 to 2023 TRI and DMR. These databases received a medium and high data quality rating in systematic review respectively. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. Factors that decrease the overall confidence for this estimate include the uncertainty in the accuracy of reported releases, and uncertainty in mapping the releases to an OES, and the uncertainty in matching TRI sites with their entries in DMR (in cases when a facility may report to both). Most facilities only report NAICS codes to DMR; therefore, it can be uncertain what specific activity involving *p*-dichlorobenzene is occuring at the site. Additionally, there are a multitude of sites that report to NEI and not TRI or DMR, indicating that *p*-dichlorobenzene is present in more facilities than are reported in the water release data available to EPA. It is unclear whether these sites do not release to water, or if the site does not meet reporting thresholds for TRI.

Air releases are assessed using reported releases from 2019 to 2023 TRI, and 2017 and 2020 NEI. NEI received a high data quality rating in systematic review. A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. Factors that decrease the

overall confidence in information from the NEI database include the uncertainty in the accuracy of reported releases, and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites. Additionally, EPA made assumptions on the number of operating days to estimate daily releases.

Land releases are assessed using reported releases from 2019 to 2023 TRI. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. Factors that decrease the overall confidence for this estimate 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.

In 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 release assessment relevant to OESs that had release data available is moderate to robust. Some OESs did not have release data available, and these cases were assessed qualitatively using the assumption that these cases would not have releases higher than those releases reported to the databases. These qualitative cases received a moderate rating in consideration of the strengths and limitations of reasonably available data. Table 4-8 presents which assessments were assessed quantitatively versus qualitatively.

Table 4-8. Summary of the Data Sources for Environmental Releases by OES

OES	Release Media	Reported Data[a]	Data Quality Rating[b]	Qualitative Assessment[c]	WOSE Conclusion
Manufacturing	Air	✓	M/H	×	Moderate-to-Robust
	Water	✓	H	×	
	Land	×	Not applicable	✓	
Repackaging	Air, water, land	×	Not applicable	✓	Moderate
Processing as a Reactant	Air	✓	M/H	×	Moderate-to-Robust
	Water	✓	M/H	×	
	Land	✓	M	×	
Incorporation into Formulation	Air	✓	M/H	×	Moderate-to-Robust
	Water	✓	M/H	×	
	Land	×	Not applicable	✓	
Plastic Compounding	Air	✓	H	×	Moderate-to=Robust
	Water	×	Not applicable	✓	
	Land	×	Not applicable	✓	
Incorporation into Air Care Products	Air	✓	M/H	×	Moderate-to-Robust
	Water	✓	H	×	
	Land	×	Not applicable	✓	
Plastic Converting	Air, water, land	×	Not applicable	✓	Moderate
Incorporation into Grinding Wheels	Air, water, land	×	Not applicable	✓	Moderate

OES	Release Media	Reported Data[a]	Data Quality Rating[b]	Qualitative Assessment[c]	WOSE Conclusion
Use in Functional Fluids	Air, water, land	×	Not applicable	✓	Moderate
Use in Air Care Products	Air, water, land	×	Not applicable	✓	Moderate
Use as Laboratory Chemical	Air, water, land	×	Not applicable	✓	Moderate
Application of Sealants	Air, water, land	×	Not applicable	✓	Moderate
Waste handling, treatment, and disposal	Air	✓	M/H	×	Moderate-to-Robust
	Water	✓	H	×	
	Land	✓	M	×	

[a] Reported data includes data obtained from EPA databases (*i.e.,* TRI, DMR, and NEI).
[b] Data quality ratings for reported data are based on EPA systematic review and include ratings low (L), medium (M), and high (H)
[c] Where no data were available to estimate releases for an OES, releases were described qualitatively.

Table 4-9 provides further discussion on the rating of each OES.

Table 4-9. Summary of Assumptions, Uncertainty, and Overall WOSE Conclusions in Release Estimates by OES

OES	Weight of Scientific Evidence Rating
Manufacturing	Environmental releases to air were assessed using reported releases from 2019–2023 TRI (U.S. EPA, 2023f), which received a medium rating in EPA's systematic review. Releases to water from DMR data from 2019–2023 (U.S. EPA, 2026z), and releases to air from NEI data from 2017 to 2020 (U.S. EPA, 2023a, 2019e) were also considered but not expected to be significant due to the screening-level assessments conducted on both databases (Section 4.2.3). DMR and NEI received a high rating from EPA's systematic review process. No releases to land for this OES were reported. TRI, DMR, and NEI data capture air and water environmental releases from seven manufacturing facilities that potentially manufacture *p*-dichlorobenzene as a byproduct in their chemical manufacturing process. As Westlake reported that *p*-dichlorobenzene is manufactured as a byproduct during the production of vinyl chloride monomer (VCM) {Exponent Inc, 2024, 13170985}, facilities indicating the release of *p*-dichlorobenzene, and were seen to produce VCM or indicated in TRI that the chemical's presence is due to its manufacture as a byproduct, were categorized into this OES. These facilities reported no releases to land in TRI. EPA judges the weight of scientific evidence for the release assessment for this OES to be moderate to robust, based on the availability of facility-reported release data in EPA programmatic databases for this OES
Repackaging	This OES covers repackaging activities as well as the loading/unloading and repackaging associated with importing p-dichlorobenzene (transportation is excluded). Given the low reported amounts, EPA conducted a qualitative assessment of releases from this OES. Environmental releases to air, water, and land from this OES are expected to be negligible and lower than those OESs reporting releases any EPA programmatic database (e.g., Processing as a reactant). EPA concluded that the weight of scientific evidence for this assessment is moderate, considering the strengths and limitations of reasonably available data.
Processing as a Reactant	Environmental releases to air, water, and land were assessed using reported releases from 2019–2023 TRI (U.S. EPA, 2023f), which received a medium rating in EPA's systematic review. Releases to water from DMR data from 2019–2023 (U.S. EPA, 2026z), and releases to air from NEI data from 2017–2020 (U.S. EPA, 2023a, 2019e) were also considered but not expected to be significant due to the screening-level assessments conducted on both databases (Section 4.2.3). DMR and NEI received a high rating from EPA's systematic review process. TRI, DMR, and NEI data capture environmental releases from 14 processing sites. EPA concludes that the evidence base supporting release assessments for this OES is moderate to robust based on the availability of facility-reported release data in EPA program databases for this OES.
Incorporation into Formulation, Mixture, or Reaction Product	Environmental releases to air were assessed using reported releases from 2019–2023 TRI (U.S. EPA, 2023f), which received a medium rating in EPA's systematic review. Releases to water from DMR data from 2019–2023 (U.S. EPA, 2026z), and releases to air from NEI data from 2017–2020 (U.S. EPA, 2023a, 2019e) were also considered but not expected to be significant due to the screening-level assessments conducted on both databases (Section 4.2.3). DMR and NEI received a high rating from EPA's systematic review process. TRI, DMR, and NEI data capture environmental releases from 106 sites related to this OES. EPA concludes that the evidence base for release assessments for this OES is moderate to robust based on the availability of facility-reported release data in EPA program databases for this OES.

OES	Weight of Scientific Evidence Rating
Plastic Compounding	Environmental releases to air from NEI data from 2017–2020 (U.S. EPA, 2023a, 2019e) were considered in this assessment but not expected to be significant since the highest releasing facility in NEI had a lower release than the highest TRI facility release (Section 4.2.3). NEI received a high rating from EPA's systematic review process. No releases to air, water, or land for this OES were reported in TRI or DMR. NEI data captured environmental releases from 35 sites. Because the programmatic data provide a holistic assessment of releases from facilities that use *p*-dichlorobenzene in plastic compounding, there is increased confidence that the release data cover all known manufacturing releases in the United States. The main strength of the analysis includes using industry reported release data from an EPA database. The limitations of the analysis include the temporal relevancy of the release data compared to the current year. Therefore, EPA concluded that the weight of scientific evidence for this assessment is moderate to robust, considering the strengths and limitations of reasonably available data.
Incorporation into Air Care Products	Environmental releases to air were assessed using reported releases from 2019–2023 TRI (U.S. EPA, 2023f), which received a medium rating in EPA's systematic review. Releases to water from DMR data from 2019–2023 (U.S. EPA, 2026z), and releases to air from NEI data from 2017–2020 (U.S. EPA, 2023a, 2019e) were also considered but not expected to be significant due to the screening-level assessments conducted on both databases (Section 4.2.3). DMR and NEI received a high rating from EPA's systematic review process. No releases to land for this OES were reported. TRI, DMR, and NEI data capture environmental releases from 2 sites where incorporation into air care products occurs. However, no releases to land for this OES were reported. EPA finds that the evidence base supporting release assessments for this OES is moderate to robust, based on the availability of facility-reported release data in EPA program databases for this OES
Plastic Converting	There were 12 facilities that reported air release data to NEI from facilities that may use *p*-dichlorobenzene in plastic converting. Since residual *p*-dichlorobenzene (after the OES Processing as a reactant) in PPS resin is expected to be below 100 ppm, the amount available for release is further reduced during the Plastic Compounding OES. Accordingly, quantitative release estimation for plastic compounding was not necessary, consistent with the absence of reported *p*-dichlorobenzene releases from EPA programmatic databases. Due to this, there is increased confidence in the qualitative assessment of releases from plastic converting facilities, which contain even lower residual *p*-dichlorobenzene concentrations that *p*-dichlorobenzene releases from plastic compounding facilities. The strengths of the qualitative analysis include the comparison with processing data that is expected to be higher. However, the limitations of the analysis include the lack of directly applicable release data. Therefore, EPA concluded that the weight of scientific evidence for this assessment is moderate, considering the strengths and limitations of reasonably available data.
Incorporation into Grinding Wheels	There were no release data for air, water, or land from facilities that incorporate *p*-dichlorobenzene into grinding wheels. Consequently, EPA provided a qualitative assessment of releases. It is expected that releases to air, water, and land from this OES will be less than processing uses, due to the low expected production volume of *p*-dichlorobenzene going to this use, and because a higher release volume would have been reported to the release databases. Due to this, there is increased confidence in the qualitative assessment of releases from facilities that repackage *p*-dichlorobenzene.

OES	Weight of Scientific Evidence Rating
	The strengths of the qualitative analysis include the comparison with processing data that is expected to be higher. However, the limitations of the analysis include the lack of directly applicable release data. Therefore, EPA concluded that the weight of scientific evidence for this assessment is moderate, considering the strengths and limitations of reasonably available data.
Use in Functional Fluids	There was 1 facility that reported water release data to DMR from facilities that may use *p*-dichlorobenzene in functional fluids. Due to the low amounts reported EPA provided a qualitative assessment of releases, as it is expected that releases to air, water, and land from this OES will be less than processing uses due to the low expected production volume of *p*-dichlorobenzene going to this use. Due to this, there is increased confidence in the qualitative assessment of releases from facilities that repackage *p*-dichlorobenzene. The strengths of the qualitative analysis include the comparison with processing data that is expected to be higher. However, the limitations of the analysis include the lack of directly applicable release data. Therefore, EPA concluded that the weight of scientific evidence for this assessment is moderate, considering the strengths and limitations of reasonably available data.
Use in Air Care Products	There were no release data for air, water, or land from facilities that use *p*-dichlorobenzene in air care products. Consequently, EPA provided a qualitative assessment of releases. It is expected that releases to air, water, and land from this OES will be less than processing uses, due to the low expected production volume of *p*-dichlorobenzene going to this use, and because a higher release volume would have been reported to the release databases. Due to this, there is increased confidence in the qualitative assessment of releases from facilities that use *p*-dichlorobenzene in air care products. The strengths of the qualitative analysis include the comparison with processing data that is expected to be higher. However, the limitations of the analysis include the lack of directly applicable release data. Therefore, EPA concluded that the weight of scientific evidence for this assessment is moderate, considering the strengths and limitations of reasonably available data.
Use as Laboratory Chemical	There were 2 facilities that reported air release data to NEI from facilities that may use *p*-dichlorobenzene as a laboratory chemical. Due to the low amounts reported EPA provided a qualitative assessment of releases, It is expected that releases to air, water, and land from this OES will be less than processing uses, due to the low expected production volume of *p*-dichlorobenzene going to this use, and because a higher release volume would have been reported to the release databases. Due to this, there is increased confidence in the qualitative assessment of releases from facilities that use *p*-dichlorobenzene as a laboratory chemical. The strengths of the qualitative analysis include the comparison with processing data that is expected to be higher. However, the limitations of the analysis include the lack of directly applicable release data. Therefore, EPA concluded that the weight of scientific evidence for this assessment is moderate, considering the strengths and limitations of reasonably available data.
Application of Sealants	There were no release data for air, water, or land from facilities that use *p*-dichlorobenzene in sealants. Consequently, EPA provided a qualitative assessment of releases. It is expected that releases to air, water, and land from this OES will be less than processing uses, due to the low expected production volume of *p*-dichlorobenzene going to this use, and because a higher release volume would have been reported to the release databases. Due to this, there is increased confidence in the qualitative assessment of releases from facilities that use *p*-dichlorobenzene in sealants.

OES	Weight of Scientific Evidence Rating
	The strengths of the qualitative analysis include the comparison with processing data that is expected to be higher. However, the limitations of the analysis include the lack of directly applicable release data. Therefore, EPA concluded that the weight of scientific evidence for this assessment is moderate, considering the strengths and limitations of reasonably available data.
Waste Handling, Treatment, and Disposal	Environmental releases to air and land were assessed using reported releases from 2019–2023 TRI (U.S. EPA, 2023f), which received a medium rating in EPA's systematic review. Releases to water from DMR data from 2019–2023 (U.S. EPA, 2026z), and releases to air from NEI data from 2017–2020 (U.S. EPA, 2023a, 2019e) were also considered but not expected to be significant due to the screening-level assessments conducted on both databases (Section 4.2.3). DMR and NEI received a high rating from EPA's systematic review process. TRI, DMR, and NEI data capture environmental releases from 816 disposal sites. EPA judges the weight of scientific evidence for release assessments for this OES to be moderate to robust, based on the availability of facility-reported release data in EPA program databases for this OES.

2971

4.4.2 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for the Release Assessment

EPA estimated air, water, and land releases of *p*-dichlorobenzene using TRI, DMR, and NEI data. TRI was determined to have an overall data quality rating of medium through EPA's systematic review process, DMR was determined to have a high-quality rating, and NEI was determined to have a high-quality rating.

Strengths

TRI (which reports releases to air, land, and water) and NEI (which reports releases to air) provided a comprehensive amount of release data for *p*-dichlorobenzene. A strength of using TRI is that it compiles the best readily available release data for all facilities that reported to EPA. For air releases, NEI data captures additional sources that are not included in TRI due to reporting thresholds. Additionally, point sources in NEI report at the emission-unit level.

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. However, this approach assumes average quantities, concentrations, and hydrologic flows for a given period are representative of other times of the year.

Limitations

When using TRI data to analyze chemical releases, it is important to acknowledge that TRI reporting does not include all releases of the chemical and therefore, the number of sites for a given OES may be underestimated. For each OES that had TRI, DMR, or NEI data, the analysis of releases for those OESs was limited to the facilities that reported releases to TRI, DMR, or NEI. Therefore, it is uncertain the extent to which sites not captured in these databases have air, water, or land releases of *p*-dichlorobenzene.

EPA was unable to map certain facilities in NEI to an OES due to the lack of information regarding the activity of *p*-dichlorobenzene at the site. Therefore, some facilities are mapped to an "Unknown" OES.

Assumptions

To assess daily air and water discharges, EPA assumed that the number of facility operating days was equal to the number of release days. In some cases, EPA assumed the number of operating days based on industry information described in generic scenarios. In all other cases, the Agency has developed generic estimates for operating days described in Section 4.2.5.

There is uncertainty that all sites for a given OES operate for the assumed duration; therefore, the average daily releases may be higher if sites have fewer release days or lower if they have greater release days. Furthermore, *p*-dichlorobenzene concentrations in air emissions and wastewater release to receiving waterbodies at each facility may vary from day-to-day such that on any given day the actual daily releases may be higher or lower than the estimated average daily discharge. Thus, this approach minimizes variations in emissions and discharges from day to day. EPA did not estimate daily land releases due to the high level of uncertainty in the number of release days associated with land releases. The Agency expects that sites may not send waste to landfills every day and are more likely to accumulate waste for periodic shipments to landfills. However, sites that release to municipal landfills may have more frequent release days based on the frequency of shipments.

Uncertainties

Uncertainties with using TRI, DMR, and NEI data include underestimation of the number of sites for a given OES due to reporting thresholds in TRI, the accuracy of EPA's mapping of sites reporting to TRI, DMR, and NEI to a specific OES, and quality of the data reported to TRI, DMR, and NEI.

Some uncertainties of using DMR data include the accuracy of EPA's mapping of sites reporting to DMR to a specific OES, and quality of the data reported to DMR. Also, an uncertainty of using the ECHO Pollutant Loading Tool Advanced Search option is that average measurements may be reported as a quantity (kg/day) or a concentration (mg/L). Calculating annual loads from concentrations requires adding wastewater flow to the equation, which increases the uncertainty of the calculated annual load. In addition, for facilities that reported having zero pollutant loads to DMR, the EZ Search Load Module uses a combination of setting non-detects equal to zero and as one-half the detection limit to calculate the annual pollutant loadings. This method could cause overestimation or underestimation of annual and daily pollutant loads.

Some uncertainties of using NEI data include the accuracy of EPA's mapping of sites reporting to NEI to a specific OES. For point sources, there may be multiple feasible OESs at a single facility. NEI does not require stack testing or continuous emissions monitoring, and reporting agencies may use a number of different emission estimation methods with varying degrees of reliability. These methodologies include continuous emissions monitoring, stack testing, site- and vendor-specific emission factors, SLT and/or other emission factors, and engineering judgement.

In some cases, the number of facilities for a given OES was estimated using data from the U.S. Census. In such cases, the average daily release calculated from sites reporting to TRI or NEI was applied to the total number of sites reported (U.S. BLS, 2023b). It is uncertain how accurate this average release is to actual releases at these sites; therefore, releases may be higher or lower than the calculated amount.

5 ENVIRONMENTAL MEDIA CONCENTRATIONS

5.1 Approach and Methodology

A literature search was conducted to identify peer-reviewed or gray sources of *p*-dichlorobenzene measured and reported modeled data. Environmental media concentration data from studies and databases identified through systematic review were evaluated according to the process described in the 2012 Draft Systematic Review Protocol (U.S. EPA, 2021a).

EPA searched peer-reviewed and gray literature[3] published from 1990 through 2019, and databases through 2023, to obtain concentrations of *p*-dichlorobenzene in various media (air, water and land). While the systematic review included studies conducted outside of the U.S., discussion herein is focused on U.S. and Canada studies as these studies are most informative for this draft assessment. Supplemental information is provided for these studies and details on how to read and interpret the figures are provided in Appendix H. For more details on the systematic review for *p*-dichlorobenzene, see the *Draft Systematic Review Protocol for p-Dichlorobenzene (p-DCB)* (U.S. EPA, 2024f).

The approaches for estimating the concentrations of *p*-dichlorobenzene in environmental media rely on facility-specific releases associated with TSCA COUs as reported to TRI (air, water, and land), NEI (air), and National Pollutant Discharge Elimination System (NPDES) DMRs (surface water). Where facility-specific releases were not identified for a given TSCA COU, releases were estimated, as described in detail in Section 4. Across all studies, concentrations of chemicals were from monitoring surveys and not spills or contaminations.

5.2 Air Pathway

5.2.1 Measured Concentrations in Ambient Air

5.2.1.1 Ambient Monitoring Technology Information Center (AMTIC) Ambient Monitoring Archive

To complement measurements available in peer-reviewed literature, measured ambient air concentrations of *p*-dichlorobenzene were obtained from the EPA's Ambient Monitoring Technology Information Center (AMTIC[4]) Ambient Monitoring Archive for Hazardous Air Pollutants (HAPs) database (U.S. EPA, 2022b). The AMTIC Ambient Monitoring Archive houses data from over 5,000 ambient air monitoring sites across the United States collected from 1990 to present. Contributing data sources include the EPA's Air Quality System (AQS), the Texas Commission on Environmental Quality (TCEQ), the South Coast Air Quality Management District (SCAQMD), the National Atmospheric Deposition Program (NADP), the National Oceanic and Atmospheric Administration (NOAA), the Massachusetts Institute of Technology (MIT), the Louisiana Department of Environmental Quality (LDEQ), other state, local, tribal, and federal monitoring agencies, and academic, community, and short-term studies. EPA evaluated monitoring data for samples collected from January 2019 through December 2022 to align with the TRI 2019 to 2023 reported releases; AMTIC 2023 data was not yet available during this draft publication.

[3] Gray literature is defined as the broad category of data or information sources not found in the standard, peer-reviewed literature databases such as PubMed and Web of Science. It is produced by organizations outside of traditional academic publishing channels. Gray literature includes data/information sources such as white papers, conference proceedings, technical reports, reference books, dissertations, information on various stakeholder websites, and various databases.
[4] See https://www.epa.gov/amtic/air-toxics-ambient-monitoring (accessed June 17, 2026) for more information.

The *p*-dichlorobenzene AMTIC monitoring data from January 2019 to December 2022 included over 31,000 24-hour sampling entries. Samples were collected using pressurized canisters over 24-hour durations and analyzed using GC-MS with the resulting *p*-dichlorobenzene concentrations converted to µg/m^3 based on both standard temperature and pressure, and local conditions. 54.1% of samples were reported as non-detects (NDs[5]) and 30.5% of samples reported as below the method detection limit (<MDL[6]), with the MDL ranging from 0.017 to 3.06 µg/m^3. The samples that had detectable *p*-dichlorobenzene concentrations ranged from 0.0018 to 24.5 µg/m^3. The highest 24-hour concentration was reported in 2019 from a monitoring station in Philadelphia, PA (AMA site code 421010055). This specific monitoring site reported 24-hour measurements every 6 days from January 2019 to December 2022 for a total of 213 measurements. 209 (94.3%) of the measurements were reported as either ND or less than the MDL.

Overall, across all detected (*i.e.,* non-zero measurements, 24-hour concentrations from all monitoring stations between 2019–2022), the arithmetic mean was 0.43 µg/m^3, the geometric mean was 0.23 µg/m^3, and the median was 0.22 µg/m^3—indicating a positive skewness in the distribution of the monitoring data with 93.4% of the detected concentrations reported as less than 1 µg/m^3 with a majority of the samples with concentrations between 0.02 to 0.26 µg/m^3 (Figure 5-1).

When including NDs and detections less than MDLs, the arithmetic mean ranged from 0.067 to 0.099 µg/m^3 across 2019 to 2022, and the geometric mean and median were 0.00 µg/m^3. See Table_Apx G-1 for a summary of the AMTIC monitoring data for *p*-dichlorobenzene.

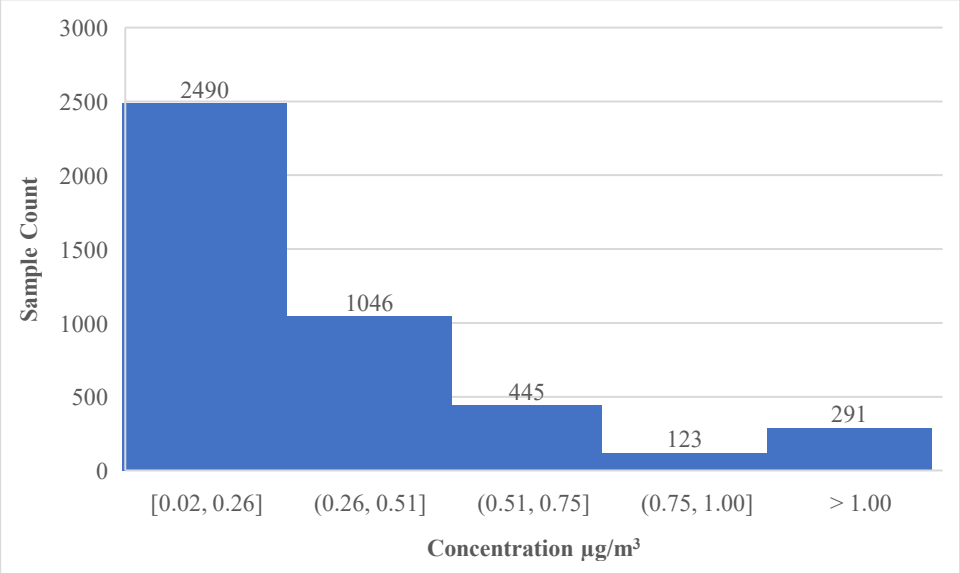

Figure 5-1. Histogram of AMTIC *p*-Dichlorobenzene 24-Hour Monitoring Concentrations

5.2.1.2 Air Quality System (AQS)

Measured ambient air concentrations of *p*-dichlorobenzene were also obtained from the EPA's Air Quality System (AQS[7]), which contains ambient air pollution data collected by EPA and SLT air pollution control agencies from over thousands of monitors. This latter database serves as a repository of

[5] Non-detect (ND) indicates that *p*-dichlorobenzene was not detected during sample analysis.
[6] Below method detection limit (<MDL) indicates that *p*-dichlorobenzene was detected but not quantifiable above the MDL.
[7] See https://www.epa.gov/aqs (accessed June 17, 2026) for more information.

ambient air quality data that assists in air quality assessments, designations, modeling for permit review and preparing reports for Congress as mandated by the Clean Air Act (accessed June 17, 2026).

EPA evaluated monitoring data for samples collected from January 2019 through December 2023 in AQS. The *p*-dichlorobenzene monitoring data included over 34,000 24-hour sampling entries. Samples were collected using pressurized canisters over 24-hour durations and analyzed using gas chromatograph mass spectrometer (GC/MS). The resulting *p*-dichlorobenzene concentrations were reported in parts per billion-carbon (ppb-C) and were converted into ppb by dividing by 6 (the number of carbon atoms in *p*-dichlorobenzene) and then converted to µg/m^3 based on standard ambient temperature (25 ºC) and pressure (1 atm). 66.6% of *p*-dichlorobenzene samples collected between 2019 through 2023 reported concentrations as zero[8] (*i.e.,* ND or <MDL). Detected air concentrations, *i.e.,* non-zero measurements, ranged from 0.01 to 22.1 µg/m^3 with the highest concentration was reported in the state of Pennsylvania in 2019 from the same monitoring station (date and time) that reported the highest concentration in the AMTIC database.

Overall, across all detected 24-hour concentrations from all AQS monitoring stations between 2019 to 2023, the arithmetic mean was 0.29 µg/m^3, the geometric mean was 0.15 µg/m^3 and the median was 0.12 µg/m^3 indicating a positive skewness in the distribution of the monitoring data with 95.1% of the detected concentrations reported as less than 1 µg/m^3 with most of the samples reporting between 0.01 to 0.26 µg/m^3 (Figure 5-2). The method detection limit (MDL) from AQS was not reported.

When including zero measurements, the arithmetic mean ranged from 0.076 to 0.093 µg/m^3 across 2019 to 2023 and the geometric mean and median were 0.0 µg/m^3. See Table_Apx G-2 for a summary of the AQS monitoring data for *p*-dichlorobenzene.

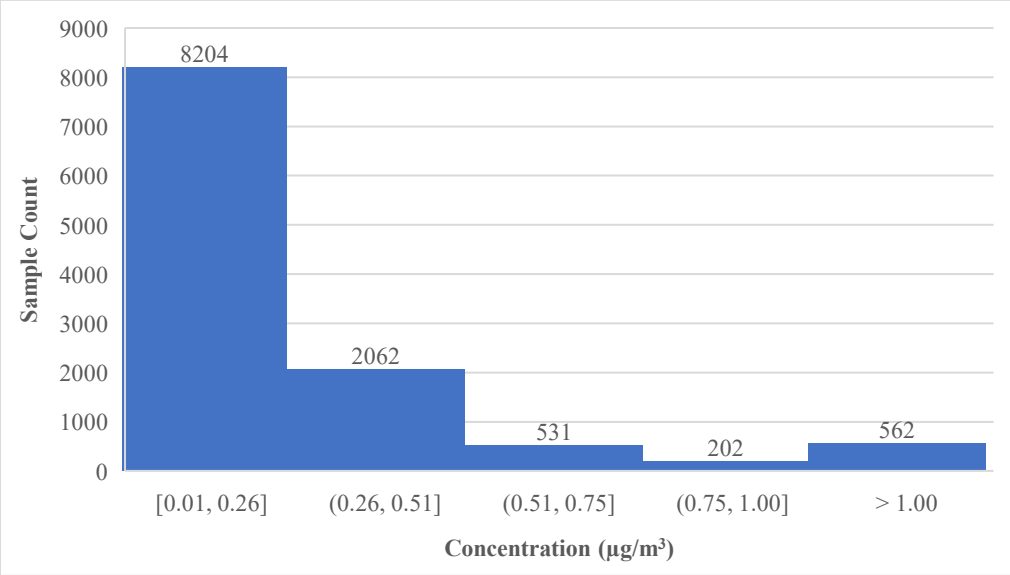

Figure 5-2. Histogram of AQS *p*-Dichlorobenzene (*p*-Dichlorobenzene) 24-Hour Monitoring Concentrations

For more information on *p*-dichlorobenzene ambient air monitoring data see the supplemental file *Draft Air Quality System (AQS) and AMTIC Monitoring Data 2019 to 2023 for p-Dichlorobenzene* (U.S. EPA, 2024a). Data for this supplemental file was downloaded from the AQS and AMTIC databases.

[8] Air Qualtiy System dataset does not report the MDL or samples less than MDL or NDs; these values are reported as zeros.

5.2.1.3 Peer-Reviewed Literature

Measured concentrations of *p*-dichlorobenzene in ambient air were extracted from eleven U.S. studies published between 2003 and 2017 (Figure 5-3). These measured concentrations were classified as representing general population exposures (*i.e.,* ambient measurements taken in areas near residential populations with no known facility sources nearby) or near facility (*i.e.,* measurements collected in areas with industrial and/or commercial activities). Within the United States, Logue et al. (2010) collected measurements in Pittsburgh, Pennsylvania, and reported measurements from both near facility (0.00–0.30 µg/m^3) and general population (0.00–1.38 µg/m^3; downtown Pittsburgh) sites. For near facility measurements, *p*-dichlorobenzene concentrations were attributed to emissions from chemical plants and metallurgic coke plants, while *p*-dichlorobenzene concentrations at the general population sites were attributed to mobile emissions from vehicular traffic. Measurements collected at an exurban (a region situated beyond the suburbs) background site, outside of Pittsburgh, had a range of 0.0 to 0.12 µg/m^3. Bereznicki et al. (2012) reported a residential general population concentration range of ND to 71.5 µg/m^3 (MDL of 0.134 µg/m^3) in Detroit, Michigan, attributed to industry and vehicular emission. Sax et al. (2006) reported a mean concentration of 4.59 µg/m^3 and a maximum concentration of 34.1 µg/m^3 in outdoor residential air samples throughout New York City, New York, and a mean concentration of 2.65 µg/m^3 and maximum concentration of 12.2 µg/m^3 in outdoor residential air samples throughout Los Angeles, CA. Yu et al. (2014) reported a range of 0.02 to 1.39 µg/m^3 near industrial areas in Paterson, New Jersey, with 23% of the 195 samples as NDs. The study observed that *p*-dichlorobenzene measurements collected at the commercial site were significantly higher than the industrial/mobile sites and attributed *p*-dichlorobenzene concentrations to sources, such as dry cleaners, fast food restaurants, photo finishing, commercial heating/boilers, nail salons, print shops, etc. Supplemental information is provided for these studies in Appendix H. For more details on the systematic review for *p*-dichlorobenzene, see the *Draft Systematic Review Protocol for p-Dichlorobenzene* (U.S. EPA, 2024f).

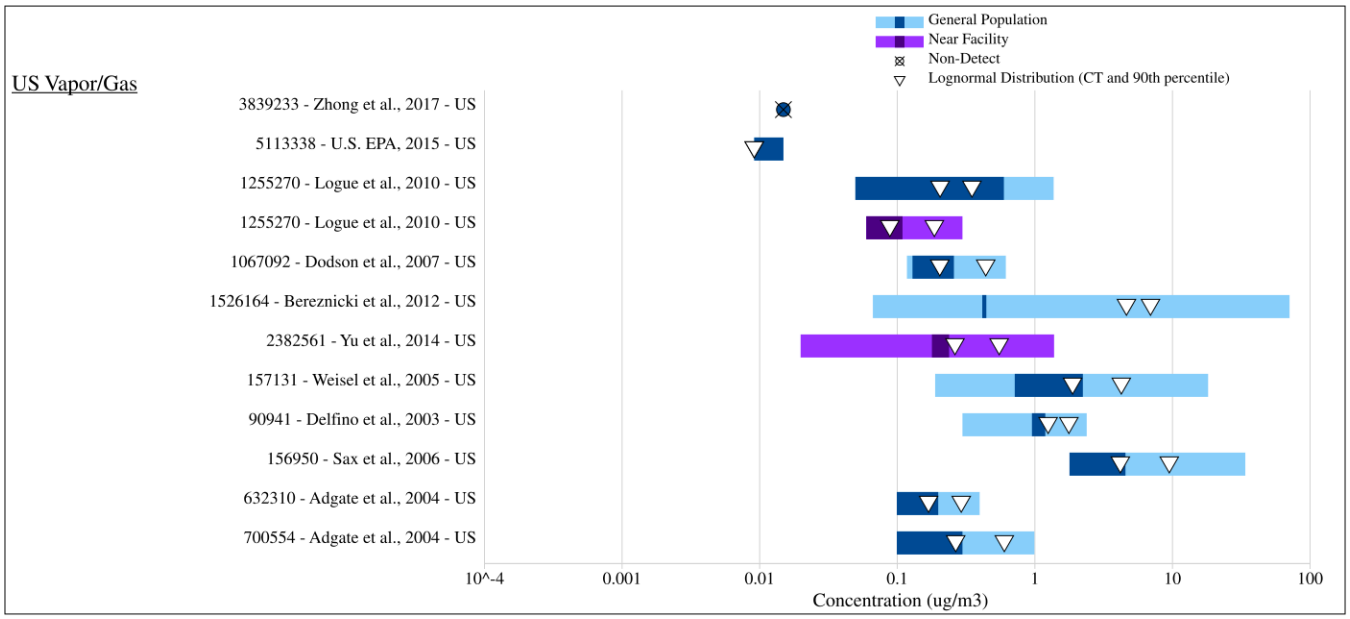

Figure 5-3. Concentrations of *p*-Dichlorobenzene (µg/m^3) in the Vapor/Gas Fraction of Ambient Air from 1997–2016

5.2.2 Measured Concentrations in Indoor Air

5.2.2.1 Peer-Reviewed Literature

EPA identified studies through systematic review that measured *p*-dichlorobenzene in indoor air from homes and nonresidential buildings. To capture relevant studies that are representative of the U.S. population, EPA filtered these studies to include only ones that are published after 1991 and are sampled in the Unites States or Canada. This information was not used in modeling but rather as a comparison with modeling results, giving context to concentrations found from monitoring data.

Measured concentrations of *p*-dichlorobenzene in indoor air were extracted from 14 U.S. and two Canadian studies published between the years 1995 and 2017 (Figure 5-4). Within the United States, Chin et al. (2014) collected samples in 126 residential homes in Detroit, Michigan, and reported a concentration range of 0.01 to 2,125.94 µg/m^3 (MDL of 0.02 µg/m^3). The study attributed sources of *p*-dichlorobenzene to deodorants, repellants and pesticides along with solvent-related emissions from degreasers and paints. Sax et al.(2006) reported a mean concentration of 75.0 µg/m^3 and a maximum concentration of 1,452 µg/m^3 in homes throughout New York City, and a mean concentration of 47.4 µg/m^3 and maximum concentration of 261 µg/m^3 in homes in Los Angeles, California. Sampling was conducted in two seasons, winter (February–April 1999) and summer (June–August 1999) in New York City (n = 41) and winter (February–March 2000) and fall (September–October 2000) in Los Angeles (n = 40). The study also attributed indoor sources of *p*-dichlorobenzene to primarily mothballs and room deodorizers. Supplemental information is provided for these studies in Appendix H. For more details on the systematic review for *p*-dichlorobenzene, see the *Draft Systematic Review Protocol for p-Dichlorobenzene* (U.S. EPA, 2024f).

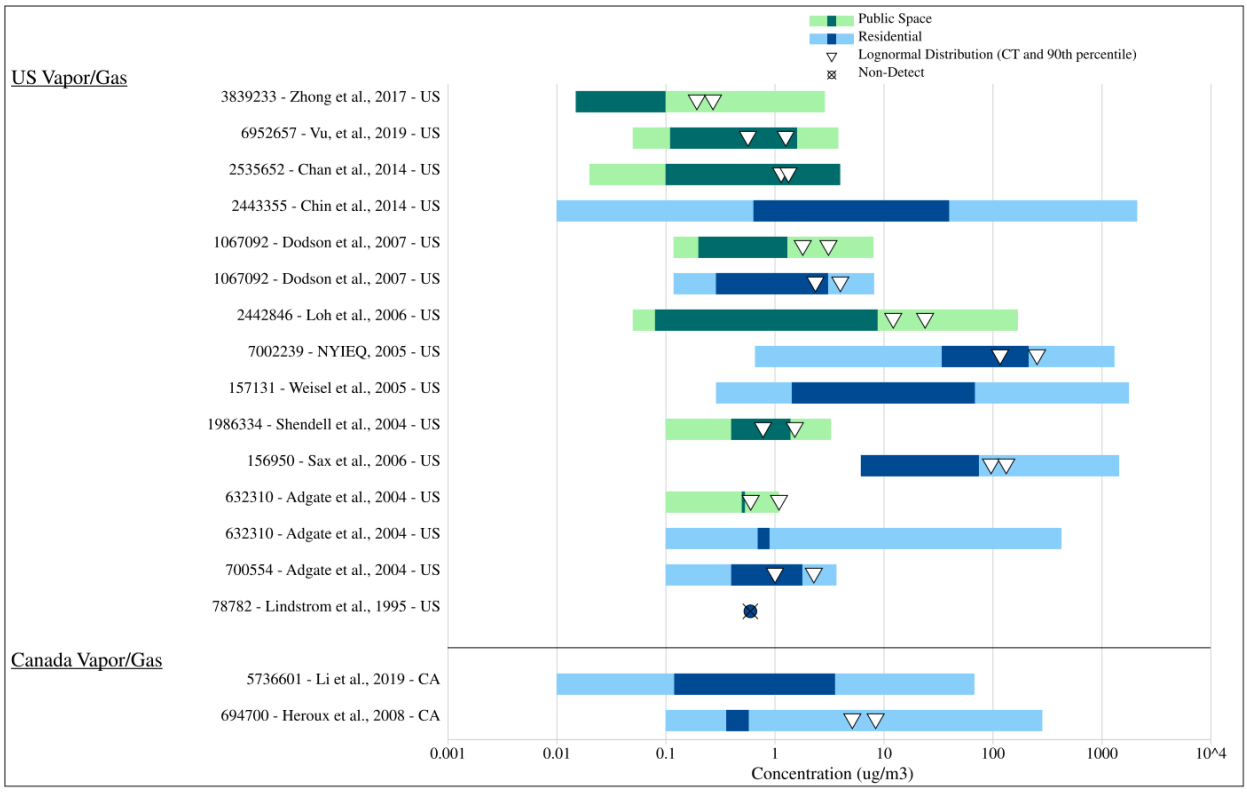

Figure 5-4. Concentrations of *p*-Dichlorobenzene (µg/m^3) in the Vapor/Gas Fraction of Indoor Air from 1992–2016

5.2.3 Measured Concentrations from Personal Air Monitoring

5.2.3.1 Peer-Reviewed Literature

Measured concentrations of *p*-dichlorobenzene from personal monitoring samples (ambient and indoor air) were available from nine U.S. studies conducted from 1995 and 2015 (Figure 5-5). Heavner et al. (Heavner et al., 1995) reported a mean of 3.45 µg/m^3 and maximum of 25.39 µg/m^3 in non-smoking homes in Columbus, Ohio; samples were collected in February 1991 over a 3-hour sampling period (n = 24). Heavner et al. (1996) reported mean concentrations of 5.18 and 1.46 µg/m^3, and max concentrations of 121.86 and 23.44 µg/m^3, in non-smoking homes (n = 61) and non-smoking workplaces (n = 51), respectively, in Mt. Laurel, New Jersey; samples were collected 24 hours per day, over a 2-week period in November 1992. The studies attributed mothballs as the indoor source for *p*-dichlorobenzene in residential homes. Shin et al. (2015) reported a mean concentration of 19.01 µg/m^3 based on data collected from the Detroit Exposure and Aerosol Research Study (DEARS), which collected personal monitoring samples throughout six Detroit area neighborhoods during summer and winter periods over 3 years between 2004 and 2007 (n = 239) and noted industrial solvents as an outdoor source of *p*-dichlorobenzene. Sax et al. (2006) reported a mean of 41.7 and 36.6 µg/m^3 for personal monitoring samples collected from residential homes in New York City and Los Angeles, respectively. Sampling was conducted in two seasons, winter (February–April 1999) and summer (June–August 1999) in New York City (n = 41) and winter (February–March 2000) and fall (September–October 2000) in Los Angeles (n = 40).

Dodson et al. (2007) as part of the Boston Exposure Assessment in Microenvironments (BEAM) Study, reported a mean and median concentration of 3.4 and 0.54 µg/m^3, respectively, and LOD ranged from 0.135 to 0.338 µg/m^3. The study attributed *p*-dichlorobenzene to room deodorizers and mothballs. Jia et al. (2008) reported a mean concentration of 27.3 µg/m^3 and a maximum concentration of 2,235.6 µg/m^3 from the 1999 to 2000 National Health and Nutrition Examination Survey (NHANES); personal air samplers were collected for 669 individuals over 48- to 72-hour periods. The study also cited mothballs, air fresheners, and other deodorants as possible sources. The measurements from these personal monitoring studies are similar to the measurements reported in the ambient air and indoor air peer-reviewed literature. However, due to the range of participants and sample sizes, varying exposure factors; for example, smoking, behavioral, and activity patterns, it is difficult to extrapolate results from individual exposures to expected population-based exposures. Supplemental information is provided for these studies in Appendix H. For more details on the systematic review for *p*-dichlorobenzene, see the *Draft Systematic Review Protocol for p-Dichlorobenzene* (U.S. EPA, 2024f).

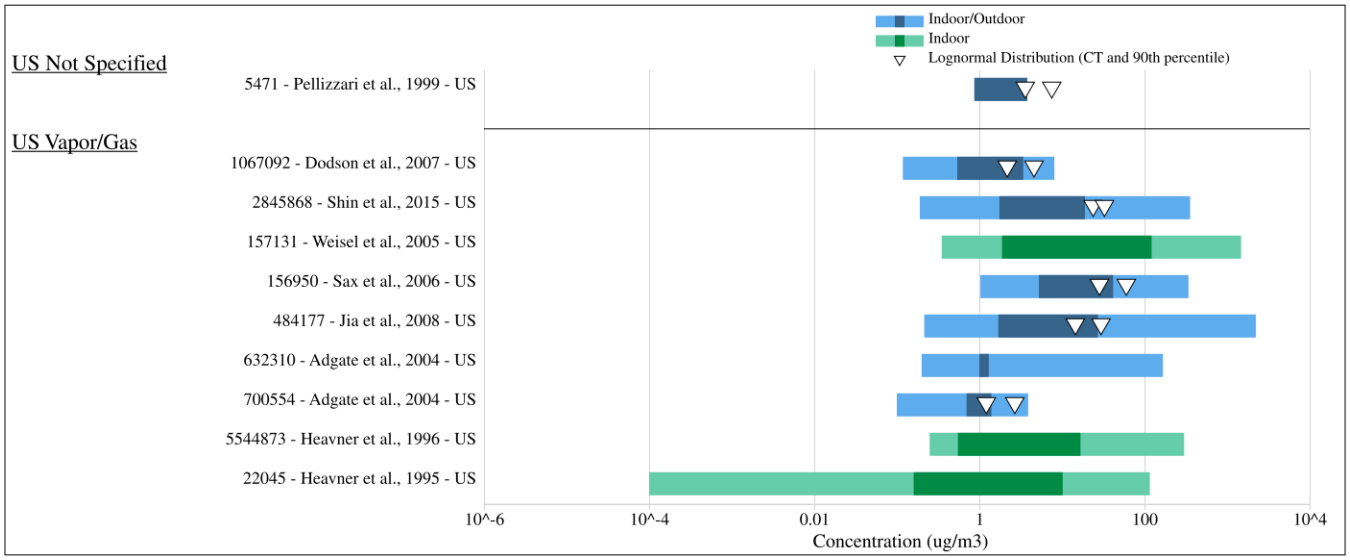

Figure 5-5. Concentrations of *p*-Dichlorobenzene (µg/m^3) in the Vapor/Gas Fraction of Personal Monitoring Inhalation Samples from 1991–2007

5.2.4 Evidence Integration for Air

Data from AQS, AMTIC, and the literature show *p*-dichlorobenzene in ambient and indoor air, indicating environmental and general population exposure; therefore, EPA conducted a quantitative exposure assessment. EPA used the Integrated Indoor-Outdoor Air Calculator (IIOAC) to model ambient air concentrations based on facility releases from the TRI 2019 to 2023 database to assess environmental and general population exposure to air from facility releases of *p*-dichlorobenzene. See Section 6 for more details.

In addition, EPA used two models: the Consumer Exposure Model (CEM) and the Indoor Environmental Concentrations in Buildings with Conditioned and Unconditioned Zones (IECCU) Model, to assess consumer exposure for individuals using products containing *p*-dichlorobenzene within the indoor environment. See Section 7 for more details.

5.3 Water Pathway

EPA searched peer-reviewed literature, gray literature, and databases of environmental monitoring data to obtain concentrations of *p*-dichlorobenzene in ambient surface water, drinking water, and aquatic sediments. Though the available monitoring data were limited, *p*-dichlorobenzene was found in detectable concentrations in surface waters.

5.3.1 Measured Concentrations in Surface Water and Sediment

5.3.1.1 Water Quality Portal

The Water Quality Portal (WQP) (NWQMC, 2022) is a publicly available resource that integrates water quality data from the U.S. Geological Survey (USGS) National Water Information System (NWIS) (USGS, 2013) and EPA's Water Quality Exchange Data Warehouse (WQX) (U.S. EPA, 2019g). The NWIS database contains current and historical water data from more than 1.5 million sites across the nation. The WQX is the EPA's repository of water quality monitoring data collected by water resource management groups across the nation. The complete set of *p*-dichlorobenzene monitoring results stored in WQP was retrieved in June 2025 with only the chemical name applied as a filter. The raw dataset included 17,606 samples from across the United States collected between 2019 and 2025. While the *p*-

dichlorobenzene WQP data set exceeded 17,000 samples, most of the samples were groundwater with only 3,231 samples from surface waters.

Surface water monitoring data indicate that *p*-dichlorobenzene is usually below detection limits (detection limit ≤0.21 mg/L). Specifically, 99.6% of all *p*-dichlorobenzene surface water samples were either below detection limits (256 samples), below reporting limit (11 samples), not detected (2,735 samples), or present below quantification limit (211 samples). The highest detection limit across surface water monitoring data was 0.21 mg/L with two surface water samples having *p*-dichlorobenzene measured at the detection limit. Seven samples (0.2%) had measured concentrations of *p*-dichlorobenzene in surface water above detection limits with the maximum concentration of 0.16 mg/L. Similarly, all sediment samples (100% of 533 samples) from the WQP database measured *p*-dichlorobenzene at or below detection limits with a maximum detection limit of 0.17 mg/L.

For more information and details, see the supplemental file *Draft Water Quality Portal (WQP) Monitoring Data for Dichlorobenzenes* (U.S. EPA, 2026y).

5.3.1.2 Peer-Reviewed Literature

EPA has identified studies through systematic review that measured *p*-dichlorobenzene in surface water and sediment. Measured concentrations of *p*-dichlorobenzene in surface water were extracted from six U.S. studies published between 1995 and 2017 (Figure 5-6). Elliott et al. (2017) reported 291 surface water samples collected in the Great Lakes Basin between 2013 to 2014 with a detection frequency of 19% and a maximum concentration of 0.292 µg/L (reporting limit = 0.08 µg/L). Kolpin et al. (2002) reported 85 samples collected from 139 streams across the United States between 1999 to 2000 with a detection frequency of 25.9% and a median and maximum concentration of 0.09 and 4.3 µg/L, respectively (reporting limit = 0.03 µg/L). The selection of sampling sites primarily focused on areas considered susceptible to contamination from human, industrial, and agricultural wastewater.

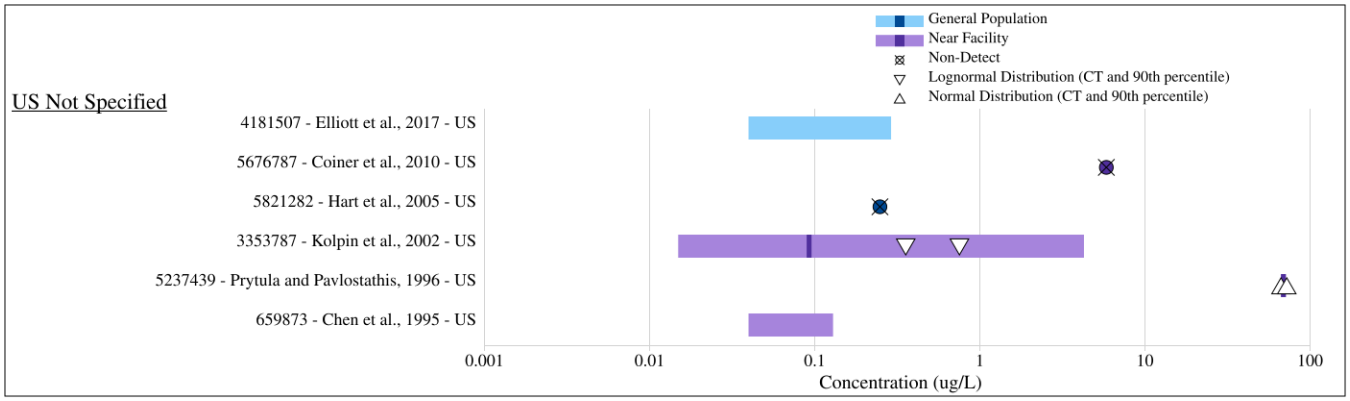

Figure 5-6. Concentrations of *p*-Dichlorobenzene (µg/L) in Surface Water from 1989–2014

Measured concentrations of *p*-dichlorobenzene in sediment were extracted from five U.S. studies published between 1996 and 2017 (Figure 5-7). Yun and Kannan (2011) reported 75 surface sediment samples collected from the Pine River, Tittabawassee River, Shiawassee River, Saginaw River, and Saginaw Bay, Michigan between 2002 to 2004, with a concentration range of from below the LOD (<0.02) to 50.97 ng/g dry weight. Elliott et al. (2017) reported 76 sediment samples collected in the Great Lakes Basin between 2013 to 2014 with a detection frequency of 30% and a maximum concentration of 1,160 µg/kg (= 1,160 ng/g with a reporting limit of 33 µg/kg).

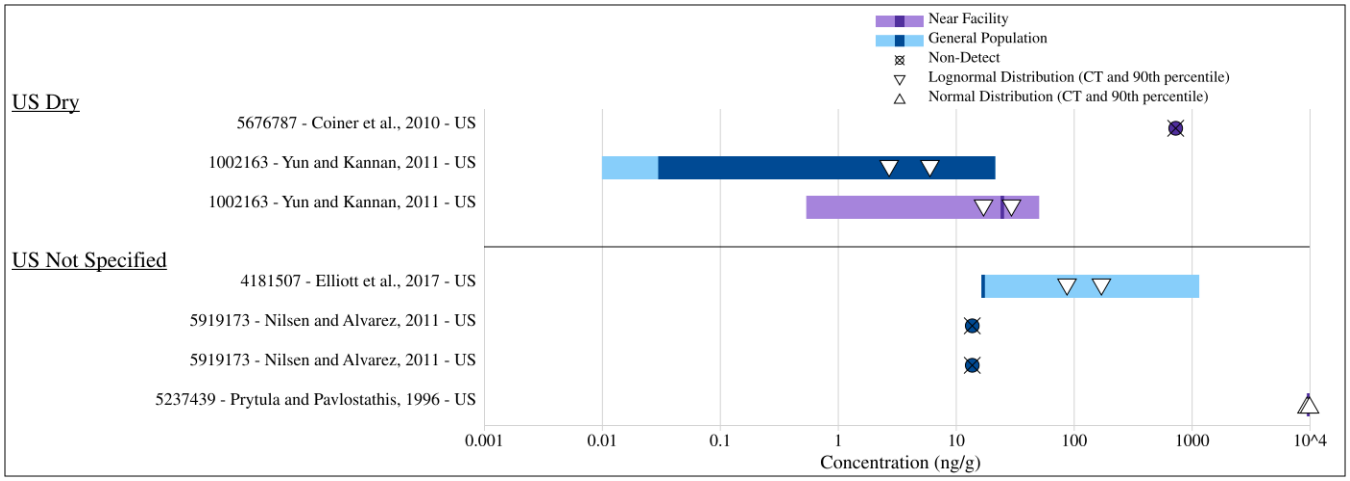

Figure 5-7. Concentrations of *p*-Dichlorobenzene (ng/g) in Sediment from 1993–2014

5.3.2 Measured Concentrations in Drinking Water

5.3.2.1 Peer-Reviewed Literature

EPA identified studies through systematic review that measured *p*-dichlorobenzene in drinking water. Measured concentrations of *p*-dichlorobenzene in drinking water were extracted from three U.S. studies published between 2008 and 2024 (Figure 5-8). Kingsbury et al. (2008) and Hopple et al. (2009) are both studies published in the USGS as part of the National Water Quality Assessment (NAWQA) Program. Kingsbury et al. (2008) detailed concentrations of organic compounds, including *p*-dichlorobenzene, in surface water as the source for community drinking water treatment systems and Hopple et al. detailed concentrations of organic compounds in groundwater as the source for community drinking water treatment systems. Both studies measured concentrations at the source (surface and groundwater) and at the finished water (post-drinking water treatment). For *p*-dichlorobenzene, Kingsbury et al. (2008) reported 94 samples with a detection frequency of 3.2% and a maximum concentration of 0.05 µg/L in the finished water (reporting limit = 0.034 µg/L). Hopple et al. (2009) reported 71 samples with a detection frequency of 11% and a maximum concentration of 0.056 µg/L in the finished water (reporting limit = 0.034 µg/L). Bugher et al. (2024) collected samples across 307 private groundwater wells in West Virginia, Ohio, and Pennsylvania and reported detection frequency of 1.3% with a maximum concentration of 0.052 µg/L (LOD = 0.004 µg/L).

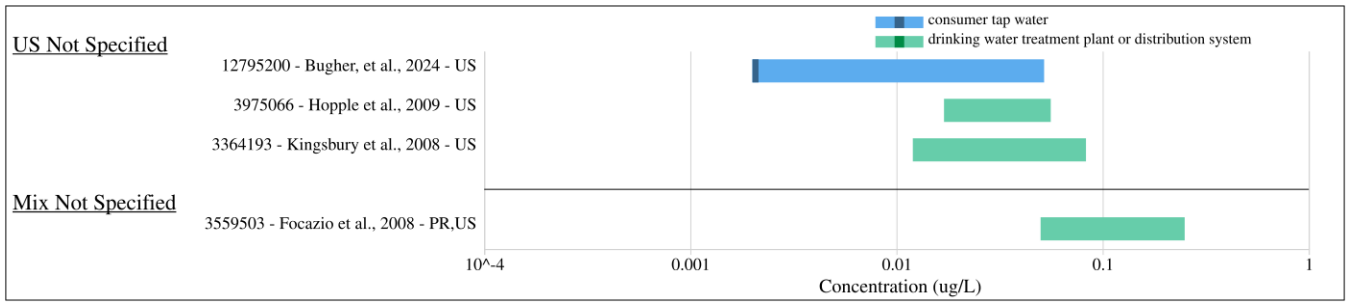

Figure 5-8. Concentrations of *p*-Dichlorobenzene (µg/L) in Drinking Water from 2001–2020

5.3.3 Measured Concentrations in Wastewater

5.3.3.1 Water Quality Portal

Effluent monitoring data from the WQP were below detection limits. Specifically, 100% of all *p*-dichlorobenzene effluent samples were below detection limits (17 samples) with a maximum detection limit of 0.17 mg/L. Industrial effluents (3 samples) measured were also below detection limits. For more information and details, see the supplemental file *Draft Water Quality Portal (WQP) Monitoring Data for Dichlorobenzenes* (U.S. EPA, 2026y).

5.3.3.2 Peer-Reviewed Literature

EPA identified studies through systematic review that measured *p*-dichlorobenzene in wastewater. Measured concentrations of *p*-dichlorobenzene in wastewater were extracted from three U.S. studies published between 1996 and 2006 (Figure 5-9). Sauer and Tyler (1996) collected 11 septic tank effluent samples from 4 publicly-owned motor vehicle service stations in Wisconsin between 1991 and 1992. The study reported a concentration range of 10 to 90 µg/L, a mean concentration of 15 µg/L, and detection frequency of 19%. Keefe et al. (2004) collected muncipal wastewater treatment effluent samples (n = 8) entering a constructed wetland near Phoenix, Arizona, in 2000. The study reported a concentration of 0.74 µg/L and a reporting limit (RL) of 0.05 µg/L. Conn et al. (2006) collected 90 samples across 30 onsite wastewater treatment systems: 22 tank-based, 7 biofilter-based, and 1 sub-surface flow constructed wetland, from residential and non-residential areas in Summit and Jefferson Counties, Colorado, between 2003 to 2004. For residential areas, the maximum concentration reported was 2.1 µg/L and the median concentration was below the RL; the RL was 0.5 µg/L and detection frequency was 13%. For non-residential areas, the maximum concentration reported was 59 µg/L and the median concentration was below the RL with a detection frequency of 35%.

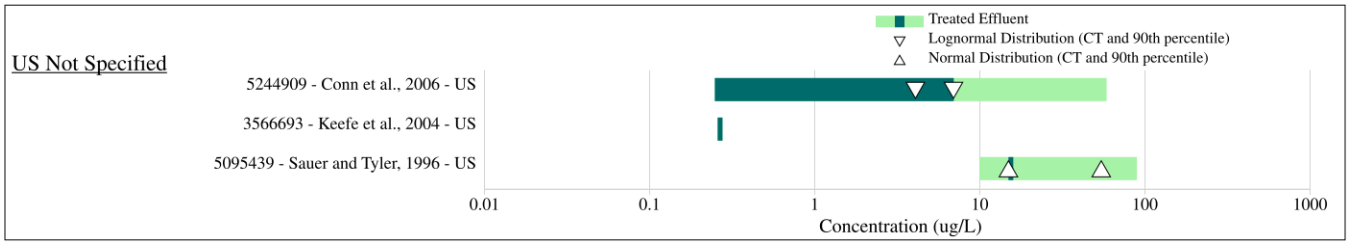

Figure 5-9. Concentrations of *p*-Dichlorobenzene (µg/L) in Wastewater in Treated Effluent from 1991–2004

5.3.4 Measured Concentrations in Groundwater

5.3.4.1 Water Quality Portal

From 2019 to 2025, 17,606 samples from diverse monitoring sites across the country measured *p*-dichlorobenzene in groundwater samples (NWQMC, 2022). Of these samples, 99.3% were at or below detection limits (0.2 mg/L *p*-dichlorobenzene). A total of 103 samples (0.7%) measured *p*-dichlorobenzene above detection limits in groundwater (maximum concentration = 0.30 mg/L). For more information and details, see the supplemental file *Draft Water Quality Portal (WQP) Monitoring Data for Dichlorobenzenes* (U.S. EPA, 2026y).

5.3.4.2 Peer Reviewed Literature

Measured concentrations of *p*-dichlorobenzene in groundwater were extracted from six U.S. studies published between 1992 and 2009 (Figure 5-10). Westinghouse Savannah River Company (1997) collected samples from 89 wells underneath the sanitary landfill at the Savannah River site, South

Carolina in 1996 and reported a range from below the LOD (<0.05 µg/L) to 169 µg/L. Chen et al. (1995) collected groundwater samples from monitoring wells at the Orange County municipal landfill in Orlando, Florida, between 1992 to 1993 and a reported a range of ND to 10.71 µg/L. Heck et al. (1992) performed a similar investigative study for the Reno County landfill, Kansas, between 1990 and 1991 and reported a range of below the LOD (<0.20) to 15 µg/L. Most of the samples from these studies were reported as "NDs/<LOD." Hopple et al. (2009) detailed concentrations of organic compounds in groundwater as source for community water systems nationwide and collected 221 groundwater samples; all samples were reported as NDs for *p*-dichlorobenzene (RL = 0.034 µg/L). The highest reported concentration of *p*-dichlorobenzene in groundwater was used for a screening-level assessment, and no additional refinements were needed.

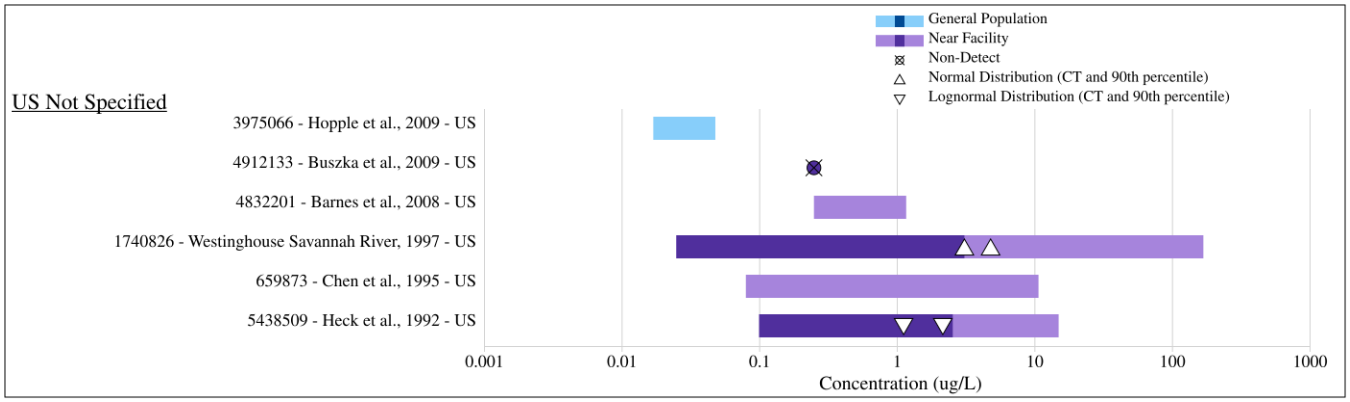

Figure 5-10. Concentrations of *p*-Dichlorobenzene (µg/L) in Groundwater from 1989–2005

5.3.5 Evidence Integration for Water

Across monitoring sources and available literature data, *p*-dichlorobenzene is often below detection limits in water sources (Table 5-1). Additionally, when *p*-dichlorobenzene is detected in water, it is measured at concentrations less than 1 mg/L.

Table 5-1. Summary of Measured Data for *p*-Dichlorobenzene in Water

Source	Maximum Concentration	Detection Frequency (%)[a]
Surface Water: WQP	0.16 µg/L	0.4
Surface Water: Literature[b]	0.29 µg/L	19.0–25.9
Sediment: WQP	<0.17 µg/L	0.0
Sediment: Literature	4.3 µg/L	30
Drinking Water: WQP	<0.17 µg/L	0.0
Drinking Water: Literature	0.05 µg/L	1.3–11.0
Wastewater Effluent: WQP	<0.17 µg/L	0.0
Wastewater Effluent: Literature	90 µg/L	19
Groundwater: WQP	0.2 µg/L	0.7
Groundwater[c]: Literature	169 µg/L	<5

[a] Detection limit range = 0.01–0.5 mg/L
[b] Literature value measured concentration as a survey of contaminants in the Great Lakes area
[c] From landfill wells

Although *p*-dichlorobenzene is expected to volatilize from water given its physical and chemical properties (Section 2), and deposition from air is expected to be negligible (Section 6.2.1.4), *p*-dichlorobenzene can be present in water as evidenced by the available measured data (Table 5-1).

Based on the low reported releases to surface water (Section 4), physical and chemical properties (Section 2), as well as monitoring data indicating minimal detections of *p*-dichlorobenzene in wastewater, EPA did not perform a quantitative analysis for the wastewater because exposure to the general population is not expected to occur.

5.4 Land Pathway

EPA searched peer-reviewed literature, gray literature, and databases of environmental monitoring data to obtain concentrations of *p*-dichlorobenzene in soils and groundwater. Though the available monitoring data were limited, *p*-dichlorobenzene was found in detectable concentrations in soil and groundwater samples.

5.4.1 Measured Concentrations in Soil

5.4.1.1 Peer-Reviewed Literature

EPA has identified studies through systematic review that measured *p*-dichlorobenzene in soil. Measured concentrations of *p*-dichlorobenzene in soil were extracted from two U.S. studies published in 2001 and 2011 (Figure 5-11). Yun and Kannan (2011) reported 38 soil samples collected from the Pine River, Tittabawassee River, Shiawassee River, Saginaw River, and Saginaw Bay, Michigan between 2002 to 2004 with a concentration range of below the LOD (<0.02) to 30.84 ng/g dry weight). Jang and Townsend (2001) did not report any detection of *p*-dichlorobenzene (LOD = 5.0 µg/kg) in recovered soil fines samples collected from 14 construction and demolition waste recycling facilities in Florida (n = 43).

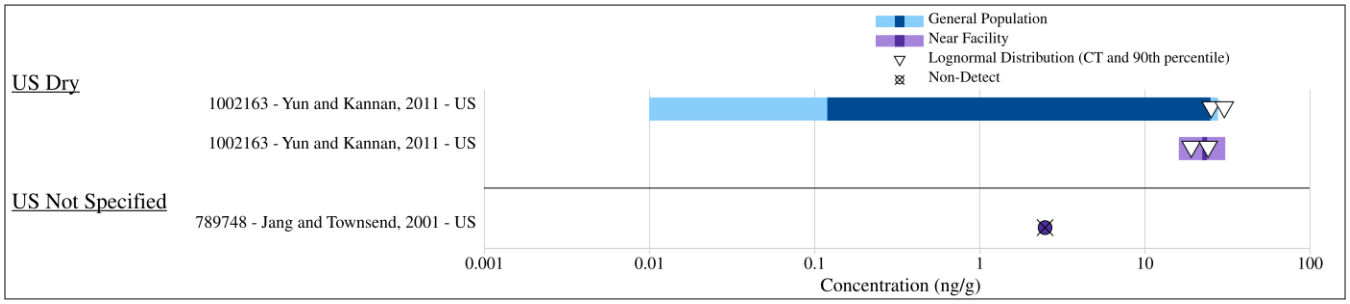

Figure 5-11. Concentrations of *p*-Dichlorobenzene (ng/g) in Soil from 2001–2004

5.4.2 Evidence Integration for Soil

There are no direct releases of *p*-dichlorobenzene to land. Rather, release of *p*-dichlorobenzene to land is through underground injection and landfills (Section 4) which are assumed to be impermeable. Class I Injection Wells are required to be well designed and constructed to prevent movement of injected waste streams into any additional pathways including drinking water systems or other water pathways. Although some studies from systematic review have reported concentrations of *p*-dichlorobenzene in soil, most samples reported in the studies were either NDs, or low concentrations overall. Based on the low volume of releases to land, the low risk of failure of the predominant release scenario, the physical and chemical properties of *p*-dichlorobenzene, as well as monitoring data indicating no detections of *p*-dichlorobenzene in soil, EPA did not perform a quantitative analysis for the land pathway because

exposure to the general population is not expected to occur.

However, based on the physical and chemical properties indicating that *p*-dichlorobenzene exists as a solid in ambient conditions, EPA used the IIOAC Model to estimate air to soil deposition of *p*-dichlorobenzene based on TRI 2019 to 2023 facility release data for ecological exposure and risk characterization. See Section 6.2.1.5 for more details.

5.5 Weight of Scientific Evidence Conclusions for Environmental Media Concentration Assessment

5.5.1 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for the Environmental Media Concentration Assessment

AQS and AMTIC data have been previously reviewed and verified by the Ambient Air Monitoring Group, which has taken various quality assurance steps to ensure data quality and has been certified in accordance with 40 CFR 58.15. Due to strictly regulated monitoring requirements, EPA has high confidence in the AQS (U.S. EPA, 2017) and AMTIC (U.S. EPA, 2022b) ambient air dataset, which also received a high-quality rating from EPA's systematic review process for *p*-dichlorobenzene (U.S. EPA, 2026x, 2021a). A primary limitation of the AQS and AMTIC data, and other monitoring data, is that because the data have not been annualized, they represent a diverse collection of sampling durations (none of which are annual averages), which are not directly comparable to modeled data. Additionally, because monitoring data represents a total aggregate concentration from all sources of *p*-dichlorobenzene contributing to ambient air concentrations, monitoring data cannot be used to characterize exposures exclusively from sources associated with COUs.

The WQP contains data from the WQX. Many data fields in WQX are highly variable to accommodate the many original sources of data that WQX captures. The data also provide results based on different analytical methods and study goals. WQX data are often not nationally representative, and the data often overlap with nationally representative water data such as the USGS NAWQA Program. NAWQA provides current conditions and water quality with the information stored in the National Water Information System (NWIS). Because NWIS data reflects that *p*-dichlorobenzene is typically not detected above the detection limit in surface water or groundwater, EPA has robust confidence that in areas lacking data, which are mainly areas associated with lower releases, *p*-dichlorobenzene will not be present in the water. In addition, based on the physical and chemical properties of *p*-dichlorobenzene and low release quantities to water and land, EPA has confidence that the WQP data are representative of the entire United States. Furthermore, WQP is not specific to only the TSCA COUs.

The *p*-dichlorobenzene media concentrations (air, water, sediment, and soil) from systematic review were extracted from multiple studies, primarily from the United States. All media types included studies and data collected in the United States with ratings of medium- or high-quality, which are representative of both environmental exposure and exposure for the U.S. general population. See Appendix H.2 for study ratings for all peer-reviewed literature from systematic review. Notably, measured data from systematic review vary temporally, media concentrations are especially subject to season variation and vary geospatially. Methodology for sample collection and analysis are specific to each peer-reviewed literature and vary with instrumentation and analysis. Concentrations of *p*-dichlorobenzene across all media are attributed to many different sources, including but not limited to facility emissions and consumer activities.

6 GENERAL POPULATION AND ENVIRONMENTAL EXPOSURE ASSESSMENT

6.1 Approach and Methodology

6.1.1 General Population Exposure Scenarios

Figure 6-1 illustrates potential exposure pathways for the general population. For *p*-dichlorobenzene, EPA expects ambient air to be a potential exposure pathway. *p*-Dichlorobenzene 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, *p*-dichlorobenzene 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 *p*-dichlorobenzene to the ambient air in Section 6.2.

In addition, based on concentrations reported in studies from systematic review, EPA expects drinking water to be a potential exposure pathway and details the drinking water exposure scenario for adults and infants in Section 6.3. General population exposure pathways through soil, swimming and fish ingestion are not expected because *p*-Dichlorobenzene in soil and surface water is expected to volatilize given its physical and chemical properties as described in Section 3.5.2 and that *p*-Dichlorobenzene has low potential to bioaccumulate in organisms based on measured BCF values as described in Section 3.7.

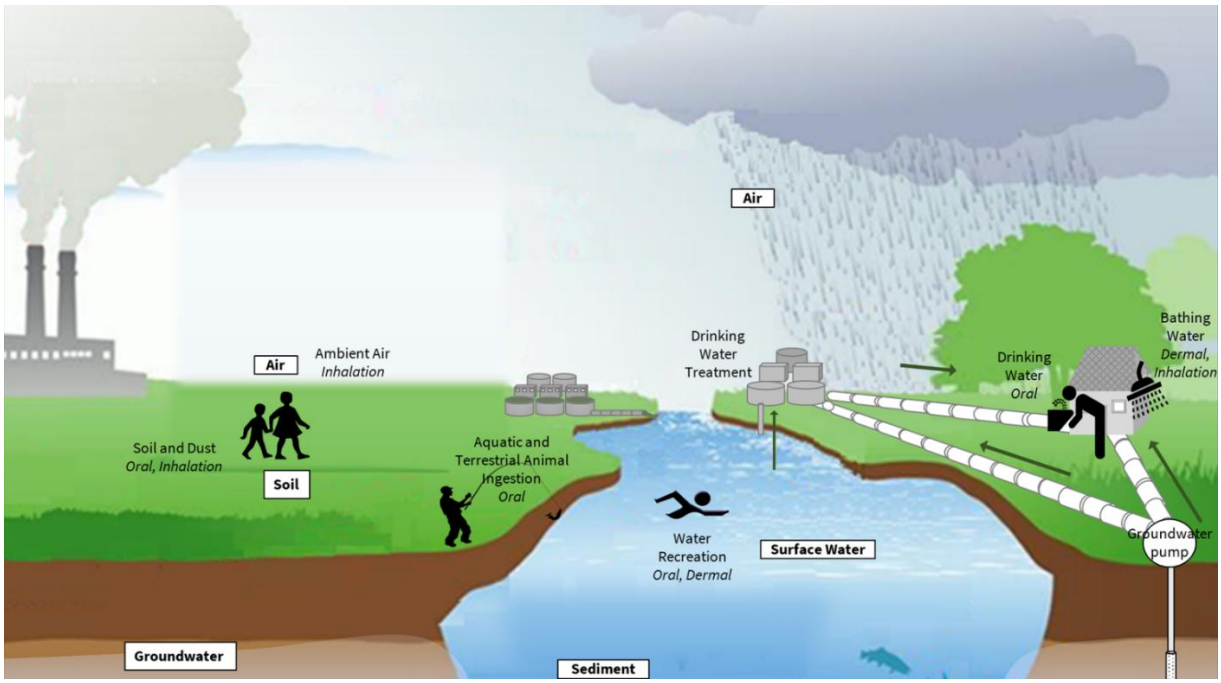

Figure 6-1. Potential Human Exposure Pathways to *p*-Dichlorobenzene for the General Population

6.1.2 Environmental Releases

Industry-reported air releases of *p*-dichlorobenzene from industrial sources were extracted from the TRI for reporting years 2019 through 2023 as described in Section 4. The TRI dataset for *p*-dichlorobenzene

included 1 form A and 21 Form R reporting facilities across the 6 years of reporting data queried, equaling a total of 78 individual reported releases. Total annual fugitive releases for Form R reporters ranged from 10,597 to 12,041 kg/yr, while total annual stack releases for the Form R reporters ranged from 974 to 1,313 kg/yr.

Each TRI-reporting facility is assigned to an OES based on similarities or differences in release and exposure sources, worker activities, and use patterns occurring at a facility. OESs are then mapped to COUs shown in Table 4-1. TRI facility releases were associated with the following five OESs and associated COUs below in Table 6-1 (see Table 4-1 for the full list of OESs and associated COUs). Because there are no quantifiable facility releases tied to the other OESs and associated COUs, general population ambient air exposures to those OESs from facility releases are not expected to occur.

Table 6-1. Occupational Exposure Scenarios and Conditions of Use for General Population Exposures

Life Cycle Stage	Category	Subcategory	Occupational Exposure Scenario (OES)
Processing	Processing – Incorporation into formulation, mixture or reaction product	Soap, cleaning compound, and toilet preparation manufacturing	Incorporation into Air Care Products
Processing	Processing – Incorporation into formulation, mixture or reaction product	Solvents (which become part of product formulation or mixture)	Incorporation into Formulation
Manufacturing	Manufacture	Domestic manufacturing	Manufacturing
Processing	Processing as a reactant	Processing as a reactant	Processing as a Reactant
Disposal	Disposal	Disposal	Waste Handling, Treatment, and Disposal

6.2 Air Exposure Assessment

6.2.1 Integrated Indoor/Outdoor Air Calculator Model (IIOAC)

IIOAC estimates indoor and outdoor ambient air concentrations at three distances: 100, 100–1,000, and 1,000 m, from sources that release chemical substances to the air. IIOAC uses pre-run results from a suite of dispersion scenarios modeled with EPA's American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD; accessed June 17, 2026)). While the pre-run scenarios include a variety of meteorological and land-use settings, the IIOAC Model is still 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, 2019h).

EPA used the IIOAC model and 2019 to 2023 TRI *p*-dichlorobenzene release data to estimate daily and annual average ambient and indoor air concentrations at 100, 100 to 1,000, and 1,000 m from reporting facilities. These results informed a screening-level assessment of general population exposures near industrial sources, identifying facilities and COUs that may warrant higher-tier analysis or refined modeling.

6.2.1.1 Model Input Parameters and Settings

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. Releases from individual facilities reported in TRI 2019 to 2023 were reported as stack and/or fugitive releases; with facilities reporting both types of releases. Stack and fugitive releases were used as direct inputs to IIOAC and were modeled separately (stack releases as point sources, fugitive releases as area sources). 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 6-2. As described in Section 3, air deposition to soil and water may occur, although it is not expected to be significant because *p*-dichlorobenzene is not expected to associate strongly with airborne particulates. EPA also modeled air deposition for *p*-dichlorobenzene because it exists as a crystalline solid at room temperature.

Table 6-2. 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. The annual release values reported by Form R individual facilities (assigned to OESs and mapped to respective COUs for the TRI 2019–2023 datasets), assuming the total annual reported releases are continuous and equally distributed across all days of operation.
2. An operating scenario representing industrial facilities releasing *p*-dichlorobenzene to the ambient air operating 24 hours/day, 7 days/week, 365 days/year. This is a conservative assumption for this screening-level estimate, in which, facilities are constantly releasing *p*-dichlorobenzene every day and every hour throughout the year.
3. 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.
4. For conservative air deposition rates, the Pittsburgh, Pennsylvania (northeast inland) meteorological station was selected along with coarse particles. These designations of meteorology, land settings and particle size are recommended in the *User's Guide: Integrated Indoor-Outdoor Air Calculator (IIOAC)* (also called the "IIOAC User Guide") (EPA, 2019) for when conservative estimates are desired. These assumptions result in conservative air concentration and deposition results that are appropriate for a screening-level assessment.

6.2.1.2 Model Output

IIOAC provides output values for daily-average and annual-average high-end (95th percentile) and mean (50th percentile) ambient air concentrations in circular rings at two finite distances (100 and 1,000

m) and one area distance (between 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 *p*-dichlorobenzene to the ambient air with a steady, continuous release over time, operating 24 hours/day, 7 days/week, 365 days/year, the daily-average and annual-average concentrations are equal.

For the two finite distances (100 and 1,000 m), IIOAC considers a polar grid of 16 modeled exposure receptors evenly spaced around each distance ring. Since EPA considered 5 years of environmental release data (TRI 2019–2023) for this assessment, and the exposure scenario assumes 365 days of operation each year (366 for a leap year), this results in a total of 1,826 separate daily-averaged concentrations for each receptor around each finite distance ring. For the area distance (between 100–1,000 m from the releasing facility), IIOAC uses a cartesian grid of 228 and 234 receptors, for stack and fugitive releases, respectively, placed at 100-meter intervals across the entire area. The daily and annual averages for the area distance are calculated across all receptors within the area distance and therefore represents an average concentration within the area distance rather than at each receptor within the area distance.

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 TRI 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, using a non-site-specific estimate for dispersion and dilution. Additional information on IIOAC model outputs can be found in the user guide (EPA, 2019).

Across all facilities, reporting years and modeled distances (100, 100–1,000, and 1,000 m), the mean (50th percentile) modeled concentrations ranged from 0.00 to 43.18 µg/m^3 and the 95th percentile ambient air modeled concentrations ranged from 0.00 to 47.14 µg/m^3 with the highest modeled concentration at 100 m (Table 6-3). Highest modeled concentrations were associated with the OES: Processing as a Reactant; Fortron LLC (as much as 27 kg fugitive release/day) and Solvay (as much as 7 kg fugitive release/day) reported much higher releases than the other OES TRI facilities, which ranged from 0 to 0.3 kg/day. For full IIOAC modeling results, see the supplemental file: *Draft Integrated Indoor Outdoor Air Calculator (IIOAC) TRI 2019–2023 Exposure and Risk Analysis for p-Dichlorobenzene* (U.S. EPA, 2024c).

Table 6-3. IIOAC-Modeled Concentrations from TRI Facility Releases

Life Cycle Stage	Category	Subcategory	Occupational Exposure Scenario (OES)	Facility Count	Maximum 50th Percentile Modeled Concentration (µg/m³)			Maximum 95th Percentile Modeled Concentration (µg/m³)		
					Distance			Distance		
					100 m	100– 1,000 m	1,000 m	100 m	100– 1,000 m	1,000 m
Processing	Processing – Incorporation into formulation, mixture or reaction product	Soap, cleaning compound, and toilet preparation manufacturing	Incorporation into Air Care Products	2	0.49	0.06	0.02	0.53	0.06	0.02
Processing	Processing – Incorporation into formulation, mixture or reaction product	Solvents (which become part of product formulation or mixture)	Incorporation into Formulation	1	0.29	0.03	0.01	0.32	0.04	0.01
Manufacturing	Manufacture	Domestic manufacturing	Manufacturing	3	0.18	0.02	0.01	0.2	0.02	0.01
Processing	Processing as a reactant	Processing as a reactant	Processing as a Reactant	2	43.18	4.88	1.85	47.14	5.49	2.21
Disposal	Disposal	Disposal	Waste Handling, Treatment, and Disposal	13	0.04	0	0	0.04	0	0
			Total	**21**						

For the general population, EPA assumed that populations residing near facilities (within 100–1,000 m) are exposed to modeled concentrations 24 hours a day, 365 days a year for a lifetime. For environmental exposures, ambient air concentrations at 100 m from the facility were evaluated.

6.2.1.3 Ambient Air Screening-Level Risk Estimates

Because of assumptions made for general population regarding exposure duration, exposure frequency, breathing rates, and other factors that are used to calculate exposure concentrations from modeled air concentrations, for this risk evaluation an individual's exposure concentration is equivalent to the modeled ambient, outdoor concentration from the IIOAC outputs. Therefore, the daily and annual-average modeled ambient air concentration results from IIOAC are equal to acute and chronic exposure concentrations used to calculate acute and chronic non-cancer screening-level risk estimates.

Since EPA used the IIOAC-modeled results as a screening-level analysis to see if one or more facilities/COUs may raise exposure (and associated risk) concerns, EPA 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 to confirm any screening-level exposure (and associated risk) concerns identified.

Hazard values used to calculate screening-level risk estimates are described in the *Draft Human Health and Environmental Risk Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b). Margin of exposures (MOEs) were calculated at each distance (100, 100–1,000, and 1,000 m) using the 50th and 95th percentile IIOAC-modeled ambient air concentrations as conservative exposure estimates for each individual facility and for every reporting year. See 8.3Appendix I for more details.

All non-cancer screening-level risk estimates were above the non-cancer benchmark for both acute and chronic exposures (Table 6-4 and Table 6-5). Therefore, it is not necessary to refine the conservative assumptions of the screening-level assessment. Exposure concentrations, acute and chronic non-cancer screening-level risk estimates based on IIOAC-modeled results are presented the supplemental file: *Draft Integrated Indoor Outdoor Air Calculator (IIOAC) TRI 2019-2023 Exposure and Risk Analysis for p-Dichlorobenzene* (U.S. EPA, 2024c).

Table 6-4. Acute Margin of Exposures Based on IIOAC-Modeled Concentrations

Life Cycle Stage	Category	Subcategory	Occupational Exposure Scenario (OES)	Facility Count	50th Percentile Modeled Concentration Minimum Acute MOE Benchmark = 30			95th Percentile Modeled Concentration Minimum Acute MOE Benchmark = 30		
					Distance			Distance		
					100 m	100–1,000 m	1,000 m	100 m	100–1,000 m	1,000 m
Processing	Processing – Incorporation into formulation, mixture or reaction product	Soap, cleaning compound, and toilet preparation manufacturing	Incorporation into Air Care Products	2	6.10E05	5.40E06	1.40E07	5.60E05	4.80E06	1.20E07
Processing	Processing – Incorporation into formulation, mixture or reaction product	Solvents (which become part of product formulation or mixture)	Incorporation into Formulation	1	1.00E06	9.10E06	2.40E07	9.40E05	8.10E06	2.00E07
Manufacturing	Manufacture	Domestic manufacturing	Manufacturing	3	1.60E06	1.40E07	3.60E07	1.50E06	1.30E07	3.10E07
Processing	Processing as a reactant	Processing as a reactant	Processing as a Reactant	2	6.90E03	6.10E04	1.60E05	6.30E03	5.40E04	1.40E05
Disposal	Disposal	Disposal	Waste Handling, Treatment, and Disposal	13	8.20E06	6.90E07	1.70E08	7.50E06	6.20E07	1.50E08
			Total	**21**						

Table 6-5. Chronic Margin of Exposures Based on IIOAC-Modeled Concentrations

Life Cycle Stage	Category	Subcategory	Occupational Exposure Scenario (OES)	Facility Count	50th Percentile Modeled Concentration Minimum Chronic MOE Benchmark = 30			95th Percentile Modeled Concentration Minimum Chronic MOE Benchmark = 30		
					Distance			Distance		
					100 m	100–1,000 m	1,000 m	100 m	100–1,000 m	1,000 m
Processing	Processing – Incorporation into formulation, mixture or reaction product	Soap, cleaning compound, and toilet preparation manufacturing	Incorporation into Air Care Products	2	6.70E03	6.00E04	1.60E05	6.20E03	5.30E04	1.30E05
Processing	Processing – Incorporation into formulation, mixture or reaction product	Solvents (which become part of product formulation or mixture)	Incorporation into Formulation	1	1.10E04	1.00E05	2.60E05	1.00E04	8.90E04	2.20E05
Manufacturing	Manufacture	Domestic manufacturing	Manufacturing	3	1.80E04	1.50E05	4.00E05	1.60E04	1.40E05	3.40E05
Processing	Processing as a reactant	Processing as a reactant	Processing as a Reactant	2	7.60E01	6.70E02	1.80E03	7.00E01	6.00E02	1.50E03
Disposal	Disposal	Disposal	Waste Handling, Treatment, and Disposal	13	9.10E04	7.60E05	1.90E06	8.30E04	6.80E05	1.60E06
			Total	**21**						

6.2.1.4 Air Deposition to Surface Water and Sediment

Surface water and sediment concentrations from air deposition were also estimated using IIOAC. The highest annual deposition rate modeled by IIOAC for *p*-dichlorobenzene was 1.46×10^{-3} g/m^2; this based on high-end estimate at the fenceline (100 m). Using this deposition rate, the total annual deposition and resulting surface water and sediment concentrations were calculated for a generic farm pond scenario. The scenario is based on EPA's Office of Pesticides (OPP) standard farm scenario as described in various models such as the Exposure Analysis Modeling System (EXAMS[9]) model. Equation 6-1 was used to calculate the total annual deposition to the water body (µg) and the *p*-dichlorobenzene surface water and sediment concentrations were calculated using Equation 6-2 and Equation 6-3, respectively.

Equation 6-1.

$$AnnDep = DepRate \; x \; Ar \; x \; CF$$

Where:

AnnDep	=	Total annual deposition to water body catchment (µg)
DepRate	=	Annual deposition flux to water body catchment (g/m^2)
Ar	=	Area of water body (m2); default: 10,000 m^2 from EPA OPP standard farm pond scenario
CF	=	Conversion of grams (g) to micrograms (µg): 1E6

Equation 6-2.

$$SurWaterConc = \frac{AnnDep}{Ar \; x \; Depth \; x \; CF}$$

Where:

SurWaterConc	=	Annual-average concentration in water body (µg/L)
AnnDep	=	Total annual deposition to water body catchment (µg)
Ar	=	Area of water body (m^2); default: 10,000 m^2 from EPA OPP standard farm pond scenario
Depth	=	Depth of pond; default: 2 m from EPA OPP standard farm pond scenario
CF	=	Conversion of cubic meters (m^3) to liters (L): 1E3

Equation 6-3.

$$SedConc = \frac{AnnDep}{Ar \; x \; Mix \; x \; Dens}$$

Where:

SedConc	=	Annual-average concentration in sediment (µg/kg)
AnnDep	=	Total annual deposition to water body catchment (µg)
Ar	=	Area of water body (m^2); default: 10,000 m^2 from EPA OPP standard farm pond scenario
Mix	=	Mixing depth (m); default = 0.1 m
Dens	=	Density of sediment; default = 1,300 kg/m^3 from the European Commission Technical Guidance Document (ECB 2003)

Using these equations, the *p*-dichlorobenzene surface water and sediment concentrations are provided in Table 6-6 below.

[9] https://www.epa.gov/hydrowq/exams-version-index (accessed June 17, 2026)

Table 6-6. Estimated Pond Surface Water and Sediment Concentration from Air Deposition

Scenario Name	Annualized Deposition Rate (g/m^2)	Estimated Concentration in Pond Water (µg/L)	Estimated Concentration in Pond Sediment (µg/kg)
High-end IIOAC-modeled at fenceline (100 m)	1.46E−03	0.73	11.23

The estimated surface water and sediment concentrations based on the IIOAC-modeled deposition rate are used for ecological aquatic species risk characterization; see Section 4.3.2 of the *Draft Risk Evaluation for p-Dichlorobenzene* (U.S. EPA, 2026w).

6.2.1.5 Air Deposition to Soil

Soil concentrations from air deposition were also estimated using IIOAC. The highest annual deposition rate modeled by IIOAC for *p*-dichlorobenzene was 1.46×10^{-3} g/m^2; this based on high-end estimate at the fenceline (100 m). Using this deposition rate, the *p*-dichlorobenzene soil concentration was calculated with the following equations:

Equation 6-4.

$$\boldsymbol{AnnDep = DepRate\ x\ Ar\ x\ CF}$$

Where:

AnnDep = Total annual deposition to soil (µg)
DepRate = Annual deposition rate (g/m^2)
Ar = Area of soil (m^2); default: 90,000 m^2 from EPA OPP standard farm pond scenario
CF = Conversion of g to µg: 1E6

Equation 6-5.

$$SoilConc = \frac{AnnDep}{Ar\ x\ Mix\ x\ Dens}$$

Where:

SoilConc = Annual-average concentration in soil (µg/kg)
AnnDep = Total annual deposition to soil (µg)
Ar = Area of soil (m^2); default: 90,000 m^2 from EPA OPP standard farm pond scenario
Mix = Mixing depth of soil; default: 0.1 m from the European Commission Technical Guidance Document (ECB 2003)
Dens = Density of soil; default: 1700 kg/m^3 from the European Commission Technical Guidance Document (ECB 2003)

Using these equations, the *p*-dichlorobenzene soil concentration is provided in Table 6-7 below.

Table 6-7. Estimated Soil Concentration from Air Deposition

Scenario Name	Annualized Deposition Rate (g/m^2)	Estimated Concentration in Soil (µg/kg)
High-end IIOAC-modeled at fenceline (100 m)	1.46E−03	8.59

The estimated soil concentration based on the IIOAC-modeled deposition rate is used for ecological terrestrial species risk characterization; see Section 4.3.3 of the *Draft Risk Evaluation for p-Dichlorobenzene* (U.S. EPA, 2026w).

6.3 Drinking Water Exposure Assessment

Based on the concentrations of *p*-dichlorobenzene extracted from literature. EPA conducted a screening-level approach for general population exposures using the highest concentration in treated drinking water reported from Kingsbury et al (2008) of 0.056 µg/L and highly conservative exposure parameters for daily water intake rate and bodyweight to calculate dose using Equation 6-6:

Equation 6-6.

$$D = \frac{C \times IR \times ED}{BW \times AT \times CF}$$

Where:

- D = Dose (mg/kg-day)
- C = Concentration in media (µg/L): 0.056 µg/L
- IR = Intake rate (L/day): 2.972 L/day (95th percentile All Ages)EPA Exposure Factors Handbook (2019)
- ED = Exposure Duration: 365 days
- BW = Bodyweight (kg): 80 kg (adult); 4.8 kg (birth to <1 month) EPA Exposure Factors Handbook (2011)
- AT = Averaging Time: 365 days
- CF = Conversion factor (µg to mg): 1,000

Based on the exposure scenarios for adults and infants (birth to <1 month) with a drinking water intake rate of 2.972 L/day, the calculated doses are 2.08×10^{-6} and 3.47×10^{-5} mg/kg-day, respectively.

6.3.1 Screening-Level Risk Estimates

Acute and chronic MOEs were calculated using an acute human equivalent dose (HED) of 17.6 mg/kg-day and chronic HED of 3.0 mg/kg-day using Equation_Apx I-1. The benchmark of 30 was used for both acute and chronic screening-level risk estimates. Hazard values and benchmarks are described in the *Draft Human Health and Environmental Risk Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b). Both adult and infant acute and chronic MOEs were above the benchmark (Table 6-8). In addition, when taking into the highest surface water concentration from Kolpin et al. (2002) and groundwater concentration sampled underneath a landfill from Westinghouse Savannah River Company (1997) for subpopulations that use untreated surface water or groundwater as the primary source of drinking water, the acute and chronic MOEs were still above the benchmark, with the exception of chronic MOE for infants (birth to <1 month) drinking untreated groundwater. However, this is based on an exposure scenario with a drinking water intake rate of 2.972 L/day, which is the 95th percentile intake rate for all ages. When using the recommended 95th percentile drinking water intake, specifically for infants (birth to <1 month), of 0.938 L/day, the infant chronic MOE is above the benchmark (see last row of Table 6-8

below). Therefore, it is not necessary to refine the conservative assumptions of the screening-level assessment.

Table 6-8. Calculated Drinking Water Doses for Adults and Infants

Age Group	Concentration (µg/L)	Dose (mg/kg-day)	Acute MOE (Benchmark = 30)	Chronic MOE (Benchmark = 30)
Adults	0.056	2.08E−06	8.46E6	1.44E6
	4.3	1.60E−04	1.10E5	1.88E4
	169	6.28E−03	2.80E3	4.78E2
Infant (birth to <1 month)	0.056	3.47E−05	5.08E5	8.65E4
	4.3	2.66E−03	6.61E3	1.13E3
	169	1.05E−01	1.68E2	**2.87E1**
	169	3.30E−02[a]	5.33E2	9.08E1

[a] Dose calculated using 95th percentile drinking water intake rate for infants (birth to <1 month) of 0.938 L/day

6.4 Surface Water Exposure Assessment

6.4.1 Modeling Approach for Estimating Concentrations in Surface Water

Surface water concentrations were estimated for environmental risk assessment. Although there are few direct releases of *p*-dichlorobenzene to surface water, physical and chemical properties indicate that *p*-dichlorobenzene is moderately persistent in water. Thus, a screening assessment was conducted using the highest maximum annual release of *p*-dichlorobenzene to surface water from 2019 to 2023 DMR data (maximum release = 282 kg/yr) using a simple mass balance model:

$$Q_s C_s = Q_d C_d + Q_r C_r$$

Where: Q is discharge and C is concentration of the surface water body (subscript s), discharge point (subscript d) and subsequent receiving water body (subscript r) after mixing. The model employs the conservative assumption of no volatilization though *p*-dichlorobenzene is moderately volatile. Additionally, the model assumes no *p*-dichlorobenzene present in the water body before discharge and an annual release of *p*-dichlorobenzene over 250 days of the year. Solving for receiving water concentrations (C_r), surface water concentrations do not exceed aquatic hazard concentrations of concern (COC = 0.03 mg/L) even under low flow conditions (<1 ft^3/s). Specifically, receiving water concentrations range from 0.0016 mg/L with 1 ft^3/s flow in the receiving water and 1 kg of annual *p*-dichlorobenzene release to 0.1618 mg/L with 1 ft^3/s flow in the receiving water and 10,000 kg of annual *p*-dichlorobenzene release (Table 6-9 displays calculated receiving water concentrations (C_r) with varying amounts of annual release and receiving water flow). The lowest flow reported in a receiving water body was 2,540 ft^3/s in Clear Creek-Frontal Galveston Bay, TX which also had the maximum *p*-dichlorobenzene annual discharge of 282 kg/yr.

Table 6-9. Mass Balance Model Results for Receiving Water Concentrations with *p*-Dichlorobenzene Release

Receiving Water Flow, Q_s (ft^3/s)	Receiving Water Concentrations, C_r (mg/L)					
	Annual Release (kg)					
	1	100	500	1,000	5,000	10,000
1	1.62E−05	1.62E−03	8.09E−03	1.62E−02	8.09E−02	1.62E−01
10	1.49E−05	1.49E−03	7.43E−03	1.49E−02	7.43E−02	1.49E−01
50	1.09E−05	1.09E−03	5.45E−03	1.09E−02	5.45E−02	1.09E−01
100	8.17E−06	8.17E−04	4.09E−03	8.17E−03	4.09E−02	8.17E−02
500	2.72E−06	2.72E−04	1.36E−03	2.72E−03	1.36E−02	2.72E−02
1,000	1.49E−06	1.49E−04	7.43E−04	1.49E−03	7.43E−03	1.49E−02
5,000	3.21E−07	3.21E−05	1.60E−04	3.21E−04	1.60E−03	3.21E−03
10,000	1.62E−07	1.62E−05	8.09E−05	1.62E−04	8.09E−04	1.62E−03
50,000	3.26E−08	3.26E−06	1.63E−05	3.26E−05	1.63E−04	3.26E−04
100,000	1.63E−08	1.63E−06	8.17E−06	1.63E−05	8.17E−05	1.63E−04
500,000	3.27E−09	3.27E−07	1.63E−06	3.27E−06	1.63E−05	3.27E−05
1,000,000	1.63E−09	1.63E−07	8.17E−07	1.63E−06	8.17E−06	1.63E−05
5,000,000	3.27E−10	3.27E−08	1.63E−07	3.27E−07	1.63E−06	3.27E−06
10,000,000	1.63E−10	1.63E−08	8.17E−08	1.63E−07	8.17E−07	1.63E−06

Additionally, negligible amounts of *p*-dichlorobenzene in surface water are expected via deposition from air. The Agency used the Integrated Indoor-Outdoor Air Calculator (IIOAC) to model ambient air deposition rates to surface water based on facility releases from the TRI 2019 to 2023 database to assess environmental exposure to aquatic species from facility releases of *p*-dichlorobenzene. See Section 6.2.1.4 for more details.

6.5 Consumer (Down-the-Drain)

EPA acknowledges there may be environmental releases of *p*-dichlorobenzene from consumer products containing *p*-dichlorobenzene via the end-of-life disposal and demolition of products in the built environment (*e.g.,* foam insulation). Additionally, disposal of products containing *p*-dichlorobenzene via down-the-drain release of *p*-dichlorobenzene can occur when users wash their hands or other product applying tools in a sink. These products can also be disposed when users no longer have use for them, or products become expired and are thrown into garbage or taken directly to landfills. Other down-the-drain releases of *p*-dichlorobenzene can occur with products like toilet bowl deodorizers which may slowly release *p*-dichlorobenzene down-the-drain into sewers when a toilet is flushed. Although EPA acknowledges these releases to the environment can occur, the Agency does not consider the disposal or down-the-drain COUs as pathways of concern from a consumer perspective because of the high volatility of *p*-dichlorobenzene and limited presence in water. The physical and chemical information further supports the down-the-drain pathway is not a pathway of concern due to high wastewater treatment removal (80–99%) (Matter-Müller et al., 1980). In addition, EPA's review of monitoring data

from the WQP found over 99% of samples with non-detectable levels of *p*-dichlorobenzene in surface water and groundwater samples (U.S. EPA, 2026y). In the 2021 to 2023 TRI, all land releases were to underground injection and none to landfills (U.S. EPA, 2018d).

6.6 Human Biomonitoring

From systematic review, EPA identified studies reporting either *p*-dichlorobenzene, or the metabolite 2,5-dichlorophenol (2,5-DCP) in blood or urine of test subjects. EPA focused on studies in the United States or Canada and studies conducted in 1991 and later. A total of 18 studies were identified and evaluated to contextualize exposure to *p*-dichlorobenzene from the environment and provide evidence of human exposure to *p*-dichlorobenzene.

In 1994 and 1995, a study analyzed results from the Third National Health and Nutrition Examination Survey (NHANES III) (Hill et al., 1995a; Ashley et al., 1994). The survey is "a complex, stratified, multistage, probability-cluster design survey" designed to collect data on the health and nutrition of a representative sample of the U.S. population with no age restrictions. The total number of participants was 1037 where blood samples were taken and analyzed for *p*-dichlorobenzene. The mean is 1.9 ppb, median is 0.33 ppb, and 95th percentile is 9.2 ppb. Exact LOD was not reported for *p*-dichlorobenzene; however, all analytes were detectable in at least 75% of samples examined.

In another NHANES III study, spot urine samples were collected for 1,000 adults aged 20 to 59 years (Hill et al., 1995a; Hill et al., 1995b). 2,5-DCP was detected in 98% of samples. The median creatine-corrected concentration is 24 µg/g, mean is 150 µg/g, 90th percentile is 370 µg/g, 95th percentile is 670 µg/g, and maximum is 12,000 µg/g. The median blood concentrations were 0.33 µg/L, mean is 2.1 µg/L, 90th percentile is 4.8 µg/L, and 95th percentile is 11 µg/L. The detection limit for *p*-dichlorobenzene for this study was 1 µg/L. A third study also analyzed blood samples for the 915 adults aged 20 to 59 years (Wu et al., 2006). The geometric mean was 0.466 µg/L and median was 0.322 mg/L. The detection limit for *p*-dichlorobenzene for this study was 0.073 µg/L.

In 2012, a study analyzed the 1999 to 2000 cycle of NHANES (Jia et al., 2012). A cross-sectional analysis of adults aged 20-59 years was examined. Air and blood *p*-dichlorobenzene was measured. Personal air exposure was measured using passive badges which participants wore for 48 to 2 hours. At the return of the badges, whole blood samples were drawn for 10 VOC measurements, which included *p*-dichlorobenzene. For *p*-dichlorobenzene, 67.9 and 88.8% of samples were above the detection limit for air concentrations and blood concentrations, respectively. Detection limit was not specifically reported for *p*-dichlorobenzene, but were below 50 ppt (pg/mL) for a majority of the VOCs tested. The mean blood samples were 1.71 ng/mL (n = 292) and mean air concentrations were 23.33 ug/m^3 (n = 355).

In 2008, another study also analyzed the 1999 to 2000 NHANES (Lin et al., 2008). Similarly, air and blood *p*-dichlorobenzene was measured and 68.2 and 88.8% of samples were above the detection limit for air concentrations and blood concentrations, respectively. The median detection limit for air was 0.938 µg/m^3 and 0.038 ng/mL for blood. The study looked at concentrations of smokers vs. nonsmokers. For smokers, the geometric mean blood concentration was 0.270 ng/mL, 25th percentile was 0.054 ng/mL, and 75th percentile was 0.510 ng/mL. For non-smokers, the geometric mean blood concentration was 0.235 ng/mL, 25th percentile was 0.065 ng/mL, and 75th percentile was 0.667 ng/mL. For blood concentrations measured in smokers and non-smokers, the total number of samples was 304. For air concentrations, the geometric mean for smokers was 2.24 ug/m^3, 25th percentile was 0.669 ug/m^3, and 75th percentile was 5.72 ug/m^3. For non-smokers, the geometric mean was 3.57 ug/m^3, 25th percentile

was 0.838 ug/m^3, and 25th percentile was 11 ug/m^3. For air concentrations, measured smokers and non-smokers total number was 644 samples.

In a 2021 study, a study examined the prenatal exposure to *p*-dichlorobenzene, where two urine samples were collected from each mother during pregnancy and analyzed for 2,5-DCP (Berger et al., 2021). There were 309 participants (303 Latina) from California and all concentrations were above the detection limit. Detection limit was not specified for *p*-dichlorobenzene but ranged from 0.2 ng/mL to 2.3 ng/mL for all measured chemicals in the study. The geometric mean concentration of *p*-dichlorobenzene (specific-gravity corrected) was 75.1 ng/mL, 25th percentile was 15.1 ng/mL, and 75th percentile was 473.3 ng/mL.

In a 2010 study, human breast milk was collected from 12 lactating women from Baltimore, MD to evaluate *p*-dichlorobenzene concentrations in the milk (Blount et al., 2010). The milk samples were collected in two ways: manual expression directly into a collection container and breast pump expression. The reportable range for *p*-dichlorobenzene was 0.120 to 38.0 ng/mL. The mean concentration of *p*-dichlorobenzene measured was 0.186 ng/mL, median was 0.170 ng/mL, and ranged from 0.120 to 0.59 ng/mL.

In a 2016 and 2018 study, spot urine samples were collected and analyzed during third trimester of pregnancy, assessing prenatal exposure to VOCs on fat mass in children (aged 4–9 years) in Mount Sinai Children's Environmental Health Study in New York City (Buckley et al., 2018; Buckley et al., 2016). 2,5-DCP was detected in 100% of 173 samples. The detection limit was 0.12 µg/L. The geometric mean was 71.1 µg/L, 25th percentile of 21.7 µg/L, and 75th percentile of 178 µg/L.

In a 2003 study, breath samples were taken to measure *p*-dichlorobenzene concentration from 21 pediatric subjects (98 samples) with asthma in Los Angeles, California (Delfino et al., 2003). Outdoor air pollution samples (88 samples) were also measured daily via 24h air sampling, collected in canisters and analyzed via GC-MS. The study does not mention specific detection limits, but notes that some measurements of ambient *p*-dichlorobenzene (27%) were below the method detection limit (MDL); for these days, values were set at half the MDL of 0.05ppb. Participants lived within a 3 mile radius of the central air monitoring site. *p*-dichlorobenzene was detected in 75% of the samples for breath and 27% of ambient *p*-dichlorobenzene measurements were below the MDL. The mean of the breath samples is 36.29 ng/L and median is 1.56 ng/L. For ambient air, the mean is 0.96 ng/L and median is 1.20 ng/L.

In a 1996 study, blood VOC levels were measured in 100 people that reside near an industrial complex in Kentucky, compared to 106 people from a control area (Hamar et al., 1996). Two blood samples were taken from target and control populations. Analytical details were not reported for VOC measurements. Exact percentage of values below LOD (0.073 ppb) was not reported for *p*-dichlorobenzene, but it was greater than 5%. The median of the population that reside near the complex was 0.480 ppb and control was 0.460 ppb.

In a 2019 prospective study, couples seeking fertility treatment at Massachusetts General Hospital were studied, with men and women aged 18-46 years and 18-55 years, respectively (Nassan et al., 2019). Participants provided spot urine samples at recruitment and at subsequent visits. 2,5-DCP was detected in 87% of female samples and 93% of male samples. The detection limit for 2,5-DCP ranged from 0.10 to 0.20 µg/L. The geometric mean of (25th, 75th percentile) female partners was 1.03 µg/L, the 25th percentile was 0.40 µg/L, and 75th percentile was 2.40 µg/L. For male partners, the geometric mean was 1.60 µg/L, the 25th percentile was 0.50 µg/L, and 75th percentile was 4.15 µg/L, with 249 couples sampled.

In a 2024 prospective study, urinary 2,5-DCP were analyzed during early pregnancy of 302 women aged 18 to 40 years (Ryva et al., 2024). Urinary samples were physically pooled prior to chemical biomarker measurement from 3 to 5 first morning urine samples at approximately 13, 17, 23, 28, and 34 weeks gestation. Samples were 97% above the LOD 2,5-DCP; the detection limit was 0.1 ng/mL. The median was 1.40 ng/mL, 25th percentile was 0.84 ng/mL, and 75th percentile was 3.28 ng/mL.

In a longitudinal study conducted in 2005, 2011, and 2012, 368 child participants were recruited from two neighborhoods in Minneapolis, Minnesota (Sexton and Ryan, 2012; Sexton et al., 2011; Sexton et al., 2005). Blood samples were taken at four time points between 2000 and 2001. Concentrations were at or exceeded the LOD in 79.4% of blood samples; the detection limit is 0.040 ng/mL. The geometric mean blood concentration was 0.30 ng/mL and standard deviation was 7.0 ng/mL.

In another longitudinal study conducted in Minneapolis, Minnesota, from 2000 to 2002, 43 participants were children aged 2 to 4 years for first blood sample collection (Sexton et al., 2006). Repeated attempts for blood collection every 6 to 12 months over 2 years. 77.8% of samples were above the limit of detection; however, detection limit was not reported. The mean was 0.85 ng/mL and standard deviation was 3.85 ng/mL.

A 2014 study compared serum *p*-dichlorobenzene levels among residents (aged 15–91 years) of two Louisiana parishes, with the goal of characterizing levels in population living near industries (Calcasieu Parish) vs. a population with less industrial exposure (Lafayette Parish) (Uddin et al., 2014). Participants were non-smokers who had lived in one of the parishes for at least 5 years prior. Whole blood was collected from participants. 63% of samples were above the LOD, which was 0.073 ng/mL. The geometric mean of the Calcasieu Parish was 0.322 ng/mL, 25th percentile was 0.085 ng/mL, and 75th percentile was 0.730 ng/mL (192 samples). The geometric mean of the Lafayette Parish was 0.327 ng/mL, 25th percentile was 0.085 ng/mL, and 75th percentile was 0.690 ng/mL (91 samples).

In a 1991 study, air samples were taken for participants aged 11 to 90 years, with the goal of determining the relationship between personal exposure, indoor and outdoor concentrations (Wallace et al., 1991). Participants carried a personal air monitor that took two consecutive 12-hour samples. Concurrently, two 12-hour outdoor air samples were collected in the backyards of the homes. Breath samples were collected three times over 24 hours via spirometer. Indoor air concentrations were measured in the kitchen (two 12-hour samples) and living area (one 12-hour daytime sample). Limits of detection ranged from 1 to 3 ng/cartridge. The mean concentrations for 45 samples in February for personal, indoor, outdoor (respectively): 21, 30, 2.0 µg/m^3. The mean concentrations for 40 samples in July for personal, indoor, outdoor (respectively) are: 11, 7.2, 0.58 µg/m^3.

In a 2016 study, spot urine samples in adolescent NHANES (cycles 2007–2008 and 2011–2012) participants aged 12 to 19 years were analyzed (Wei and Zhu, 2016b). 2,5-DCP was detected in 97.9% of samples. For urinary 2,5-DCP concentrations below the limit of detection (LOD; 2.1% of participants), a value of 0.14 µg/L (LOD divided by square root of 2) was assigned. The geometric mean of 2,5-DCP was 6.93 µg/L for 618 samples. In the same NHANES study (cycles 2007–2010), participants spot urine samples were analyzed for ages 20 to 79 years (Wei and Zhu, 2016a). 2,5-DCP was detected in 98.5% of samples with 1,706 samples and a geometric mean (GM) of 6.05 µg/L. Through biomonitoring studies, there is evidence that *p*-dichlorobenzene (as parent or as metabolite 2,5-DCP) is found in human urine and blood. The NHANES studies cover a broad population and demonstrate that there are concentrations of *p*-dichlorobenzene measured in people throughout the country. The highest concentration found in urine was a mean of 150 µg/g and 1.9 ppb in blood from

NHANES. However, it is important to note that these concentrations are found in low concentrations and that the source is unknown from these exposures.

6.7 Weight of Scientific Evidence Conclusions for Environmental and General Population Exposure Assessment

6.7.1 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for the General Population and Environmental Exposure Assessment

6.7.1.1 IIOAC Model

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, 2025a). 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, elevation, and land use.

6.7.1.2 TRI Release Dataset

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 *p*-dichlorobenzene 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.

When considering aggregate exposures with the TRI dataset, the total facility-reported releases are tied to a specific facility (with a latitude and longitude). This provides strength to the assessment because both the fugitive- and stack-reported releases for an aggregate assessment are spatially aligned. However, an uncertainty when considering aggregate using the TRI dataset is the accuracy and precision of the latitude and longitude reported by a facility, which is generally a single, possibly centralized location that may not represent the actual release point.

6.7.2 Conclusions

EPA has robust confidence in the overall characterization of exposure in this general population and environmental exposure assessment and that the exposure scenarios represent a conservative upper

bound on exposure. This confidence is based on EPA's use of methodologies and models that previously underwent peer review and public comment.

EPA additionally 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.

EPA presented monitoring data from the AMTIC archive and AQS. When EPA-modeled concentrations are compared to AMTIC and AQS monitoring data, modeled concentrations generally are within the same order of magnitude with monitored concentrations. Although (Padilla et al., 2024) found that nationwide measured concentrations of 79 HAPS, including *p*-dichlorobenzene, tend to be higher than modeled concentrations in 74% of comparisons over all monitors, chemicals, and years assessed, this was not the case for the screening-level assessment of *p*-dichlorobenzene where the highest 95th and 50th percentile modeled concentrations at 100 m were higher than the highest 24-hour concentrations reported in AMTC and AQS. This may lead to an overestimation of risk estimates based on IIOAC-modeled concentrations, but this conservative approach is appropriate for a screening analysis. It is also important to note that EPA acknowledges that the modeled and monitoring concentrations are not necessarily directly comparable because air monitoring stations are (1) located throughout the United States in different topographical settings (urban, suburban, rural); (2) spatially vary across distances other than those defined in model outputs; (3) specific to a select moment in time, location, season, and immediate weather conditions; and (4) representative of total ambient concentrations from all contributing sources (*i.e.,* COU-specific sources and other sources). In contrast, modeled concentrations are COU-specific, represent concentrations in defined topographical settings with defined meteorological data at defined distances from the releasing source, and include assumptions of continuous releases over time. Padilla et al. also concluded that "as long as ambient air monitoring remains sparse, the exposure models that we evaluated and similar modeling systems are the best available tools for large-scale screening-level risk assessments"—providing support to EPA's use of modeled concentrations to derive exposures and risk estimates.

Taken together, the various modeling and monitoring lines of evidence considered by EPA in this general population exposure assessment for *p*-dichlorobenzene give the Agency robust confidence in its characterization of general population and environmental exposures.

The Agency has low confidence in the modeled *p*-dichlorobenzene air deposition results and subsequent environmental exposures in surface water, sediment and soil due to the assumption that *p*-dichlorobenzene is being released as a solid particle, rather than a vapor, and depositing onto surface water, sediment and soil without undergoing volatilization, which is unlikely due to its physical, chemical, and fate properties within these media.

EPA has robust confidence in the drinking water screening-level exposure assessment for the general population. The exposure parameters used in this assessment from the EPA *Exposure Factors Handbook* (U.S. EPA, 2011b) were selected to evaluate high-end, conservative, health-protective exposure scenarios to inform whether there are exposures (and associated risk estimates) of concern for age groups ranging from infants (birth to <1 month) to adults. In addition, the highest concentration reported

in surface water and ground water were also taken into consideration for subpopulations that use untreated surface water or groundwater as a primary source of drinking water.

7 CONSUMER EXPOSURE ASSESSMENT

7.1 Exposure Approach and Methodology

p-Dichlorobenzene is primarily used in air care products, automotive lubricants and degreasers, fuels and related products, and building and construction products. Because *p*-dichlorobenzene exists in solid phase at ambient temperatures it is used in essentially pure form for air care products for aromatic odor properties as it volatilizes from solid to vapor form to the air. The volatilization of *p*-dichlorobenzene from these products has been identified as a potential mechanism of exposure. Exposure to *p*-dichlorobenzene can occur via inhalation of vapors during consumer use and via the dermal route through contact from solids or accidental splashing from liquid consumer products. Additionally, the consumer product "Marvel Mystery Oil" is the only product that falls under both the "Fuels and related products" and "Lubricants and greases" COUs. Therefore, for this assessment, EPA evaluates this product under the lubricants and greases COU.

Consumers using or disposing of products may be exposed to *p*-dichlorobenzene vapors through inhalation during volatilization, see Section 7.1.3 for further details. Direct liquid or solid contact may lead to dermal exposure. Generally, EPA used high-end input parameters for acute exposures, and 50th percentile for chronic exposures (*e.g.* duration of use, frequency of use), unless specified otherwise. If results from these exposure scenarios indicated an associated risk of concern, the Agency conducted an additional sensitivity analysis to determine at what level, if any, risk of concern may occur. This information is then used to inform risk determination, rulemaking, and regulatory decision-making.

Overall, confidence in the inhalation exposure modeled results ranged from moderate to robust, depending on the specific product and exposure scenario evaluated. EPA first identified information from manufacturer instructions, online retailer recommended use of the product (*e.g.,* quantity of product used during product application), and SDSs. When information was not found from these sources, CEM defaults or professional judgement were used. Use pattern information was either taken directly from the product manufacturer or information available in CEM (which relies on information from the EFH) (U.S. EPA, 2011a). EPA has robust confidence when inputs are based on online retailer information about the product (*e.g.,* quantity of product used during product application) because that is how the product is intended to be used. If CEM defaults were used, EPA has moderate confidence, whereas if professional judgement was used, the Agency has slight confidence.

Table 7-1. Consumer Conditions of Use Table

Life Cycle Stage[a]	Category[b]	Subcategory[c]	Reference(s)
Consumer Use	Lubricants and greases	Lubricants and greases (*e.g.,* oil additives, degreasers, penetrant for pneumatic tools)	(Marvel Oil Company, 2024b), (Marvel Oil Company, 2024a)
	Fuels and related products[d]	Fuel additive for gasoline and diesel	(Marvel Oil Company, 2024b)
	Air care products	Continuous action air fresheners (including toilet/urinal deodorizers/fresheners)	(Willert Home Products, 2019)
	Building and construction products	Sealant	(DAP Products, 2026)
Disposal	Disposal	N/A	

[a] Life Cycle Stage Use Definition (40 CFR 711.3) – "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.
[b] These categories of COUs in the life cycle diagram (LCD), reflect CDR codes, and broadly represent COUs of *p*-dichlorobenzene in industrial and/or commercial settings.
[c] These subcategories reflect more specific COUs of *p*-dichlorobenzene.
[d] Marvel Mystery Oil falls under both the lubricants and greases as well as the fuels and related products COU.

EPA also researched to determine if *p*-dichlorobenzene is present in mattresses, carpet products and other articles. In one study, concentrations were reported in new carpets, however, the study mentions that the one sample is most likely a residual from a pesticide application (Pleil and Whiton, 1990). Other studies measured carpet and other interior building materials as sinks for *p*-dichlorobenzene, though they did not specifically mention these materials to be sources of *p*-dichlorobenzene (An et al., 1999). Based on this information, EPA determined that there was minimal evidence of *p*-dichlorobenzene in mattress or carpet products and therefore was not assessed in this draft consumer exposure assessment.

EPA acknowledges that *p*-dichlorobenzene is used as a material to form polyphenylene sulfide (PPS), a high-performance plastic. PPS is used in a variety of consumer products, such as home appliances and electronics. In the ACC report "*Targeted Condition of Use Risk Evaluation for p-dichlorobenzene – use as polymerization monomer in polyphenylene sulfide (PPS)*" (ACC, 2026), ACC provided a summary on consumer exposure on *p*-dichlorobenzene in PPS. The report states any low-level traces of residual *p*-dichlorobenzene present in the final industrial product would result in de minimis exposure or otherwise insignificant risks to the consumer. Furthermore, as demonstrated by air monitoring conducted during compounding activities, *p*-dichlorobenzene was not detected above the analytical LOD in all samples even when the polymer was heated to form molten liquid as additives are mixed. These data demonstrate that inhalation exposure from residual levels in final products, if any, would be even lower (ACC, 2026). Therefore, EPA did not assess *p*-dichlorobenzene in PPS for consumer products.

The main steps in performing a consumer exposure assessment are summarized below:

1. Identification and mapping of product examples following the consumer COU table (Table 7-1).
2. Selection of exposure routes and exposed populations according to product use descriptions.
3. Compilation of product use instructions from manufacturers to determine patterns of use.

4. Identification of data gaps and further literature searching to fill gaps with studies or professional judgement.[10]
5. Selection of appropriate modeling tools based on available information and chemical properties.
6. Gathering of other input parameters (*e.g.* room of use) that are needed per exposure scenario.
7. Parameterization of selected modeling tools.
8. Conducting model simulations. Review and extraction of results.

Consumer products containing *p*-dichlorobenzene were cross-walked with TSCA COUs to determine the anticipated use of the item. For this draft consumer exposure assessment of *p*-dichlorobenzene, quantitative analysis was conducted to evaluate exposures via the inhalation and dermal routes. A qualitative analysis is provided for the oral route (ingestion). See Section 7.1.3 for more information.

To inform the COUs applicable to consumers, EPA searched and collected information from 2016 and 2020 data reported in the Chemical Data Reporting (CDR) database and from a variety of other sources including SDS, company websites and published literature. EPA last checked for updated or new SDS in 2022 to determine if certain products are currently available or discontinued to identify COUs under TSCA (see Table 7-1). There were seven SDSs identified for toilet bowl deodorizers and one for each of the other COUs. Out of the seven SDSs, one was chosen for modeling because it contains the highest weight fraction and is accessible to consumers. For more information on the SDSs used, see Section 7.1.2.

EPA used two models, the Consumer Exposure Model (CEM) and the Indoor Environmental Concentrations in Buildings with Conditioned and Unconditioned Zones (IECCU) Model to assess acute and chronic inhalation exposures to individuals using consumer products containing *p*-dichlorobenzene. Dermal exposures were calculated in a spreadsheet outside of CEM developed by EPA. Bystanders are considered as non-users that are incidentally exposed to the product as they are present during the consumer use of these products. Dermal exposure was not evaluated for bystanders because they are not direct users of the product.

Exposure via inhalation was evaluated using EPA's CEM Version 3.2 (U.S. EPA, 2023b) for all but one COU (Toilet bowl deodorizer). The Toilet bowl deodorizer COU was evaluated with EPA's IECCU Model rather than CEM as explained further in Section 7.1.4.3. Refer to Section 7.1.4 for a detailed description of inhalation modeling, consumer-specific inhalation modeling parameters, and assumptions for exposure estimates. Dermal exposure to *p*-dichlorobenzene containing consumer products was estimated using an EPA developed computational framework implemented within a spreadsheet (U.S. EPA, 2026r) for all COUs. Refer to Section 7.1.5 for a detailed description of dermal modeling, consumer-specific dermal modeling parameters, and assumptions for exposure estimates.

EPA began the consumer exposure assessment modeling using conservative approaches for each COU. When a range of concentrations were identified for a product type, EPA used the highest reported value as the input for weight fraction of the chemical in the product. If a range of weight fractions were not identified, then EPA used the single weight fraction identified for the given product/COU. Generally, for acute exposure, the 95th percentile values for duration of use and frequency of use were used to represent the upper end of product use. For chronic exposure, 50th percentile values for duration of use

[10] *Professional Judgement* as referenced throughout this draft TSD refers to the utilization of the best available data or information to assess a population, route or pathway for consumer or indoor dust exposures, especially where substantial data gaps and/or uncertainties are present. This involves conducting supplemental research to address the identified data gaps or uncertainties including a consideration of concurrent or previous experience with similar assessments, product or article manufacturer use descriptions, and realistic product and article use patterns according to the most recently available literature.

and frequency of use were used to represent average product use throughout a year. All CEM and dermal spreadsheet inputs, sources of information, assumptions, and exposure scenario descriptions are available in the *Draft Consumer Model Results for p-Dichlorobenzene* (U.S. EPA, 2026c), the *Draft Consumer Inhalation and Dermal Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026r). Furthermore, as *p*-dichlorobenzene is volatile, potential take-home exposures are likely small in comparison to the scenarios considered in this assessment; thus, take-home exposures were not further explored.

EPA assessed acute and chronic exposures to *p*-dichlorobenzene from all relevant consumer COUs. For acute 24-hour time-weighted average (TWA) concentrations, an averaging time of 1-day was used, representing the average air concentration over a 24-hour period during the exposure event. In CEM, a pre-defined activity pattern is assigned to the user throughout the simulation period. To calculate the 24-hour TWA, the air concentrations of the user's room was calculated for every 30-second time stamp when the user is in the room using the product. The rest of the time during the 24 hours, including when the user is not in the room of use, is averaged in to calculate the 24-hour TWA. In IECCU, the 24-hour TWA was calculated in the same way, except the time intervals are 0.144 hours. There is no prescribed activity pattern in IECCU, therefore, the EFH bathroom use time and time spent in rest of house were used as the averaging times to calculate the TWA. The 24-hour average concentrations were used as the health effects are derived for 24-hour health outcomes (see *Draft p-Dichlorobenzene Human Health and Environmental Hazard Assessment* (U.S. EPA, 2026p) for more information). Similar to acute concentrations, the chronic average daily concentration (CADC) in CEM is calculated iteratively at 30-second intervals during the first 24 hours and every hour after that for 60 days and averaged over one year. In IECCU, the CADC is calculated at 0.144-hour intervals over 1 month, as that is the expected use time of a toilet bowl deodorizer.

7.1.1 Scope of Exposure Routes

As described in the *Final Scope of the Risk Evaluation for p-Dichlorobenzene; CASRN 106-46-7* (U.S. EPA, 2020c), exposures to *p*-dichlorobenzene from consumer product use are primarily expected to occur via the inhalation route. The magnitude of inhalation exposure depends upon the concentration of *p*-dichlorobenzene in products, use patterns (including frequency, duration, amount of product used, and room of use), and product application methods (U.S. EPA, 2011a).

Dermal exposure to *p*-dichlorobenzene may occur via direct solid contact or with deposition on the skin during use. The magnitude of dermal exposure depends on factors like skin surface area exposed, product weight fraction, chemical loading, and exposure duration. Although *p*-dichlorobenzene that deposits on the skin is primarily expected to evaporate based on physical and chemical properties (*e.g.,* vapor pressure of 1 mm Hg and boiling point of 174 °C) limiting exposure, some may remain on the skin long enough to be absorbed dermally, particularly if the initial loading is relatively high. Therefore, EPA still evaluated dermal exposure for this consumer evaluation.

7.1.2 Products with *p*-Dichlorobenzene Content

Products are defined as consumable liquids or solids that are used a given number of times before they are exhausted. All of the *p*-dichlorobenzene consumer COUs involve products. The preferred data sources for *p*-dichlorobenzene content in U.S. consumer goods were SDSs for specific products available in the United States with reported *p*-dichlorobenzene content. EPA evaluated these products to ensure that data were representative of items which may expose U.S. consumers to *p*-dichlorobenzene. Where possible, SDSs were validated with company websites to ensure that each product could reasonably be purchased by consumers. When weight fractions in SDSs were reported as a range, the maximum was chosen as a conservative value to determine if risk was found. For scenarios with

multiple products, the highest maximum weight fraction was chosen out of those products to model the scenario and are listed in the following subsections. For details of the SDSs used, refer to the *Draft Consumer Inhalation and Dermal Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026r).

7.1.2.1 Lubricants and Greases

Two lubricant/grease products were identified with *p*-dichlorobenzene content. The first product is Marvel Mystery Oil, which reports maximum *p*-dichlorobenzene content of 0.01% (1×10^{-3} weight fraction) (Marvel Oil Company, 2024b). The second is Marvel Air Tool Oil, which reports *p*-dichlorobenzene content of 0.001 % (1×10^{-5} weight fraction) (Marvel Oil Company, 2024a).

7.1.2.2 Air Care Products

Multiple air care products were identified with *p*-dichlorobenzene content. The product with the highest maximum weight fraction is a solid toilet bowl deodorizer, which reports *p*-dichlorobenzene maximum content of 100% (1 weight fraction) (Willert Home Products, 2019).

7.1.2.3 Building and Construction Products

One building and construction product was identified with *p*-dichlorobenzene content. The product is a foam sealant which reports concentration of 7% (0.07 weight fraction) (DAP Products, 2026).

7.1.3 Qualitative Assessment

EPA evaluated consumer exposure via the oral route qualitatively, as presented in Table 7-2, and provided a qualitative discussion to support conclusions about the oral pathway and down-the-drain disposal practices and releases to the environment.

Table 7-2. COUs and Products or Articles Assessed Qualitatively

Consumer Use Category	Consumer Use Subcategory	Product/Article	Comment
Building and construction products	Sealant	Touch N Foam Mouse Shield Can Foam Sealant & Blocker	Qualitative assessment for **oral pathway**
Air care products	Continuous action air fresheners (including toilet/urinal deodorizers/freshener)	Bowl Fresh Toilet Bowl Deodorizer	
Disposal	Disposal	Down-the-drain products	Qualitative assessment – due to physical and chemical properties of *p*-dichlorobenzene

EPA acknowledges there may be ingestion to *p*-dichlorobenzene from building and construction products (foam insulation) and air care products. For the foam insulation, the product is initially a liquid in the container and becomes a solid when applied, so *p*-dichlorobenzene may be trapped in the product after application. The foam may be incidentally ingested during use after solidifying or via dust as a carrier following sanding after application. However, these quantities are low and EPA considers them as minor routes. There is also the potential for degradation of the foam over time, leading to *p*-dichlorobenzene release resulting in a possible inhalation exposure.

For air care products, *p*-dichlorobenzene will sublime to vapor and has potential to bind to dust particles. However, due to its relatively high vapor pressure, dust ingestion is considered a minor route compared to inhalation. Thus, EPA does not further evaluate the oral pathway beyond this qualitative assessment presented here for ingestion for foam insulation and air care products.

There have also been several reports of pica (ingestion of inedible substances) of toilet bowl cleaners, moth balls, or other solid *p*-dichlorobenzene sources indicate a range of neurological symptoms including fatigue, dizziness, tremors, altered mental status, reduced motor and executive functioning, brain damage, and even coma or death (Weidman et al., 2015; Buckman, 2013; Friedman et al., 2012; Murray et al., 2010; Avila et al., 2006; Campbell and Davidson, 1970; Frank and Cohen, 1961). Although EPA acknowledges ingestion from these studies, they are difficult to quantify and are incidental cases that do not represent consumer exposure.

7.1.4 Inhalation and Modeling Approach

CEM Version 3.2 (U.S. EPA, 2023b) was used to evaluate consumer exposure based on the available data for *p*-dichlorobenzene containing consumer products (other than toilet bowl deodorizers, which was modeled with IECCU, see Section 7.1.4.4) and the ability to use that data as direct inputs to CEM. The advantages of using CEM to assess exposures to consumers are as follows:

- CEM has been peer-reviewed (ERG, 2016); and
- CEM accommodates a variety of user-specified inputs for the products containing *p*-dichlorobenzene, such as weight fractions, product density, room of use, frequency and duration of use.

CEM 3.2 generates exposure estimates based on user-provided or default input parameters. The model contains a variety of pre-populated scenarios for specific product categories and allows the user to define generic categories for any product where the prepopulated scenarios are not adequate. For this consumer exposure assessment, when generic categories/scenarios are necessary, EPA uses physical and chemical properties of products identified in Section 2.2 to calculate emission profiles of volatile and SVOCs. There are six emission calculation profiles within CEM (labeled E1–E6) 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.[11]

7.1.4.1 Inhalation Modeling for Products

CEM 3.2 is a deterministic, mass-balance model which calculates indoor air concentrations and associated exposure concentrations for the consumer (an individual using the consumer product. The model uses a two-zone representation of the building of use when predicting indoor air concentrations. Zone 1 represents the room where the consumer product is used. Zone 2 represents the remainder of the building. Each zone is considered 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 (represented by a 1 cubic meter [m^3] bubble around a consumer's head), while Zone 1-far field represents the remainder of the Zone 1 room. For the foam insulation, EPA considered the user to be in the near field, as the user would be using the product near their breathing zone.

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 the two zones. Following product use, the user may follow one of three pre-defined activity patterns which determine the length of time they are present and exposed to products in each zone of the home. The pre-defined patterns correspond to full-time employment outside the home, part-time employment outside of the home, and stay-at-home. The activity use pattern determines which zone is relevant for the user and the duration of the exposures. The user will inhale airborne concentrations

[11] https://www.epa.gov/tsca-screening-tools (accessed June 17, 2026)

within these zones, which can vary over time, resulting in the overall estimated exposure. For this assessment, EPA uses the "stay-at-home" activity pattern as the most conservative activity pattern of the three for the consumer. Under this activity pattern, the consumer is assumed to be in the home the majority of the day (20 hours) resulting in the highest number of exposure hours in the home of the three activity patterns within CEM.

The air exchange rate (AER) and interzonal air flow rates (IAR) determine the movement of air from outside and within a building. The AER is a measure of the number of times per hour that the air in the room where the product is being used (Zone 1) is replaced by air from the portion of the building where the product is not being used (Zone 2) or from the outside. The IAR is the rate of volumetric air flow between Zones 1 and 2. The recommended value for AER is 0.45 air changes/hour for residential buildings (U.S. EPA, 2011a). This was derived from studies and databases that are described further in the EFH. The IAR is 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. For example, the bathroom and utility room are considered closed, while garages are considered more open. The following equations calculate IAR using the AER (0.45 air exchanges/hour) and house volume (492 m^3) (U.S. EPA, 2023b):

Equation 7-1. IAR for Closed Rooms (Bathroom, Utility Room)

$$IAR = (0.078 + 0.31 * AER) * V$$

Equation 7-2. IAR for Open Rooms (Garage)

$$IAR = (0.046 + 0.39 * AER) * V$$

Where:

IAR = Interzonal air flow rate
AER = Air exchange rate (air changes/hour)
V = Volume of house (m^3)

When applying the calculations, the bathroom and utility have an IAR of 107.01 m^3/hour, while the garage has a value of 108.98 m^3/hour. In the instance where outside is the use environment, the outside is considered Zone 1, and the interzonal ventilation rate is therefore equal to the negligible value of 1×10^{-30} m^3/hour.

The embedded model designated as E1 (Emission from Product Applied to a Surface Indoors Incremental Source Model) within CEM 3.2 was used for lubricants and greases. E1 assumes a constant use rate over a duration of use. Each application has an emission rate that declines exponentially over time, at a rate that depends on the chemical's molecular weight and vapor pressure. This model is generally applicable to liquid products that evaporate from surfaces.

The E2 (Emission from Product Applied to a Surface Indoors Double Exponential Model) was selected as the most appropriate for foam insulation. The model is applicable for products applied to a surface and dried or cured over time, where there is an initial fast release of the chemical governed by evaporation and a later slower release. Empirical studies have estimated a relationship between the fast rate of decline and vapor pressure, and between the slow rate of decline and molecular weight, leading to the equation for the time-varying emission rate (U.S. EPA, 2023b). Based on the physical-chemical properties of the chemical, the model assumes that a certain amount of the applied mass is released because a substantial fraction of the mass becomes trapped in the cured substrate when it dries.

Table 7-3 presents a crosswalk between the COU subcategories with either a predefined or generic scenario in CEM. The table provides data on emissions modeled for each exposure scenario. Emissions models were selected based upon physical and chemical properties of the product and application use method for products. Exposure pathways were selected to reflect the anticipated use of each product.

Table 7-3. Crosswalk of COU Subcategories, CEM 3.2 Scenarios, and Relevant CEM 3.2 Models Used for Inhalation Consumer Modeling

Consumer COU Category	Product	Emission Model	CEM Scenario
Lubricants and greases/Fuel Additive	Automotive	E1	Lubricants (non-spray)
	Tool		
Building and construction products	Touch N Foam Mouse Shield Can Foam Sealant & Blocker	E2	Generic product E2

7.1.4.2 Key Parameters for Products Modeled in CEM

All products were assessed using the highest reported weight fraction identified in SDS. For acute exposure, the high-end frequency of use and duration of product use were used, representing the highest exposure within 24 hours. For chronic exposure, the median frequency of use and duration of product use were selected because these values represent the average use within a year. For model input parameters that were not identified, EPA relied upon default values within CEM (either directly or calculated using physical-chemical properties) or used professional judgement define missing inputs for the product. Product densities were taken from product-specific technical specifications or provided by CEM default.

7.1.4.2.1 Mass of Product Used

For the products in Table 7-4, the volume of product per use was based on the product directions or professional judgement. This was multiplied by the density to determine mass of product per use for the lubricants and greases. For the Marvel Air Tool, EPA did not have a way to quantify "2–5 drops", so the volume per use is estimated by professional judgement.

Table 7-4. Mass of Product Used

Product	Volume Per Use (cm^3)	Density (g/cm^3) [a]	Mass Per Use (g)	Product Directions
Marvel Mystery Oil	118	0.90	106.2	At every fill-up add 4 oz to every 10 gallons of gas or diesel
Marvel Air Tool	0.3	0.90	0.27	Add 2–5 drops per use
Touch N Foam Mouse Shield Can Foam Sealant & Blocker	N/A	1.02	5	Professional judgement. Assumes 5 g of use for small to medium size project.

[a] CEM defaults
[b] https://marvelmysteryoil.com/blogs/how-to-use/automobile (accessed June 17, 2026)
[c] https://marvelmysteryoil.com/blogs/how-to-use/tool-oil (accessed June 17, 2026)

7.1.4.2.2 Duration of Use

The duration of use differs depending on the product evaluated. The EFH was consulted to obtain duration of uses for acute and chronic exposures for each of the exposure scenarios evaluated. For the lubricants and greases, professional judgement was used on how long it would take to use the product.

For the foam sealant, EPA did not identify relevant products in the EFH and therefore used adhesives as an appropriate product to estimate use. Table 7-5 lists the duration of uses for each product and the source and reasoning for each value used.

Table 7-5. Duration of Use for Consumer Products

Product	Duration of Use (min/event)		Source	Reasoning
	Acute	Chronic		
Marvel Mystery Oil Marvel Air Tool	10	5	Professional judgement	EPA assumes that the product takes 5–10 minutes to use (pouring oil into gas tank before filling; applying air tool to tool before use)
Touch N Foam Mouse Shield Can Foam Sealant & Blocker	60	4.25	EFH 17-5 (adhesives)	Based on EFH frequency of use

7.1.4.2.3 Frequency of Use

Similar to the duration of use, the EFH was consulted to obtain frequency of use for acute and chronic exposures for each exposure scenario evaluated. Table 7-6 lists the frequencies of use for each product and the source and reasoning for each value used.

Table 7-6. Frequency of Use for *p*-Dichlorobenzene Consumer Products

Product	Frequency of Use		Source	Notes
	Acute (events/day)	Chronic (events/year)		
Marvel Mystery Oil	1	52	Professional judgement	EPA assumes users could use the product every time they fill gas tank (once a week)
Marvel Air Tool		12		EPA assumes users could use the product once a month
Touch N Foam Mouse Shield Can Foam Sealant & Blocker	1	3	EFH 17-5 (adhesives)	Based on EFH frequency of use

7.1.4.2.4 Environmental Parameters

The use environment was based on the expected room where a given product may be used. The room volume was based on CEM defaults within each exposure scenario evaluated. The interzone air flow rate is calculated in the equations in Section 7.1.4.1. Section 7.1.4.2 summarizes the environmental parameters of CEM defaults. Based on Marvel Mystery Oil product directions, the product is used “at every fill up” with gas; therefore, EPA modeled the product being used at a gas station in an outdoor environment.

Table 7-7. Environmental Parameters

Product	Use Environment	Use Environ. Volume (m^3)	Interzone Air Flow Rate (m^3/h)
Marvel Mystery Oil	Outside	492	1E−030
Marvel Air Tool Oil	Garage	90	108.98
Touch N Foam Mouse Shield Can Foam Sealant & Blocker	Utility room	20	107.01

7.1.4.3 Inhalation Modeling for Toilet Bowl Deodorizer

A limitation of CEM is that there is no scenario or emission model that represents a hanging toilet bowl deodorizer. *p*-Dichlorobenzene from a toilet bowl deodorizer has a high initial emission rate but decays rapidly over a 15-day period due to the reduction in product surface area as *p*-dichlorobenzene sublimates from the product (Guerrero and Corsi, 2012). Although there are emission models within CEM account for decay, they are only applicable for other types of products (*e.g.,* E3 for products sprayed). The E5 model is applicable for a product placed in the environment, however, it assumes a constant rate of emission of the product with no decay. For example, this is applicable for a liquid wall plug in air freshener, but not a solid toilet bowl deodorizer. Therefore, EPA identified the Indoor Environmental Concentrations in Buildings with Conditioned and Unconditioned Zones Model (IECCU) as a more appropriate for modeling exposure resulting from use of this product.

7.1.4.4 IECCU Model Development and Parameterization

As a more refined model, IECCU Version 1.1 (U.S. EPA, 2019c), was selected to model consumer inhalation exposures to *p*-dichlorobenzene for the use of the toilet bowl deodorizer products using the single exponential decay model. In this decay model, the emissions are modeled at an initial rate specified by the user followed by a decay in emission rate as the chemical concentration in the product declines. The calculated emission rates are then used in a deterministic, mass balance calculation to determine indoor air concentrations. IECCU can be configured with one, two, or up to three zones within a building. Based on professional judgement, EPA has determined that a majority of US residences have at least two bathrooms. To match the conditions used in CEM for products, the toilet bowl deodorizer was modeled in IECCU using a three-zone configuration, where Zones 1 and 3 are the bathrooms (with one toilet bowl deodorizer in each) and Zone 2 represents the rest of the house.

Advantages of IECCU include that it considers chemical sources and sinks and allows generation of exposure estimates over longer periods of time. It also allows customizable time points within the chosen period, allowing for flexibility in the granularity of the data. It also allows the user to define the decay rate. IECCU is an indoor air pollutant transport model designed to estimate concentrations within various zones (conditioned and unconditioned). Unlike CEM, IECCU does not distinguish between user and bystander, does not include a near field option, and does not contain any default input parameters. To align the IECCU exposure scenario with the CEM exposure scenarios, EPA used CEM default environmental input values including building volumes, ventilation rates, and interzonal air flows, values and conditions which matched to conditions used in CEM for specific room or whole house scenarios. As with CEM, EPA evaluated representative exposure scenarios to support a health protective exposure for this product.

7.1.4.4.1 Air Zones and Ventilation

When choosing inputs for air exchange flow rates in the IECCU modeling, the values in were calculated based on the house and room volumes and interzonal flows from either the EFH or CEM default values.

The average volume of a whole house from the EFH is 492 m^3. The volume of 15 m^3 for the bathrooms was taken from CEM; thus the Zone 2 (or "rest of house") volume is 462 m^3 (492 − 15 × 2 = 462 m^3).

The average residential air exchange rate from the EFH is 0.45 exchanges per hour. The interzone ventilation rate of 107 m^3/hour was also taken from CEM. As a conservative estimate, EPA is assuming there is no HVAC in the bathroom, although most bathrooms have a fan for ventilation. When calculating air flow to different zones, the air exchange rate (0.45 air changes per hour) is multiplied by the room volume. For example, from Zone 0 (representing the ambient environment) to Zone 1 (bathroom), the value is 6.75 m^3/hour (0.45 × 15; see Table 3.1 in the IECCU user guide for example calculation) (U.S. EPA, 2019c). For Zone 0 to Zone 2, the rest of house volume of 462 m^3 multiplied by 0.45 to get 207.9 m^3/hour.

Table 7-8. Air Exchange Flow Rates (m^3/h) to and from Different Zones

	To Zone 1	To Zone 2	To Zone 3
From Zone 0	6.75	207.9	6.75
From Zone 1	N/A	107	0
From Zone 2	107	N/A	107
From Zone 3	0	107	N/A

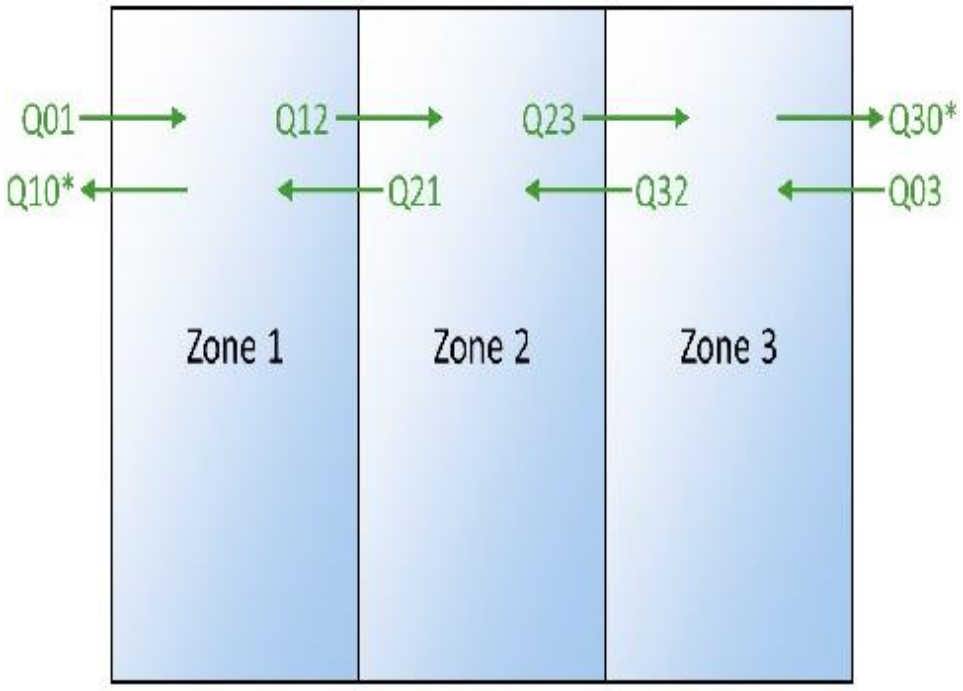

Figure 7-1. Diagram of Flow Rates from Different Zones

7.1.4.4.2 Source Model and Inputs

The "First-order decay" model within IECCU was selected as the appropriate model to determine the decay rate of *p*-dichlorobenzene emission rate from toilet bowl deodorizers. The equation is as follows:

Equation 7-3. First-Order Decay Equation

$$R = A \times E_0 \times e^{-kt}$$

Where:

R = Emission rate (µg/hour)
A = Source area (m^2), set to 1
E_0 = Initial emission factor (µg/m^2/hour)
k = First-order decay constant (1/hour)
t = Elapsed time (hour)

EPA used (Guerrero and Corsi, 2012) to determine the initial emission factor and first-order decay constant most appropriate for this COU. Ultimately, E_0 was set to 5.00×10^5 µg/m^2/h and k was set equal to 4.471×10^{-3} h^{-1}.

7.1.4.4.3 Activity Patterns

To simulate a person moving through Zones 1, 2, 3, and outside the house, EPA used the time in different areas of the house from Table 16-16 of EPA's *Exposure Factors Handbook*.

For the acute exposure calculations, the 95th percentile activity pattern was used, where the person spends 1.5 hours/day in the bathroom (Zones 1 or 3) and 24 hours per day in the house. That gives 22.5 hours per day in the "rest of the house", or Zone 2. For acute exposure concentrations, the zonal air concentrations were weighted-averaged in Excel using this activity pattern, and the 24-hour average concentration was used as representative for the acute exposures.

For the chronic exposure calculations, the 50th percentile activity pattern was used, where the person spends 25 minutes per day in the bathroom (Zones 1 or 3), and 16.4 hours per day in the house. That gives 16.0 hours per day in the "rest of the house", or Zone 2 and 7.6 hours outside the house. For chronic exposure concentrations, the zonal air concentrations were weighted-averaged in Excel using this activity pattern (assuming no exposure for the 7.6 hours outside the home), and the 30-day average was used as representative for the chronic exposures.

Table 7-9. Activity Patterns Implemented as a Post-Processing Step

	Exposure Zone	95th Percentile Hours Per Day (Acute)	95th percentile Percent of Time (Acute)	50th Percentile Hours Per Day (Chronic)	50th Percentile Percent of Time (Chronic)
In the Residence		24	100%	16.4	68.4%
In the Bathroom	1 or 3	1.5	6.3%	0.4	1.7%
In the "Rest of House"	2	22.5	93.8%	16	66.7%
Outside the House	No exposure	0	0%	7.6	31.6%

7.1.4.4.4 Model Output Time Period

IECCU was used to generate 30-day concentrations of *p*-dichlorobenzene due to product use at 0.144-hour intervals. To evaluate air concentrations relevant to acute and chronic exposure, the simulation duration selected was 720 hours (30 days), and the number of data points selected was 5,000. A toilet bowl deodorizer is expected to typically last 30 days, and 5,000 data points give the most granularity of data points during the 30 days. EPA assumes that at the end of the 30 days, the deodorizer product is replaced, and the concentration pattern begins again. Concentrations peaked at 8.02×10^3 µg/m^3 in Zones 1 and 3 at around 7 hours after the simulation start time and logarithmically decayed to 2.56×10^3 µg/m^3 in Zones 1 and 3 after 1 week.

7.1.4.4.5 Sensitivity Analysis

As a sensitivity analysis EPA used IECCU to model a scenario with one bathroom using the same inputs for two bathrooms. Instead of three zones, only one zone represents the bathroom (Zone 1) and Zone 2 for the rest of the house. For acute exposure, which includes consideration of the activity patterns, the *p*-dichlorobenzene concentration with one bathroom is 1.82 times less than with two bathrooms, and for chronic one bathroom is 1.90 times less than two bathrooms.

7.1.5 Dermal Modeling Approach

This section summarizes the available dermal absorption data related to *p*-dichlorobenzene, the interpretation of the dermal absorption data, dermal absorption modeling efforts, and uncertainties associated with dermal absorption estimation. A limitation of using CEM for dermal absorption is that it relies on total concentration rather than aqueous saturation concentration and therefore can greatly overestimate exposure to *p*-dichlorobenzene in liquid and solid products. Therefore, the dermal modeling for *p*-dichlorobenzene was conducted outside of CEM using the approaches described in Sections 7.1.5.1 and 7.1.5.2. Dermal data were sufficient to characterize consumer dermal exposures to liquids or formulations and to solids containing *p*-dichlorobenzene. Two models were used to evaluate consumer dermal exposures, the Fraction Absorbed model for liquid products and the Permeability model for solid products (see Sections 7.1.5.1 and 7.1.5.2 for more information). Both equations were derived from the *Dermal Exposure Assessment: A Summary of EPA Approaches* (U.S. EPA, 2007).

For dermal exposure, the acute daily dose and chronic average daily doses were calculated for age groups that are expected users of the product. For all products, EPA expects adults and teenager/young adults to contact the product when using them. For the purposes of this assessment, EPA is assuming that no protection was used by the consumer when using the product.

Table 7-10. Expected Users for Each Product

Product	Life Stage
Toilet bowl deodorizers	Adult Teenager and young adult Young teen
Lubricants/greases Fuel additive Building and construction products	Adult Teenager and young adult

EPA used the life stages in CEM as a guide for life stage categorization and for mean values of "inside both hands" and "10% of hand" surface area to body weight ratios. As a conservative approach, EPA is assuming that for a toilet bowl deodorizer the user could use both hands to install the product. For

lubricants/greases and foam insulation the product could splash and come in contact with 10% of the hand. Dermal surface area to body weight ratios are used in dermal modeling (*e.g.,* Equation 7-4 and Equation 7-5).

Table 7-11. Dermal Surface Area to Body Weight Ratios

Life Stage	Age (years)	Inside Both Hands (Mean)	10% of Hand (Mean)
Adult	≥21 years	6.2	1.2
Teenager and young adult	16–20 years	5.8	

7.1.5.1 Fractional Absorption Dermal Modeling

EPA used the fractional absorption dermal model for the lubricant and greases products. The fractional absorption method was identified as the most appropriate for these products as it calculates finite splash-type exposure, where there is instantaneous deposition onto the skin without deliberate contact with the product, such as pouring of lubricants and greases. For the Mystery Marvel Oil, it was assumed to have 1 event per/day and 52 events/year. For the Marvel Air Tool, it was assumed 1 event/month and 12 events/year.

The following equation calculates the fractional absorption dermal model for finite doses and was calculated for both acute and chronic doses for each life stage that is expected to use the product:

Equation 7-4. Fractional Absorption Dermal Model for Finite Doses

$$DD = \frac{Q_u \times WF \times SA \times f_{abs} \times FQ \times ED}{BW \; X \; AT}$$

Where:

- DD = Daily dose (mg/kg-day)
- *Qu* = Dermal loading (mg/cm^2 -event)
- WF = Weight fraction
- f_{abs} = Fraction absorbed
- FQ = Frequency of contact
  - Acute: (events/day)
  - Chronic: (events/year)
- ED = Exposure duration
  - Acute (1 day)
  - Chronic (1 year)
- SA = Surface area of contact (cm^2)
- BW = Body weight (kg)
- AT = Averaging time
  - Acute: (1 day)
  - Chronic: (365 days)

To calculate *Qu* (U.S. EPA, 2023b):

Equation 7-5. Amount Retained on Skin Equation

$$Q_u = FT \times \rho \times (1 - \text{FracRemove}) \times CF_1$$

Where:

Qu = Dermal loading (mg/cm^2 -event)
FT = Film thickness (cm)
ρ = Density of formulation (g/cm^3)
$FracRemove$ = Fraction of product removed by washing or wearing (unitless)
CF_1 = Conversion factor (1,000 mg/g)

The *Qu* is the amount of product retrained on the skin. For consumer products, the *Qu* is a conservative estimate as it is assuming that the consumer does not wipe or remove any of the product after it comes in contact with the skin. Therefore, the fraction removed is 0. The amount of product that is retained on the skin is multiplied by the film thickness of the liquid on the skin's surface and the density of the formulation within which the chemical exists.

The film thickness refers to the thickness of the layer of product remaining on the skin after use. Table B-3 of the *CEM User Guide Appendices* (U.S. EPA, 2023b) gives film thickness for various products. Similar to inhalation modeling, dermal modeling uses the highest weight fraction for each product. The frequency of skin contact is dependent on the product and uses and is the same as for the liquid products for inhalation in Section 7.1.4.

Fractional absorption is the appropriate metric for estimating absorption from a thin film or splash-type exposure scenario, where there is a finite or depletable amount of chemical on the skin. EPA estimated the absorption based on test order data for neat *p*-dichlorobenzene from (Charles River Laboratories, 2025). This study reported 0.93 to 2.24% absorption for *p*-dichlorobenzene concentrations of 50% or less in organic solvents. Liquid consumer products contain less than 50% of *p*-dichlorobenzene, therefore the 2% absorption from the neat chemical is applied to these exposures. See Section 3.1 of the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2026p) for more details. Table 7-12 refers to the list of dermal inputs for the fractional absorption model.

Table 7-12. Dermal Inputs for Fractional Absorption Model

Product	Film Thickness (cm)	Dermal Loading (Qu) (mg/cm^2 – Event)	Weight Fraction	Fraction Absorbed (fabs)
Marvel Mystery Oil	8.21E−05	0.123	0.00003	0.02
Marvel Air Tool			0.001	
Touch N Foam Mouse Shield Can Foam Sealant & Blocker	5.00E−03	5.94	0.07	

7.1.5.2 Flux Permeability Dermal Modeling

EPA used the flux-based permeability dermal model for solid air freshener (toilet bowl deodorizer) and foam insulation products. The flux-based method was identified as the most appropriate for this scenario as it considers a nondepletable source of *p*-dichlorobenzene with little to no evaporation of the chemical in the area contacting the skin over the duration of the exposure. This scenario applies to products comprised of a solid *p*-dichlorobenzene block and foam insulation, where absorption is driven by the duration of dermal contact. This scenario assumes that when the user is handling the product there is enough *p*-dichlorobenzene in the product to be continuously absorbed into the skin during the contact time. The toilet bowl deodorizer is changed monthly for 1 event/month and 12 events per/year. The label

on the deodorizer states that it is good for 1 month. The user was expected to have 5 minutes contact time with the product.

For the foam insulation products. The user will have 1 hour of contact time for acute and 4.25 minutes of contact time per use for chronic. The user is expected to have 1 event per month and no more than 4 events per year.

The following equation calculates the flux-based dermal model for infinite doses:

Equation 7-6. Flux-Based Permeability Dermal Model for Infinite Doses

$$DD = \frac{K_p \times C \times SA \times t_{event} \times FQ \times ED}{BW\ X\ AT}$$

Where:

- DD = Daily dose (mg/kg-day)
- K_p = Skin permeability coefficient (cm/h)
- C = Chemical concentration (mg/cm^3)
- t_{event} = Event contact time (hours)
- FQ = Frequency of contact
  - Acute: (events/day)
  - Chronic: (events/year)
- ED = Exposure duration
  - Acute: (1 day)
  - Chronic: (1 year)
- SA = Surface area of contact (cm^2)
- BW = Body weight (kg)
- AT = Averaging time
  - Acute: (1 day)
  - Chronic: (365 days)

The chemical concentration in the product is calculated from multiplying the weight fraction by density of formulation (U.S. EPA, 2023b):

Equation 7-7. Concentration of Chemical Based on Weight Fraction

$$C = WF \times \rho \times CF_1$$

Where:

- C = Chemical concentration (mg/cm^3)
- WF = Weight fraction
- ρ = Density of formulation (g/cm^3)
- CF_1 = Conversion factor (1,000 mg/g)

The skin permeability coefficient K_p, (with units of length per time such as cm/hour), is a concentration-dependent parameter that is derived from the steady-state flux of material through the skin. For short-term *p*-dichlorobenzene dermal exposure to these products, EPA used a K_p of 3.75×10^{-4} cm/h from the measured flux rate of *p*-dichlorobenzene in solution over a 10-min period (CPA, 2005). See Section 3.1 of the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* for more details (U.S. EPA, 2026p).

Similar to inhalation modeling, dermal modeling uses the highest weight fraction for each product, which is then used to calculate the concentration of chemical in the product using. The frequency of contact is dependent on the product and use. The surface area and body weight ratio assumes that when using the product, 10% of the hand may be exposed to foam insulation. For the toilet bowl deodorizer, it was assumed that the inside of both hands may be used to insert the product. This was a conservative assumption. As there was no dermal risk identified for toilet bowl deodorizers and foam insulation, additional sensitivity analyses were not conducted.

7.2 Exposure Modeling Results

This section summarizes the air concentrations from inhalation and dose estimates from dermal exposure to *p*-dichlorobenzene. The *Draft Consumer Inhalation and Dermal Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026r) shows the inputs, models, and calculations for both inhalation and dermal exposures.

7.2.1 Acute Inhalation Concentrations and Dermal Dose Rate Results

Table 7-13 summarizes the acute 24-hour air concentrations for inhalation and Table 7-14 dermal acute dose rate (ADR) results for expected life stages exposed from dermal exposures. The acute dose rate is an absorbed dose rate. For air care product dose results see Section 7.2.3.

Table 7-13. Acute 24-Hour Inhalation Concentration of *p-D*ichlorobenzene in Products

Product Type	Acute 24-Hour Concentration (mg/m^3)
Automotive lubricant/degreaser/fuel additive	2.79E−05
Tool lubricant/degreaser/fuel additive	7.33E−07
Building and construction product	3.7E−03

Table 7-14. Product Acute Dermal Dose Rates

Product Type	Age group	Acute Dose Rate (mg/kg/d)	
		Permeability Model	Fractional Absorption Model
Automotive lubricant/degreaser/fuel additive	Adult (21+ years)	N/A	1.77E−10
	Youth (16–20 years)		
Tool lubricant/degreaser/fuel additive	Adult (21+ years)	N/A	1.77E−11
	Youth (16–20 years)		
Building and construction product	Adult (21+ years)	3.15E−03	N/A
	Youth (16–20 years)		

7.2.2 Non-Cancer Chronic Air Concentrations and Dermal Dose Rate Results

Table 7-15 summarizes the non-cancer inhalation air concentrations and Table 7-16 for dermal chronic average daily dose (CADD) results for life stages with expected exposures. For air care product dose results see Section 7.2.3.

Table 7-15. Non-Cancer Chronic Air Concentrations of *p*-Dichlorobenzene in Products

Product	Chronic ADC (mg/m^3)
Automotive lubricant/degreaser/fuel additive	4.12E−06
Tool lubricant/degreaser/fuel additive	1.52E−08
Building and construction product	4.82E−05

Table 7-16. Non-Cancer Chronic Average Daily Dose Product Dermal Dose Rates

Product Type	Age group	Chronic Dose Rate (mg/kg/d)	
		Permeability Model	Fractional Absorption Model
Automotive lubricant/degreaser /fuel additive	Adult (21+ years)	N/A	2.53E−11
	Youth (16–20 years)		
Tool lubricant/degreaser /fuel additive	Adult (21+ years)	N/A	5.83E−13
	Youth (16–20 years)		
Building and construction product	Adult (21+ years)	2.45E−06	N/A
	Youth (16–20 years)		

7.2.3 Toilet Bowl Deodorizer Results

7.2.3.1 Acute Inhalation Concentrations and Dermal Dose Rate Results

Table 7-17. Toilet Bowl Deodorizer Acute 24-Hour Concentration of *p*-*D*ichlorobenzene in Products

Product	Acute ADC (mg/m^3)
Toilet bowl deodorizer, 2 bathrooms	3.90
Toilet bowl deodorizer, 1 bathroom (Sensitivity)	2.14

Dermal absorption was calculated based on a permeability constant (K_p) of 3.75×10^{-4} derived from empirical data for peak flux rate measured at 10 minutes following administration of *p*-dichlorobenzene to *ex vivo* human skin (CPA, 2005).

Table 7-18. Toilet Bowl Deodorizer Acute Dermal Dose Rates

Product Type	Age Group	Acute Dose Rate (mg/kg/d)
Toilet Bowl Deodorizer, 2 Bathrooms	Adult (21+ years)	0.581
	Youth (16–20 years)	0.544

7.2.3.2 Non-Cancer Chronic Inhalation Concentrations and Dermal Dose Rate Results

Table 7-19. Non-Cancer Chronic Air Concentrations of *p*-Dichlorobenzene in Toilet Bowl Deodorizer

Product	Chronic ADC (mg/m^3)
Toilet Bowl Deodorizer, 2 Bathrooms	0.89
Toilet Bowl Deodorizer, 1 Bathroom (Sensitivity)	0.47

Dermal absorption was calculated based on a permeability constant (Kp) of 3.75×10^{-4} derived from empirical data for peak flux rate measured at 10-min following administration of *p*-dichlorobenzene to *ex vivo* human skin (CPA, 2005).

Table 7-20. Non-Cancer Chronic Average Daily Dose Product Dermal Dose Rates

Product Type	Age Group	Chronic Dose Rate (mg/kg/d)
Toilet bowl deodorizer	Adult (21+ years)	1.91E−02
	Youth (16–20 years)	1.79E−02

Acute inhalation ADC concentrations and dermal dose rates were higher for air care products relative to other products evaluated likely due to the higher weight fractions of *p*-dichlorobenzene. Similar to acute, the chronic air concentrations and CADD were higher for the toilet bowl deodorizers than for other products. Again, this is expected as the weight fraction in toilet bowl deodorizers is much higher than other products.

7.3 Weight of Scientific Evidence

The exposure assessment of *p*-dichlorobenzene from consumer products has challenges due to variability and uncertainty. Variability comes from the following:

1. Product formulation and composition
    a. SDS concentrations vary across products. In addition, changes in ingredients by manufacturers, concentrations, and outdated SDS may impact the inputs used in modeling
2. Product use patterns
    a. Although the EFH gives estimated values for frequency and duration of use, these numbers are not specific to a product, but rather a group of products (U.S. EPA, 2011a).

Uncertainty comes from the following:

1. Application methods and time
    a. When estimating these inputs, there is professional judgement involved in finding the most representative number to use. For example, the method and time of using a foam sealant varies between users even if they are using the same exact product.

7.3.1 Inhalation and Dermal Confidence in Parameters

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. 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 uncertainties that may need to be considered.

As described in Table 7-21**,** the inhalation estimates for the lubricants/greases COU had robust overall confidence while the air care product and building and construction product COUs had moderate overall confidence. The overall confidence is determined by a variety of factors, such as where the inputs are coming from and representativeness of the inputs. The table describes each factor in detail and where the information comes from, as well as the overall confidence for each COU.

Table 7-21. Inhalation Confidence in CEM Parameters

Consumer COU Category	Weight of Scientific Evidence	Inhalation Overall Confidence
Lubricants and greases/fuel additive	Two products were assessed for this COU (Marvel Mystery Oil and Marvel Air Tool). Maximum reported weight fractions were reported though the SDS. Product and use inputs were used from manufacturer directions, EFH or CEM default values (U.S. EPA, 2023b, 2011a). EFH and CEM default parameters generally represent actual products on the market, relevant use patterns and location of use. Therefore, the overall confidence for this COU inhalation exposure estimate is robust.	Robust
Building and construction products	One product was assessed for this COU. Maximum reported weight fraction product and use inputs were used from SDS, EFH or CEM default values. Maximum reported weight fractions were reported though the SDS. There is uncertainty about the frequency and duration of use as these values can vary between users. These values were taken from the EFH, but from the "adhesives" information. The mass of product used was also based on professional judgement as it is not specified by the product. Therefore, the overall confidence in this COU inhalation exposure estimate is moderate.	Moderate
Air care products	One product with the highest weight fraction was assessed for this COU. Maximum reported weight fractions were reported though the SDS. The duration of the room of use was taken from the EFH. The emission rate used was from a peer reviewed study, although there is uncertainty in the exact product tested. Therefore, the overall confidence in this COU inhalation exposure estimate is moderate.	Moderate

For all COUs, the overall confidence in dermal exposure estimates is moderate. The K_p and f_{abs} are measured information obtained from test orders and are considered robust. The film thickness is a CEM default and is considered moderate as the value is of uncertain origin. The other inputs (mass of product used, duration and frequency of use) generally represent actual products on the market and relevant use patterns

7.3.2 Product Formulation and Composition, Use Patterns, and Modeling Tools

Variability in the formulation of consumer products, including changes in ingredients, concentrations, and chemical forms, can introduce uncertainty in exposure assessments. EPA obtained *p*-dichlorobenzene weight fractions in various products from material safety sheets, data bases, and existing literature. For the air care product, EPA obtained multiple SDSs and values for weight fractions from different products, using the highest value in the high exposure scenario. Overall, weight fraction confidence is robust for the air care products as there are multiple SDS with high concentrations, thus

confirming the concentrations used in the products. For the other products as they only have one SDS, confidence is moderate and there is some uncertainty of changing formulations.

Consumer use patterns like frequency of use, duration of use, and methods of application are expected to differ. As detailed in Section 7.1.4.2, these inputs were either determined by professional judgement or taken from the EFH. Exposure and risk estimates are considered representative of consumer use patterns and well characterized. Overall confidence in all product use patterns is rated robust confidence in mass of product per use and other values that were based on professional judgement in the absence of relevant or supporting data was rated low. For more information on the individual parameters used in the exposure scenario, see Section 7.1.4 and Section 7.1.5.

CEM 3.2 and IECCU have been peer reviewed, are publicly available, and have been applied in a manner intended by estimating exposures associated with uses of household products. The models also explicitly state the sources of the default values for inputs such as building and room volumes, interzonal ventilation rates, and air exchange rates. Overall confidence in the proper use of CEM and IECCU for consumer exposure modeling is robust.

7.4 Measured Concentrations in Indoor Air and Personal Sampling

As discussed in Sections 5.2.2 and 5.2.3, indoor air and personal sample concentrations were extracted from systematic review. The highest concentration reported was 2,125.94 µg/m^3 in indoor air and 2,235.6 µg/m^3 for personal sampling, which falls in the same magnitude of 2,570 µg/m^3 for acute 24-hour TWA concentration modeled in this assessment (Chin et al., 2014; Jia et al., 2008). The sources were attributed to deodorants, mothballs, repellants, and pesticides along with solvent-related emissions from degreasers and paints. Although the monitored sources vary in products, they suggest high confidence in the toilet bowl deodorizer modeling and that *p*-dichlorobenzene is found in residential settings as well as confirms human exposure to the chemical.

As described in the studies, the high maximum concentrations could be explained by the use of a combination of toilet bowl deodorizers, moth balls, or other sources, although there is no information of the source of exposure from the studies. EPA acknowledges that moth balls are not under the purview of TSCA and therefore not modeled in this risk assessment.

7.5 Conclusion and Steps Toward Risk Characterization

All COU exposure and dose results have moderate to robust confidence for use in risk estimate calculations, including for specific life stages of dermal exposure. This is based on the information available to make the calculations, confidence in this information and models available. The approaches used rely on conservative assumptions and high-end or central tendency values from distributions in which EPA has robust or moderate confidence. This ensures results are health-protective and give EPA a moderate-to-high confidence in the overall consumer exposure results depending on the specific products evaluated.

8 OCCUPATIONAL EXPOSURE ASSESSMENT

EPA assessed occupational exposures for each OES described in Table 4-1. EPA's assessment of occupational exposures includes quantifying inhalation and dermal exposures to *p*-dichlorobenzene. Generally, when not provided specific data on workers at a facility, the Agency categorizes occupational exposures into two groups: exposures to workers and exposures to occupational non-users (ONUs) (EPA considers workers as those who directly handle *p*-dichlorobenzene and ONUs as those who do not directly handle *p*-dichlorobenzene but may be exposed to vapors, particulates, or mists that enter their breathing zone while working in locations in close proximity to *p*-dichlorobenzene). For many of these exposure estimates, EPA relied on exposure data provided in response to a test order sent to various industrial entities that manufacture, process, and/or use *p*-dichlorobenzene. Some of these study reports included their own groupings of workers based on worker activities that may lead to exposure to *p*-dichlorobenzene. When these data were used, EPA prioritized using exposure groupings identified in the test order study reports. This is further discussed in Section 8.1. In this assessment, EPA evaluated inhalation exposures and dermal exposures to workers, ONUs, and industry-specific worker groups.

Note that the Agency's estimates of occupational exposure presented in this assessment do not assume the use of PPE; however, the effect of respiratory protection fit factors on EPA's occupational exposure estimates can be explored in the *Risk Calculator for Occupational Exposures for* p-*Dichlorobenzene* (U.S. EPA, 2026v, 2024d).

See the *Draft Consumer Indoor Air Inhalation and Dermal Acute and Chronic Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026f) for a summary of the inhalation data used in this assessment and the calculations that resulted in the estimates presented in this section as well as the calculations that lead to the dermal exposures presented in this section.

8.1 Approach and Methodology

An occupational exposure assessment was conducted for each OES specified in Table 4-1. For each OES, the following components are presented:

- ***Worker Activities:*** A description of the worker activities, including an assessment of potential points of worker and ONU exposure.
- ***Number of Workers and ONUs:*** An estimate of the number of workers and ONUs potentially exposed to the chemical for the given OES.
- ***Occupational Inhalation Exposure Results:*** Central tendency and high-end estimates of inhalation exposure to workers and ONUs. See Section 4.2.3.3 for a discussion of EPA's statistical analysis approach for assessing inhalation exposure.
- ***Occupational Dermal Exposure Results:*** Central tendency and high-end estimates of dermal exposure to workers. See Section 8.1.4 for a discussion of EPA's approach for assessing dermal exposure.
- ***Exposure Controls and PPE:*** A description of any known exposure controls and PPE that may be present during this use.

For the remainder of this section, the approach and methodology for completing each of the above components is described in additional detail.

EPA used a variety of sources to estimate workplace exposures for each OES, resulting in different OESs having different levels of granularity in their exposure estimates. In some cases, EPA received inhalation exposure data from companies that manufacture, process, and use *p*-dichlorobenzene in response to a test order. In these test order study reports, the companies grouped employees into similar

exposure groups (SEGs) based on their expected work activities and potentials for exposure to *p*-dichlorobenzene. In this assessment, EPA generally grouped exposure data provided by these reports into the designated SEGs that the company specified in their data, and so in many cases an OES may have multiple exposure estimates within it, each corresponding to these designated SEGs.

For other OESs, particularly those that assessed exposures using data that did not come from industry sources and thus had limited associate metadata, the more general SEGs of "workers" and "ONUs" were used. Workers are defined as employees who may directly handle *p*-dichlorobenzene, while ONUs are employees at the facility who do not directly handle *p*-dichlorobenzene but perform job activities in an area where the chemical is present. Typically, EPA assesses only inhalation exposures to ONUs and assesses dermal exposures as negligible. However, for chemicals in solid form or in spray or mist applications, EPA may also assess dermal exposures from dusts/droplets that settle onto workplace surfaces.

Figure 8-1 presents the conceptual model for exposure pathways, exposure routes, and hazards to human populations from industrial and commercial activities and uses of *p*-dichlorobenzene. There is potential for exposure to workers and/or ONUs via inhalation of vapor due to the activities and uses of *p*-dichlorobenzene. Exposure may occur due to fugitive emissions present during activities such as the manufacture and processing of *p*-dichlorobenzene. Fugitive air emissions are emissions that are not routed through a stack and include fugitive equipment leaks from valves, pump seals, flanges, compressors, sampling connections and open-ended lines; evaporative losses from surface impoundment and spills; and releases from building ventilation systems. Exposure may also occur due to uses of *p*-dichlorobenzene such as use as a laboratory chemical or the application of a sealant containing *p*-dichlorobenzene. Exposure may also occur through the dermal route for workers who handle *p*-dichlorobenzene. Dermal exposure is not expected for ONUs when the chemical is in liquid form as they are not expected to directly handle *p*-dichlorobenzene; however, ONU exposure to solids that may settle on surfaces is considered in this draft assessment/TSD.

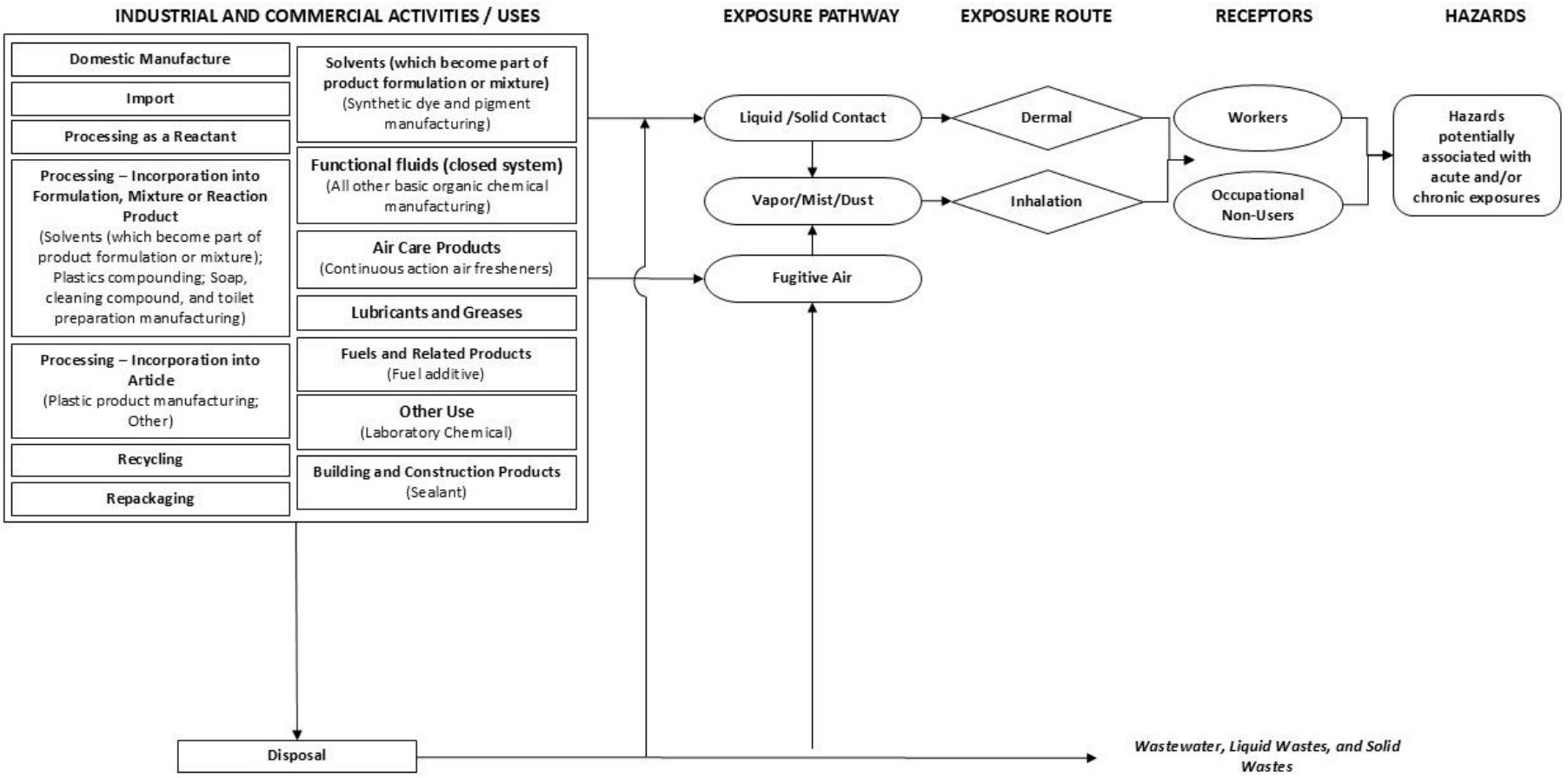

Figure 8-1. *p*-Dichlorobenzene Conceptual Model for Industrial and Commercial Activities and Uses: Potential Exposure and Hazards

Inhalation exposure to workers and ONUs may occur via fugitive emissions (equipment leaks, spills, ventilation) and uses such as laboratory work and adhesives/sealants; dermal exposure may occur for workers but is not expected for ONUs in cases aside from exposure to solids that may settle on surfaces.

EPA provided occupational inhalation and dermal exposure results representative of central tendency and high-end conditions. The central tendency is assumed to be representative of occupational exposures that are expected to be typical for a given COU. For the draft risk evaluation, EPA used the 50th percentile (median), mean (arithmetic or geometric), mode, or midpoint values of a distribution as representative of the central tendency scenario. The Agency's preference is to provide the 50th percentile of the distribution. However, if the full distribution is not known, EPA may assume that the mean, mode, or midpoint of the distribution represents the central tendency depending on the statistics available for the distribution.

The high-end is assumed to be representative of occupational exposures that occur at probabilities above the 90th percentile but below the exposure of the individual with the highest exposure (U.S. EPA, 1992a). For risk evaluation, EPA provided high-end results at the 95th percentile. If the 95th percentile is not available, the Agency used a different percentile greater than or equal to the 90th percentile but less than or equal to the 99.9th percentile, depending on the statistics available for the distribution. If the full distribution is not known and the preferred statistics are not available, EPA estimated a maximum or bounding estimate in lieu of the high-end.

For each OES, EPA attempted to provide central tendency and high-end full-shift time-weighted averages (TWAs) (typically as 8-hour TWAs) inhalation exposure concentrations and central tendency and high-end acute potential dermal dose rates (APDR). EPA uses the following hierarchy in selecting data and approaches for assessing occupational exposures:

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 or analogous monitoring data
    b. Fundamental modeling approaches
    c. Statistical regression modeling approaches
3. Occupational exposure limits (OELs; these limits would likely be used jointly in an assessment):
    a. Company-specific OELs (for site-specific exposure assessments, for example, there is only one manufacturer that provides EPA with their internal OEL but does not provide monitoring data)
    b. Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs)
    c. Voluntary limits (American Conference of Governmental Industrial Hygienists [ACGIH] Threshold Limit Values [TLV], National Institute for Occupational Safety and Health [NIOSH] Recommended Exposure Limits [REL], Occupational Alliance for Risk Science (OARS) workplace environmental exposure level (WEEL) [formerly by AIHA])

Once EPA has estimated the central tendency and high-end full-shift TWA inhalation exposure concentrations and the APDR for dermal exposure, the exposure metrics required for risk evaluation are then calculated. Exposure metrics for inhalation exposures include acute concentrations (AC), intermediate average daily concentrations (IADC), and average daily concentrations (ADC). Exposure metrics for dermal exposures include APDR, acute absorbed dose (AAD) and chronic absorbed dose (CAD) non-cancer. Relevant equations and sample calculations can be found in Appendix K. With exposure estimates identified for all OESs using monitoring data and modeling, OELs were not used in this assessment.

These exposure metrics are important because they allow for the assessment of different timeframes of exposure. Acute exposures occur over the course of a single working day. An 8-hour exposure duration is assumed each day to represent a typical worker's shift, unless otherwise specified (12-hour shifts, for example, are used in some cases when industry information indicates the presence of these shift lengths). Intermediate exposure occurs over one month, or 22 working days to account for a worker's usual schedule where they do not work on weekends. Chronic exposure (non-cancer and cancer) occurs over the worker's working years and is assumed to be 31 years at central tendency, and 40 years at high-end. It is assumed a worker will work no more than 250 days per year.

See *Draft Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026v), "Inhalation Exposure" tab, for a summary of the inhalation data used in this assessment. Click on the "Dermal Exposure" tab for details on how dermal exposure was estimated for this draft risk evaluation. More details about these estimates can be found in the *p-Dichlorobenzene Inhalation Monitoring Data Summary* (U.S. EPA, 2026s) for a summary of the inhalation data used in this assessment and the calculations that resulted in the estimates presented in this section. See the *p*-dichlorobenzene dermal assessment supplemental file (U.S. EPA, 2026c) for the calculations that lead to the dermal exposures presented in this section.

8.1.1 Identifying Worker Activities

EPA performed a literature search to identify worker activities that could potentially result in occupational exposures. Where worker activities were unclear or not available, the Agency referenced relevant ESDs or GSs. Worker activities for each OES are provided in Section 8.2.

For number of working days, unless informed otherwise by industry, EPA assumes these to be the same as facility operating days, discussed in Section 4.2.2, with a maximum number of routine working days per year being 250 days for workers on an 8-hour shift (5 days per week for 50 weeks, and 2 weeks of leave). For workers on a 10-hour shift, a maximum of 200 working days per year is assumed. For workers on a 12-hour shift, a maximum of 167 working days per year is assumed unless company information indicates otherwise.

8.1.2 Estimating Number of Workers and Occupational Non-Users

Where available, EPA used CDR data to provide a basis to estimate the number of workers and ONUs. The Agency supplemented the available CDR data with U.S. economic data using the following method:

1. Identify the North American Industry Classification System (NAICS) codes for the industry sectors associated with these uses.
    a. Refine the identification of applicable NAICS codes by reviewing CDR data for the chemical.
    b. Refine the identification of applicable NAICS codes by referencing EPA/OPPT GSs and Organisation for Economic Co-operation and Development (OECD) ESDs.
2. Estimate total employment by industry/occupation combination using the Bureau of Labor Statistics' Occupational Employment Statistics data (BLS Data).
3. Refine 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. Use market penetration data to estimate the percentage of employees likely to be using *p*-dichlorobenzene instead of other chemicals.
5. Where market penetration data are not available, use the estimated workers/ONUs per site in the 6-digit NAICS code and multiply by the number of sites estimated from CDR, TRI, DMR and/or

NEI. In DMR data, sites report Standard Industrial Classification (SIC) codes rather than NAICS codes; therefore, EPA mapped each reported SIC code to a NAICS code for use in this analysis.

6. Combine the data generated in Steps 1 through 5 to produce an estimate of the number of employees using *p*-dichlorobenzene in each industry/occupation combination and sum these to arrive at a total estimate of the number of employees with exposure within the COU.

There are uncertainties surrounding the estimated number of workers potentially exposed to *p*-dichlorobenzene. 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 *p*-dichlorobenzene for the assessed applications. EPA addressed this issue by refining the Occupational Employment Statistics data using total employment data from the U.S. Census' SUSB. However, this approach assumes that the distribution of occupation types (Standard Occupational Classification, or SOC, codes) in each 6-digit NAICS is equal to the distribution of occupation types at the parent 5-digit NAICS level. If the distribution of workers in occupations with *p*-dichlorobenzene exposure differs from the overall distribution of workers in each NAICS, then this approach will result in inaccuracy. 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 SOC codes) that are associated with the OESs assessed in this report are based on EPA's understanding of how *p*-dichlorobenzene 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 it would be unlikely to systematically either overestimate or underestimate the count of exposed workers.

8.1.3 Estimating Inhalation Exposures

8.1.3.1 Inhalation Monitoring Data

To assess inhalation exposure, EPA reviewed workplace inhalation monitoring data collected by government agencies such as OSHA and NIOSH, monitoring data found in published literature (*i.e.,* personal exposure monitoring data and area monitoring data), and monitoring data submitted via test orders and public comments. Studies were evaluated using the evaluation strategies laid out in the *Application of Systematic Review in TSCA Risk Evaluations* (U.S. EPA, 2018a). Data and studies considered in this assessment can be found in *Draft Systematic Review Protocol for p-Dichlorobenzene (p-DCB)* (U.S. EPA, 2026x), and in the "Inhalation Exposure" tab of the *Draft Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026ab).

EPA calculated exposures from the monitoring datasets provided in the sources discussed above, using different methodologies depending on the size of the dataset. For datasets with six or more data points, EPA estimated central tendency and high-end exposures using the 50th percentile and 95th percentile. For datasets with three to five data points, EPA estimated central tendency exposure using the 50th percentile and the maximum as the high-end exposure estimate. For datasets with two data points, EPA estimated the central tendency using the midpoint value and the higher of the two values as the high-end. Finally, for datasets with only one data point, EPA 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, 1994a), 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.

When a dataset contains many non-detect samples (greater than 40%), the substitution method described above may not be appropriate. In these cases, the use of Maximum Likelihood Estimation (MLE) was also considered as an option for accounting for exposure data below the limit of detection. MLE may be appropriate when a dataset has a sample size of 20 or more, with 5 of more detected samples. These criteria was not met in any case for *p*-dichlorobenzene, so the substitution method was used in all cases.

EPA combined the exposure data from all studies applicable to a given OES into a single dataset unless otherwise identified in the description of the assessments in Section 8.2.

EPA received inhalation exposure data from companies that manufacture, process, and use *p*-dichlorobenzene in response to a test order. These data were used to assess multiple OESs. In these test order study reports, the companies grouped employees into SEGs based on their expected work activities and potentials for exposure to *p*-dichlorobenzene. In this assessment, EPA generally grouped exposure data provided by these reports into the designated SEGs that the company specified in their data, and so in many cases an OES may have multiple exposure estimates within it, each corresponding to these designated SEGs.

For some OESs, particularly those that assessed exposures using data that did not come from industry sources and thus had limited associate metadata, the more general SEGs of "workers" and "ONUs" were used. Here, workers are defined as employees who may directly handle *p*-dichlorobenzene, while ONUs are employees at the facility who do not directly handle *p*-dichlorobenzene but perform job activities in an area where the chemical is present.

OSHA Chemical Exposure Health Data

OSHA CEHD (Chemical Exposure Health Data) is collected through industrial hygiene samples taken by OSHA compliance officers during monitoring of worker exposures to chemical hazards. OSHA CEHD data are obtained typically from facilities when there is suspicion about high workplace exposure levels or potential violations. OSHA CEHD represents a reasonably available source of information to obtain monitoring data and has received a rating of high from EPA's systematic review process. Air sampling data records from inspections are entered into the OSHA CEHD that can be accessed online. The database includes PBZ monitoring data, area monitoring data, bulk samples, wipe samples, and serum samples. The collected samples are used for comparing to OSHA's PELs. OSHA's CEHD website indicates that they do not: perform routine inspections at every business that uses toxic/hazardous chemicals, completely characterize all exposures for all employees every day, or always obtain a sample for an entire shift. Rather, OSHA performs targeted inspections of certain industries based on National and regional emphasis programs, often attempts to evaluate worst case chemical exposure scenarios, and develop "snapshots" of chemical exposures and assess their significance (*e.g.,* comparing measured concentrations to PELs).

Analogous Inhalation Monitoring Data

Where inhalation exposures are expected for an OES but directly applicable monitoring data were not available or sufficiently representative of the use, EPA utilized analogous monitoring data, which are monitoring data of the same chemical but for a different (similar) activity.

Specific details related to the use of monitoring data for each COU can be found in Section 8.2.

8.1.3.2 Inhalation Exposure Modeling

Where inhalation exposures are expected for an OES but monitoring data were not available or where EPA determined monitoring data did not sufficiently capture the exposures for an OES, and there are no analogous options, EPA utilized models to estimate inhalation exposures of *p*-dichlorobenzene.

For exposure models, outputs from models may be the result of deterministic calculations, stochastic calculations, or a combination of both deterministic and stochastic calculations. For each OES with modeled inhalation exposures, EPA followed these steps to estimate exposures:

1. Identified worker activities/sources of exposures from process.
2. Identified or developed relevant models for estimating exposures from each source.
3. Identified model input parameter values from relevant literature sources, including activity durations associated with sources of exposures.
4. If a range of input values was available for an input parameter, determined the associated distribution of input values.
5. Calculated exposure concentrations associated with each activity.
6. Calculated full-shift TWAs based on the exposure concentration and activity duration associated with each exposure source.
7. Calculated exposure metrics (AC, IADC, ADC) from full-shift TWAs.

Only one OES utilized models, Use of Laboratory Chemicals for when *p*-dichlorobenzene is in a solid state. Detailed descriptions of the model approach used for this OES, model equations, input parameter values and associated distributions are provided in Section 8.2.13 and Appendix K.

8.1.3.3 Acute, Intermediate, and Chronic (Non-Cancer) Inhalation Exposure

For each OES, EPA used the estimated TWA exposures to calculate acute exposure concentrations (AC), intermediate average daily concentrations (IADC), average daily concentrations (ADC) for chronic, and non-cancer risks. These calculations require additional parameter inputs, such as years of exposure, exposure duration, and exposure frequency. Lifetime average daily concentrations, used to estimate cancer risk, were not calculated in this assessment because *p*-dichlorobenzene is not likely to be carcinogenic to humans. See the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* for more information (U.S. EPA, 2026p).

For the final exposure result metrics, each of the input parameters (*e.g.,* air concentrations, working years, exposure frequency) 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. EPA 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, EPA used Monte Carlo modeling to estimate exposure concentrations but only had point estimates of exposure

duration and frequency. In this case, EPA documented the approach and rationale for combining point estimates with distribution results for estimating central tendency and high-end results.

Equations, parameter inputs, and sample calculations for these exposures can be found in Appendix K and Appendix L, respectively.

8.1.4 Dermal Exposure Approach and Methodology

Dermal exposure data were not reasonably available for the COUs in the assessment. For the OESs where *p*-dichlorobenzene is assessed as a liquid, EPA estimated dermal exposures via a fractional absorption approach. The key parameters involved in this approach are the dermal loading value (mg product/cm^2), *p*-dichlorobenzene concentration (mg *p*-dichlorobenzene/mg product), fractional absorption of *p*-dichlorobenzene into the skin (percent absorbed), and surface area of dermal contact (cm^2).

The dermal loading value is the quantity of the 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 liquids, 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). For powders and solid articles, EPA used data from literature (Marquart et al., 2006; Lansink et al., 1996).

EPA assessed concentrations of *p*-dichlorobenzene in the chemical products being handled using available Test Order data, CDR data, generic scenarios, emission scenario documents, product safety data sheets, and the *p*-Dichlorobenzene Use Report (U.S. EPA, 2020e). Fractional absorption data was obtained empirically via a Test Order. Per the data, 4% of the applied dose is absorbed through the skin, for products with *p*-dichlorobenzene concentrations greater than 50% weight fraction. Otherwise, the 2% of the applied dose is absorbed (Charles River Laboratories, 2025).

EPA used an exposed skin surface area for workers based on a range between 0 to 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, 2011a). For ONUs experiencing incidental contact to mist or dust deposited on surfaces, EPA assumed a representative exposure surface area equivalent to the mean value for one palm.

EPA varied all of the above parameters via a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method in response to recommendations from SACC on prior chemical risk evaluations such as the *Draft Risk Evaluation for 1,1-Dichloroethane* (U.S. EPA, 2025b, 2024e). EPA did not assess dermal exposures to ONUs for *p*-dichlorobenzene as a liquid as EPA does not expect ONUs to directly handle liquid *p*-dichlorobenzene as part of their duties, and thus ONUs are not expected to have dermal exposures to liquid *p*-dichlorobenzene during the course of their work. Specific details of the dermal exposure assessment for each OES can be found in this section and equations for estimating dermal exposures can be found in Appendix M.

8.1.4.1 Acute, Intermediate, and Chronic (Non-Cancer) Dermal Exposure

For each COU, the estimated exposures were used to calculate acute, intermediate, and chronic (non-cancer) dermal doses. These calculations require additional parameter inputs, such as years of exposure, exposure duration, and exposure frequency. For the final exposure result metrics, each of the input parameters (*e.g.,* dermal doses, working years, exposure frequency) 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, EPA used Monte Carlo modeling to estimate exposure concentrations but only had point estimates of exposure duration and frequency. In this case, EPA documented the approach and rationale for combining point estimates with distribution results for estimating central tendency and high-end results.

Chronic (cancer) dermal dose, used to estimate cancer risk, was not calculated in this assessment because *p*-dichlorobenzene is not likely to be carcinogenic to humans. See the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* for more information (U.S. EPA, 2026p).

Equations and sample calculations for these exposures can be found in Appendix M.

8.1.5 Consideration of Engineering Controls and Personal Protective Equipment

For each OES EPA discusses personal protective equipment (PPE) typically worn by workers and ONUs, if available. EPA's occupational exposure estimates do not assume the use of PPE. However, the effect of respiratory protection on EPA's occupational exposure estimates can be explored in the "Risk Reduction" tab of the *Draft Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026v).

OSHA and NIOSH recommend employers utilize the hierarchy of controls to address hazardous exposures in the workplace. The hierarchy of controls strategy outlines, in descending order of priority, the use of elimination, substitution, engineering controls, administrative controls, and lastly PPE. The hierarchy of controls prioritizes the most effective measures first, which is to 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 (*e.g.,* source enclosure, local exhaust ventilation systems), followed by administrative controls (*e.g.,* do not open machine doors when running), or changes in work practices (*e.g.,* maintenance plan to check equipment to ensure no leaks) to reduce exposure potential. Administrative controls are policies and procedures instituted and overseen by the employer to limit worker exposures. Under CFR 1910.1000, OSHA requires the use of engineering or administrative controls to bring exposures to the levels permitted under the air contaminants standard. The respirators do not replace engineering controls, and they are implemented in addition to feasible engineering controls (29 CFR 1910.134(a)(1)). The PPE (*e.g.,* respirators, gloves) could be used 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, including protection factors for various respirators. EPA's estimates of occupational exposure presented in this document do not assume the use of engineering controls or PPE; however, the effect of respiratory assigned protection factors on the

Agency's occupational exposure estimates can be explored in the "Risk Reduction" tab of the *Draft Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026v).

8.1.5.1 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, provide respirators that are applicable and suitable for the purpose intended. Engineering and administrative controls must be implemented whenever employees are exposed above the PEL. If engineering and administrative controls do not reduce exposures to below the PEL, respirators must be worn. Respirator selection provisions are provided in CFR 1910.134(d) and require that appropriate respirators are selected based on the respiratory hazard(s) to which the worker will be exposed and workplace and user factors that affect respirator performance and reliability. Assigned protection factors (APFs) are provided in Table 1 under CFR 1910.134(d)(3)(i)(A) (Table 8-1)and refer to the level of respiratory protection that a respirator or class of respirators could provide to employees when the employer implements a continuing, effective respiratory protection program. Respirators must meet or exceed the required level of protection listed in Table 8-1. Based on the APF, inhalation exposures may be reduced by a factor of 5 to 10,000 if respirators are properly worn and fitted.

For atmospheres that are immediately dangerous to life and health, workers must use a full facepiece pressure demand self-contained breathing apparatus (SCBA) certified by NIOSH for a minimum service life of 30 minutes or a combination full facepiece pressure demand supplied-air respirator (SAR) with auxiliary self-contained air supply. Respirators that are provided only for escape from an atmosphere that is immediately dangerous to life and health must be NIOSH-certified for escape from the atmosphere in which they will be used.

Table 8-1. 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)					

8.1.6 Evidence Integration for Occupational Exposure

Evidence integration for occupational exposure assessment includes analysis, synthesis and integration of information and data to produce estimates of occupational inhalation and dermal 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. Sources are rated with one of four possibilities: high, medium, low, and uninformative. Key factors EPA considered when integrating evidence include 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 data set 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. For example, if available, the Agency gave preference to high quality modeled data over low-quality measured data to estimate exposures. 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.

8.2 Occupational Exposure Assessment By OES

The following sections contain process descriptions and the specific details (worker activities, analysis for determining number of workers, exposure assessment approach and results) for the assessment for each OES.

Refer to Table 4-1 to see how each OES described below pairs with the COU stated in the *Final Scope of the Risk Evaluation for p-Dichlorobenzene; CASRN 107-46-7* (U.S. EPA, 2020c)

For all OESs that have inhalation monitoring data, the annual and daily central tendency and high-end exposures for these occupational exposures can be found in the "Inhalation Data" tab of the *Draft Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026v).

For those OESs that use exposure modeling, and all dermal modeling see the following supplemental documents, as applicable:

- *Draft Combined Dermal Modeling Results for p-Dichlorobenzene* (U.S. EPA, 2026d)
- *Draft Dermal Modeling Results (liquid) for p-Dichlorobenzene* (U.S. EPA, 2026k)
- *Draft Dermal Modeling Results (solid worker) for p-Dichlorobenzene* (U.S. EPA, 2026o)
- *Draft Dermal Modeling Results (solid ONU) for p-Dichlorobenzene* (U.S. EPA, 2026n)
- *Draft Dermal Modeling Results (solid article worker) for p-Dichlorobenzene* (U.S. EPA, 2026m)
- *Draft Dermal Modeling Results (solid article ONU) for p-Dichlorobenzene* (U.S. EPA, 2026l)
- *Draft Number of Workers for p-Dichlorobenzene* (U.S. EPA, 2026u)
- *Draft Commercial Use Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026e)
- *Draft IECCU Commercial Modeling for p-Dichlorobenzene (air care)* (U.S. EPA, 2026q)
- *Draft CEM Commercial Modeling for p-Dichlorobenzene (sealant)* (U.S. EPA, 2026b)

8.2.1 Manufacturing

As listed in Table 4-1, this OES includes the following COU: Domestic manufacture. As previously described in Section 4.2.1, EPA identified cases where *p*-dichlorobenzene is manufactured as a byproduct during the production of VCM (Exponent, 2024).

8.2.1.1 Worker Activities

Using test order data from Westlake Corporation, EPA identified activities which exposed workers to *p*-dichlorobenzene, manufactured as a byproduct, during the production of vinyl chloride monomer (VCM) (Exponent, 2024). Based on its physical and chemical properties, *p*-dichlorobenzene is typically a solid at standard temperature and pressure; however, in the described manufacturing process, the chemical is heated and present in liquid form (U.S. EPA, 2019f). See Table 4-1 and Section 4.3.1.1 for a full manufacturing process description.

Based on the Westlake test order, which described worker activities from a single facility, SEGs involved in the manufacture of *p*-dichlorobenzene as a byproduct include the following occupational worker groups: Operators (VCM unit, Pre-Tri unit, and Waste Treatment), Shipping Tankerman, and Laboratory Technicians. SEGs for ONUs included the following groups: Maintenance (VCM unit and Per-Tri unit), Supervisors (VCM unit and Waste Treatment), and VCM Unit Engineer. Activities associated with each SEG that may result in exposures are provided below:

- VCM Unit (Operator) – Inhalation of vapors and dermal exposure to liquids during worker activities such as product sampling, equipment cleaning, container cleaning, reactor operation, or loading *p*-dichlorobenzene into reactors.
- Per-Tri Unit (Operator) – Inhalation of vapors and dermal exposure to liquids during worker activities such as product sampling, equipment cleaning, container cleaning, reactor operation, or loading *p*-dichlorobenzene into reactors.
- Waste Treatment (Operator) – Inhalation of vapors and dermal exposure to liquids during worker activities such as product sampling, equipment cleaning, container cleaning, or disposing of waste containing *p*-dichlorobenzene.
- Shipping Tankerman – Inhalation of vapors and dermal exposure to liquids during worker activities such as equipment cleaning, container cleaning, or packaging and loading of *p*-dichlorobenzene into transport containers for shipment.
- Laboratory Technicians – Inhalation of vapors and dermal exposure to liquids during worker activities such as product sampling, analyzing samples, equipment cleaning, or container cleaning.
- VCM Unit (Maintenance) – Inhalation of vapors while in an area where the chemical is present for their Per-Tri production process.
- VCM Unit (Supervisor) – Inhalation of vapors while in an area where the chemical is present.
- VCM Unit (Engineer) – Inhalation of vapors while in an area where the chemical is present.
- Per-Tri Unit (Maintenance) – Inhalation of vapors while in an area where the chemical is present.
- Waste Treatment (Supervisor) – Inhalation of vapors while in an area where the chemical is present (Exponent, 2024).

8.2.1.2 Number of Workers and Occupational Non-Users

EPA identified seven sites that reported releases due to the manufacture of *p*-dichlorobenzene as a byproduct; however, due to the uncertainty associated with reporting limits in the release databases, the Agency believes that the number of sites reporting *p*-dichlorobenzene releases from the databases may be an underestimate, and therefore EPA also used data from CDR to estimate the number of facilities, and also the number of workers and ONUs per site potentially exposed to *p*-dichlorobenzene during

manufacturing (U.S. EPA, 2020c). *p*-Dichlorobenzene is only manufactured in the United States as a byproduct of VCM production. Therefore, EPA assessed 14 *p*-dichlorobenzene manufacturing sites, which is equal to the number of VCM manufacturers that reported to CDR in 2020 (U.S. EPA, 2020c). To calculate the number of workers and ONUs, EPA used a per-site average based on all VCM manufacturers that reported to CDR in 2020. Of the 14 sites, 10 sites publicly reported the number of workers (four sites claimed this information as CBI). Per CDR, a range of 1,960 to 5,101 workers is estimated over the 10 non-CBI sites, for a total of 196 to 510 workers per site. As there are typically more workers at sites than ONUs, EPA assessed the upper bound of 510 workers per site and the lower bound of 196 ONUs per site.

EPA could not identify worker count data for each SEG in the test order; therefore, EPA estimated a number of workers which includes the following SEGs: Operators (VCM unit, Pre-Tri unit, and Waste Treatment), Shipping Tankerman, and Laboratory Technicians. SEGs for ONUs included the following groups: Maintenance (VCM unit and Per-Tri unit), Supervisors (VCM unit and Waste Treatment), and VCM Unit Engineer. Table 8-2 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.2.2.

Table 8-2. Estimated Average Number of Workers per Site Potentially Exposed to *p*-Dichlorobenzene During Manufacturing

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site	Potentially Exposed ONUs per Site
14	N/A – CDR used to estimate number of workers and ONUs.	510	196

8.2.1.3 Occupational Inhalation Exposure Results

EPA was provided with inhalation monitoring data from one facility under the control of Westlake Corporation, which manufactures *p*-dichlorobenzene as a byproduct of their VCM Per-Tri production process. The Westlake data includes 70 occupational full-shift personal air samples taken in total between April 2024 and July 2024 and 12 occupational task-based personal air samples. Task-based samples were below the limits of detection. LOD ranged between 0.043 to 1.10 ppm with durations between 10 and 308 minutes. Of the full-shift samples taken, 25 samples were classified as 8-hour TWAs (sample durations between 421–518 minutes) while the remaining 45 samples were classified as 12-hour TWAs (sample durations between 386–699 minutes). The collected samples were further classified into the SEGs discussed in Section 8.2.1.1 (Exponent, 2024).

For full-shift samples, all 70-inhalation data sampled were reported as non-detects (NDs), with limits of detection ranging from 0.022 to 0.04 ppm for the 45 samples at 12-hour TWA and 0.030 to 0.036 ppm for the 25 samples at 8-hour TWA. Because of this, EPA assessed the maximum LOD and half the maximum LOD as the high-end and central tendency TWA exposure concentrations for each SEG respectively. Because there are no measured air concentrations of *p*-dichlorobenzene, the actual exposure to workers is unknown. Therefore, EPA assumed exposure levels less than the LOD. Using the LOD as the high-end allows EPA to assess the "worst case" for this OES, and using half the LOD as the central tendency allows EPA to assess what may be a more realistic estimate of exposures. EPA then calculated the AC, IADC, and ADC for both 8- and 12-hour TWAs. See Section 8.1.3 for a description of the calculations. The inhalation exposure results are present in Table 8-3 and

Table 8-4 below.

Note that the 8-hour estimate indicates a higher exposure than the 12-hour estimate. This is due to the longer sample time of the 12-hour samples, which results in a lower LOD for the 12-hour dataset, and thus lower exposure estimate when the substitution method is applied.

Table 8-3. Summary of Worker Inhalation 8-Hour TWA Exposure to *p*-Dichlorobenzene During Manufacturing

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Worker – Laboratory Technician	8-Hour TWA exposure concentrations	1.7E−02	3.3E−02
	Acute exposure concentrations (AC) based on 8-hour TWA	1.1E−02	2.2E−02
	Intermediate average daily concentration (IADC) based on 8-hour TWA	8.2E−03	1.6E−02
	Average daily concentration (ADC) based on 8-hour TWA	7.7E−03	1.5E−02
ONU – VCM Unit (Maintenance)	8-Hour TWA exposure concentrations	1.7E−02	3.3E−02
	Acute exposure concentrations (AC) based on 8-hour TWA	1.1E−02	2.2E−02
	Intermediate average daily concentration (IADC) based on 8-hour TWA	8.2E−03	1.6E−02
	Average daily concentration (ADC) based on 8-hour TWA	7.7E−03	1.5E−02
ONU – VCM Unit (Engineer)	8-Hour TWA exposure concentrations	1.8E−02	3.6E−02
	Acute exposure concentrations (AC) based on 8-hour TWA	1.2E−02	2.4E−02
	Intermediate average daily concentration (IADC) based on 8-hour TWA	9.0E−03	1.8E−02
	Average daily concentration (ADC) based on 8-hour TWA	8.4E−03	1.7E−02
ONU – Per-Tri Unit (Maintenance)	8-Hour TWA exposure concentrations	1.6E−02	3.2E−02
	Acute exposure concentrations (AC) based on 8-hour TWA	1.1E−02	2.2E−02
	Intermediate average daily concentration (IADC) based on 8-hour TWA	8.0E−03	1.6E−02
	Average daily concentration (ADC) based on 8-hour TWA	7.5E−03	1.5E−02
ONU – Waste Treatment (Supervisor)	8-Hour TWA exposure concentrations	1.7E−02	3.3E−02
	Acute exposure concentrations (AC) based on 8-hour TWA	1.1E−02	2.2E−02
	Intermediate average daily concentration (IADC) based on 8-hour TWA	8.2E−03	1.6E−02
	Average daily concentration (ADC) based on 8-hour TWA	7.7E−03	1.5E−02

Table 8-4. Summary of Worker Inhalation 12-Hour TWA Exposure Metrics to *p*-Dichlorobenzene During Manufacturing

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Worker – VCM Unit (Operator)	12-hour TWA exposure concentrations	1.3E−02	2.5E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.3E−02	2.6E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	6.2E−03	1.2E−02
	Average daily concentration (ADC) based on 12-hour TWA	5.8E−03	1.2E−02
Worker – Per-Tri Unit (Operator)	12-Hour TWA exposure concentrations	1.2E−02	2.4E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.2E−02	2.4E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	6.0E−03	1.2E−02
	Average daily concentration (ADC) based on 12-hour TWA	5.6E−03	1.1E−02
Worker – Waste Treatment (Operator)	12-Hour TWA exposure concentrations	2.0E−02	4.0E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	2.0E−02	4.1E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	1.0E−02	2.0E−02
	Average daily concentration (ADC) based on 12-hour TWA	9.3E−03	1.9E−02
Worker – Shipping Tankerman	12-Hour TWA exposure concentrations	1.2E−02	2.4E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.2E−02	2.4E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	6.0E−03	1.2E−02
	Average daily concentration (ADC) based on 12-hour TWA	5.6E−03	1.1E−02
Worker – Laboratory Technician	12-Hour TWA exposure concentrations	1.2E−02	2.4E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.2E−02	2.4E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	6.0E−03	1.2E−02
	Average daily concentration (ADC) based on 12-hour TWA	5.6E−03	1.1E−02
ONU – VCM Unit (Supervisor)	12-hour TWA exposure concentrations	1.5E−02	3.0E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.5E−02	3.1E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	7.5E−03	1.5E−02
	Average daily concentration (ADC) based on 12-hour TWA	7.0E−03	1.4E−02
ONU – Waste Treatment (Supervisor)	12-Hour TWA exposure concentrations	1.6E−02	3.1E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.6E−02	3.2E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	7.7E−03	1.5E−02
	Average daily concentration (ADC) based on 12-hour TWA	7.2E−03	1.4E−02

8.2.1.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using a Monte Carlo simulation with 100,000 iterations.

The Agency modeled dermal exposure using a fraction absorbed value of 0.02 for *p*-dichlorobenzene as a liquid and followed the processes discussed in Section 8.1.4. The fraction absorbed value of 0.02 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more information). The study indicated that an estimate of 0.02 (or 2%) absorption should apply to all formulations with a less than 50% concentration of *p*-dichlorobenzene. The concentration evaluated for this dermal exposure is 2% based on Westlake Corporation Test Order data (Exponent, 2024).

Table 8-5 summarizes the APDR, AAD, and CAD (non-cancer) for *p*-dichlorobenzene during manufacturing. The high-end exposures are the 95th percentiles of the respective simulation output, and the central tendency exposures are the 50th percentiles. The SEGs included in the "Average Adult Worker" category include laboratory technicians, Per-Tri operators, shipping tankermen, VCM operators, and waste treatment operators. These SEGs were grouped for the purposes of modeling as they are expected to have similar risks of dermal exposure. Dermal exposures for ONUs are expected to be negligible as they do not directly handle the chemical. OES-specific parameters for dermal exposures are described in Appendix M.

Table 8-5. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene for Manufacturing

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	0.27	0.68
	Acute absorbed dose (AAD) (mg/kg-day)	3.4E−03	8.4E−03
	Intermediate average daily dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	2.5E−03	6.2E−03
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	1.9E−03	4.9E−03

8.2.1.5 Exposure Controls and PPE

PPE documented at the Westlake Corporation facility includes nitrile gloves used by operators and maintenance personnel, safety glasses used by operators, supervisors, engineers, and maintenance personnel. Respiratory protection through half-face respirators was used by select Per-Tri and VCM unit operators. One Per-TRI unit maintenance employee used supplied air/SCBA for respiratory protection. Other task-specific PPE included use of hard hats, aprons, boots, face shields, thermal gloves, and fire-retarded clothing. SEG-specific PPE is provided below:

- Worker – VCM Unit (Operator) – nitrile gloves, safety glasses, fire-resistant clothing, ear protection, safety boots, a hard hat, and an escape respirator.
- Worker – Per-Tri Unit (Operator) – nitrile gloves, safety glasses, fire-resistant clothing, ear protection, safety boots, a hard hat, and an escape respirator.
- Worker – Waste Treatment (Operator) – safety glasses, fire-resistant clothing, hearing protection, safety boots, a hard hat, and an escape respirator.
- Worker – Shipping Tankerman – full-face respirator or a half-mask respirator and face shield, chemical splash apron, gloves, fire-resistant clothing, and safety boots.
- Worker – Laboratory Technicians – nitrile gloves, a face shield, safety glasses/goggles, and a fire-resistant lab coat. During product analysis, lab technicians work under a fume hood with an area that allows for max air flow. Additionally, fume hoods are inspected annually and have visual and audible alarms.

- ONU – VCM Unit (Maintenance) – gloves, safety glasses, fire-resistant clothing, safety boots, and a hard hat
- ONU – VCM Unit (Supervisor) – gloves, safety glasses, fire-resistant clothing, safety boots, and a hard hat.
- ONU – VCM Unit (Engineer) – gloves, safety glasses, fire-resistant clothing, safety boots, and a hard hat
- ONU – Per-Tri Unit (Maintenance) – gloves, safety glasses, fire-resistant clothing, safety boots, and a hard hat.
- ONU – Waste Treatment (Supervisor) – gloves, safety glasses, fire-resistant clothing, safety boots, hearing protection, and a hard hat.

8.2.2 Repackaging

As listed in Table 4-1, this OES includes the following COU: Import.

8.2.2.1 Worker Activities

Worker activities during repackaging of *p*-dichlorobenzene were assessed using Test Order data provided by Willert Home Products, and data provided by the American Chemistry Council (ACC). Worker inhalation samples were taken from these datasets for workers performing activities such as disconnecting/connecting chemical transfer lines, handling *p*-dichlorobenzene, or packing/unpacking shipping containers. These data were analyzed and used as analogous data for sites that repackage *p*-dichlorobenzene. Per the 2020 CDR, *p*-dichlorobenzene is imported and repackaged as a solid; however, the data from ACC and the Test Order data from Westlake indicated that *p*-dichlorobenzene may be imported and/or packaged as a liquid (Charles River Laboratories, 2025; Exponent, 2024; U.S. EPA, 2022a). See Table 4-2 and 4.3.2.1 for a full repackaging process description.

Based on the data provided by industry, EPA assessed two exposure scenarios for repackaging of *p*-dichlorobenzene:

1. As a pure solid after import; and
2. As a neat liquid after manufacturing.

Solid Formulation

EPA assessed exposures based on Test Order data from Willert Home Products, a company that imports and repackages *p*-dichlorobenzene for use in their manufacturing processes (SCI Engineering, 2024). Willert Home Products provided job titles and brief worker activity descriptions for their data, which EPA used to group into two SEGs: "workers" and "ONUs." Job titles involved in the repackaging of solid *p*-dichlorobenzene and included in the occupational worker SEG were as follows: Material Handler and Lead, Packer, and Stockperson. Job titles for ONUs included the following: Shipping, Shipping – Driver, UPS Lead, and Warehouse Lead (SCI Engineering, 2024). Activities associated with each SEG that may result in exposures are provided below:

- Workers – Inhalation of solid particles and dermal contact with solids during container unloading, container cleaning, repackaging equipment cleaning, or loading of repackaged containers.
- ONUs – Inhalation of dust while in an area where the chemical is present and dermal contact with settled dust.

Neat Liquid Formulation

EPA assessed exposures based on exposure data provided by the ACC Consortium. ACC included job titles and brief worker activity descriptions; which EPA used to group the data into two SEGs: "workers" and "ONUs." All workers that performed material unloading and unloading, disconnecting,

or connecting railcars were included in this assessment. ONUs were listed as "ONU" in the ACC Consortium data (ACC, 2023). Activities associated with each SEG are provided below:

- Workers – Inhalation of vapors and dermal contact with liquids during container unloading, container cleaning, equipment cleaning, or loading of repackaged containers.
- ONUs – Inhalation of vapors while in an area where the chemical is present.

8.2.2.2 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 *p*-dichlorobenzene during import and repackaging (U.S. BLS, 2023a; U.S. Census Bureau, 2017). This approach involved first identifying the relevant NAICS codes for the OES. EPA identified two facilities from the release databases for this OES, which EPA believes may be an underestimate. Therefore, EPA assessed a bounding estimate of 21,286 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this OES. Relevant SOC codes were identified within the BLS data for the 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 J 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
- 325130 – Synthetic Dye and Pigment Manufacturing
- 325991 – Custom Compounding of Purchased Resins
- 325199 – All Other Basic Organic Chemical Manufacturing
- 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 8-6 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.2.2.

Table 8-6. Estimated Average Number of Workers per Site Potentially Exposed to *p*-Dichlorobenzene During Manufacturing

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site[a]	Potentially Exposed ONUs per Site[a]
21,286	325211 – Plastics Material and Resin Manufacturing	3	2
	325130 – Synthetic Dye and Pigment Manufacturing 325991 – Custom Compounding of Purchased Resins		
	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)		

[a] Number of workers and ONUs per site calculated by dividing the exposed number of workers or ONUs by the number of establishments.

8.2.2.3 Occupational Inhalation Exposure Results

EPA was provided with *p*-dichlorobenzene Test Order inhalation data for exposed workers and ONUs from Willert Home Products, along with compiled exposure data from the ACC Consortium. While none of these sources provided directly applicable data to workers in a repackaging facility of *p*-dichlorobenzene, the data from these two sources included worker job titles and activity descriptions that matched repackaging activities expected to be relevant to this OES. Individual data points that had work activities that matched repackaging-type activities (such as loading/unloading material) were used in this assessment. The Willert Home Products Test Order data included 220 full-shift personal air samples taken between February and October 2024 and 4 occupational task-based personal air samples. Of these, 75 full-shift samples were associated with repackaging activities and therefore included under this OES (SCI Engineering, 2024). The data provided by ACC included 74 full-shift personal air samples taken between September and October 2024 and 31 occupational task-based personal air samples. Of these, 16 full-shift samples and 22 task-based samples were associated with repackaging activities and therefore included in this OES (ACC, 2023).

From this monitoring data, EPA calculated the central tendency and high-end estimates of potential occupational inhalation exposures using the following methods:

Solid Formulation

Using Test Order data from Willert Home Products, EPA calculated the 50th and 95th percentile 8- and 10-hour TWA concentrations representing the central tendency and high-end estimates of potential occupational inhalation exposures, respectively. In cases where the data were below the LOD, the LOD ranged between 0.11 and 1.4 ppm, and sample durations ranged between 233 to 525 minutes for 8-hour TWAs and 595 to 633 minutes for 10-hr TWAs. Willert provided 41 relevant samples for 8-hour workers, 17 relevant samples for 8-hour ONUs, and 17 relevant samples for 10-hour ONUs (SCI Engineering, 2024). Note that while the 8-hour ONU data were obtained from ONUs that were present at the facility where *p*-dichlorobenzene is processed, the 10-hour ONUs were present in a different process area called the "Bluewater" facility. This facility is located approximately 830 feet from the facility that uses *p*-dichlorobenzene to manufacture air care products. Willert has stated that raw *p*-dichlorobenzene is not used in the manufacturing process that occurs within this facility, however these

workers were monitored as *p*-dichlorobenzene may still be present. Since the 10-hour ONU employees at Bluewater are further removed from the process than the 8-hour ONUs in the facilities that use raw *p*-dichlorobenzene, the 10-hour ONU exposures are expected to be lower than the 8-hour ONU exposures.

Neat Liquid Formulation

EPA assessed this scenario using data provided by the ACC Consortium, more specifically the SEG for material handlers. The 10-hour dataset, which provided ONU exposure data, and the 12-hour dataset, which provided both worker and ONU exposure data, were obtained from different facilities and so variations in exposures may be due to the differing shift lengths or due to other differences between facilities such as engineering controls or company-specific procedures. For the 12-hour TWA concentrations for workers, the ACC Consortium data only contained five samples with durations between 648 to 712 minutes. For this subset of data, the median and maximum were used to represent a central tendency and high-end estimate, respectively. All ONU samples (10- and 12-hour full shift) were reported non-detects for *p*-dichlorobenzene, with the LOD ranging from 0.0041 to 0.026 ppm and sample durations between 626 to 712 minutes. Because of this, EPA assigned the central tendency TWA exposure concentration as one-half of the maximum LOD (0.013 ppm), while the high-end TWA exposure concentration was assigned as the maximum LOD (0.026 ppm) reported for the dataset. Note that the 8-hour estimate indicates a higher exposure than the 12-hour estimate. This is due to the longer sample time of the 12-hour samples, which results in a lower LOD for the 12-hour dataset, and thus lower exposure estimates when the substitution method is applied. Task-based samples had concentrations that ranged between 0.9 to 10.2 ppm with durations between 14 to 55 minutes (ACC, 2023).

Using these 8-, 10-, and 12-hour TWA estimates, EPA calculated the AC, IADC, and ADC as described in Appendix K. The results of these calculations are shown in Table 8-7, Table 8-8, and Table 8-9 below.

Table 8-7. Summary of Worker Inhalation 8-Hour TWA Exposure to *p*-Dichlorobenzene During Repackaging

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Worker – Solid Formulation	8-Hour TWA exposure concentrations	8.1	24
	Acute exposure concentrations (AC) based on 8-hour TWA	5.5	16
	Intermediate average daily concentration (IADC) based on 8-hour TWA	4.0	12
	Average daily concentration (ADC) based on 8-hour TWA	3.8	11
ONU – Solid Formulation	8-Hour TWA exposure concentrations	0.45	3.0
	Acute exposure concentrations (AC) based on 8-hour TWA	0.31	2.1
	Intermediate average daily concentration (IADC) based on 8-hour TWA	0.22	1.5
	Average daily concentration (ADC) based on 8-hour TWA	0.21	1.4

Table 8-8. Summary of Worker Inhalation 10-Hour TWA Exposure to *p*-Dichlorobenzene During Repackaging

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
ONU – Solid Formulation	10-Hour TWA exposure concentrations	0.27	0.86
	Acute exposure concentrations (AC) based on 10-hour TWA	0.23	0.73
	Intermediate average daily concentration (IADC) based on 10-hour TWA	0.13	0.43
	Average daily concentration (ADC) based on 10-hour TWA	0.13	0.40
ONU – Neat Liquid Formulation	10-Hour TWA exposure concentrations	1.3E−02	2.6E−02
	Acute exposure concentrations (AC) based on 10-hour TWA	1.1E−02	2.2E−02
	Intermediate average daily concentration (IADC) based on 10-hour TWA	6.5E−03	1.3E−02
	Average daily concentration (ADC) based on 10-hour TWA	6.1E−03	1.2E−02

Table 8-9. Summary of Worker Inhalation 12-Hour TWA Exposure to *p*-Dichlorobenzene During Repackaging

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Worker – Neat Liquid Formulation	12-Hour TWA exposure concentrations	1.5E−02	0.38
	Acute exposure concentrations (AC) based on 12-hour TWA	1.5E−02	0.39
	Intermediate average daily concentration (IADC) based on 12-hour TWA	7.5E−03	0.19
	Average daily concentration (ADC) based on 12-hour TWA	7.0E−03	0.18
ONU – Neat Liquid Formulation	12-Hour TWA exposure concentrations	2.4E−03	4.7E−03
	Acute exposure concentrations (AC) based on 12-hour TWA	2.4E−03	4.8E−03
	Intermediate average daily concentration (IADC) based on 12-hour TWA	1.2E−03	2.3E−03
	Average daily concentration (ADC) based on 12-hour TWA	1.1E−03	2.2E−03

8.2.2.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using a Monte Carlo simulation with 100,000 iterations.

For *p*-dichlorobenzene as a solid powder, the Agency modeled dermal exposure using a fraction absorbed value of 0.04 and followed the processes discussed in Section 8.1.4 and Appendix M.2.4. The fraction absorbed value of 0.04 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more information). The study indicated that an estimate of 0.04 (or 4%) absorption should apply to all formulations with a greater than

50% concentration of *p*-dichlorobenzene. The concentration evaluated for this dermal exposure is assessed as a uniform distribution from 90% to 100% based on 2020 CDR data (U.S. EPA, 2020a) as presumably the chemical arrives at site and is repackaged as a neat substance.

For the neat liquid, the Agency modeled dermal exposure using a fraction absorbed value of 0.04 for *p*-dichlorobenzene and followed the processes discussed in Section 8.1.4 and Appendix M.2.4. The concentration evaluated for this dermal exposure is 100% based on data provided by the ACC Consortium (ACC, 2023). Table 8-10 and Table 8-11 summarize the APDR, AAD, IADC, and CAD (non-cancer) for *p*-dichlorobenzene during repackaging. For the different repackaging scenarios, the SEG areas included in the "Average Adult Worker" category for *p*-dichlorobenzene during repackaging include the following:

- Solids – Material Handler and Lead, Packer, and Stockperson.
- Neat Liquid Formulation – Material Handler.

These SEGs were grouped for the purposes of modeling as they are expected to have similar risks of dermal exposure. The high-end exposures are the 95th percentiles of the respective simulation output, and the central tendency exposures are the 50th percentiles. Dermal exposures for ONUs for *p*-dichlorobenzene as a liquid are expected to be negligible as they do not directly handle the chemical. ONUs included in the assessment for *p*-dichlorobenzene as a solid include employees who do not directly handle the chemical but may come into contact with dust that settles on surfaces in the process area. For this reason, ONU dermal exposure to *p*-dichlorobenzene as a solid is assessed using central tendency values from worker exposure. OES-specific parameters for dermal exposures are described in Appendix M.

Table 8-10. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene as a Solid for Repackaging

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	61	129
	Acute absorbed dose (AAD) (mg/kg-day)	0.76	1.6
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	0.56	1.2
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	0.42	0.94
ONU	Acute potential dose rate (APDR) (mg/day)	6.3	8.4
	Acute absorbed dose (AAD) (mg/kg-day)	7.9E−02	0.11
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	5.8E−02	7.7E−02
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	4.8E−02	7.0E−02

Table 8-11. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene as a Neat Liquid for Repackaging

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	27	68
	Acute absorbed dose (AAD) (mg/kg-day)	0.34	0.84
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	0.25	0.62
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	0.19	0.49

Note that *p*-Dichlorobenzene is a solid at room temperature, and so for transport as a neat liquid it must be heated above its melting point. Section 2.2.3 states that the melting point of *p*-dichlorobenzene is 53.1 °C. ACC reports that at a processing facility, neat *p*-dichlorobenzene is stored and transported at greater than 65.6°C (EPA-HQ-OPPT-2018-0446-0073). According to EPA's Chemical Engineering Branch manual for the preparation of engineering assessments, contact is expected to be negligible for materials that are above 140°F (60°C) because contact with the skin at this temperature will cause burns (CEB, 1991). Although the melting point of *p*-dichlorobenzene is lower than this temperature threshold, heating to a temperature above the melting point would be expected at industrial facilities to prevent solidification during temperature fluctuations within the lines at a facility. The temperature reported by ACC exceeds the melting point of *p*-dichlorobenzene by 12.5°C, and exceeds the temperature threshold to consider dermal exposure by 5.6°C. It is unknown whether all facilities that handle neat liquid *p*-dichlorobenzene heat their streams to a temperature above the 60°C threshold, which is an uncertainty to this dermal assessment.

8.2.2.5 Exposure Controls and PPE

Although EPA did not find information about exposure controls or PPE specific to repackaging facilities, PPE from workers performing relevant tasks (such as loading and unloading of the chemical) was available for each scenario from the same source as the inhalation exposure data utilized earlier in this section.

Solid Formulation

At the Willert Home Products site, engineering controls such as air circulation fans were employed. In the production areas there was an air filtration system and exhaust vent fans, as well as a vacuum system observed in areas where employees dumped raw *p*-dichlorobenzene. Garage doors were also opened as needed to help with air flow

PPE documented in the Willert Home Products Test Order data includes closed toe boots, disposable gloves, safety glasses, hearing protection, coveralls, lab coats, medical masks, and hairnets for production area employees. Employees operating mixers also wore N95 masks and heavy-duty chemical gloves (SCI Engineering, 2024).

Neat Liquid Formulation

The exposure data provided by ACC described the following PPE for material handlers, which is the SEG that was used as analogous in this assessment: flame resistant clothing, chemical resistant jacket, safety glasses, face shield, steel toe shoes, gloves, hearing protection. ACC also reports that workers wear chemically resistant gloves with specific application training, which ACC reports equates to a protection factor of 20. See *Draft Occupational Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026v) for more information about protection factors. (ACC, 2023).

8.2.3 Processing as a Reactant

As listed in Table 4-1, this OES includes the following COU: Processing as a reactant, recycling.

8.2.3.1 Worker Activities

In the ACC report "*p*-dichlorobenzene (*p*-DCB) Occupational Inhalation Exposure Study Conducted During Polyphenylene Sulfide Manufacture and Compounding," the ACC gathered inhalation exposure data and worker activity descriptions for sites that process *p*-dichlorobenzene into polyphenylene sulfide (PPS). The report states that *p*-dichlorobenzene arrives at the processing site in liquid form from a tank truck or rail car where it is unloaded into storage tanks. PPS is then formed by a reaction of *p*-dichlorobenzene and sodium sulfide in a polar solvent (ACC, 2023). Unreacted *p*-dichlorobenzene may be separated from the product stream and recycled back into the reactor to increase product purity and reaction yield. See Table 4-1 and 4.3.3.1 for a full processing as a reactant process description.

Based on the report from ACC, SEGs involved in the processing of *p*-dichlorobenzene included the following occupational worker groups: Material Handlers, Process Field Operators, and Laboratory Technicians. In the report, ONUs included the following occupational worker groups: Board Operator, Warehouse Technician Warehousing, and DCS Engineer. Activities associated with each SEG that may result in exposures are provided below:

- Material Handler – Inhalation of vapors and dermal exposure to liquids during worker activities such as unloading railcars and performing connecting and disconnecting activities.
- Process Field Operator – Inhalation of vapors and dermal exposure to liquids during worker activities such as adding raw materials into intermediate storage vessels when processing *p*-dichlorobenzene as an intermediate reactant and collecting process and slurry samples.
- Lab Technician – Inhalation of vapors and dermal exposure to liquids during worker activities such as analyzing samples, handline *p*-dichlorobenzene, and cleaning equipment or containers.
- ONU – Inhalation of vapors while in an area where the chemical is present.

8.2.3.2 Number of Workers and Occupational Non-Users

EPA used data from CDR, BLS, and the SUSB specific to the OES to estimate the number of workers and ONUs per site potentially exposed to *p*-dichlorobenzene during processing as a reactant (U.S. BLS, 2023a; U.S. EPA, 2020c; U.S. Census Bureau, 2017). 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 J 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;
- 325211 – Plastics Material and Resin Manufacturing;
- 325110 – Petrochemical Manufacturing; and
- 325180 – Other Basic Inorganic Chemical Manufacturing.

Table 8-12 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.3.3.2.

Table 8-12. Estimated Number of Workers Potentially Exposed to *p*-Dichlorobenzene During Processing as a Reactant

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site[a]	Potentially Exposed ONUs per Site[a]
14	325199 – All Other Basic Organic Chemical Manufacturing	27	15
	325211 – Plastics Material and Resin Manufacturing		
	325110 – Petrochemical Manufacturing		
	325180 – Other Basic Inorganic Chemical Manufacturing		

[a] Number of workers and ONUs per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.

8.2.3.3 Occupational Inhalation Exposure Results

Occupational inhalation data for *p*-dichlorobenzene during processing as a reactant were provided via a data submission from the ACC Consortium, which includes processors of *p*-dichlorobenzene (ACC, 2023). EPA estimated inhalation exposures using 31 worker and 22 ONU full-shift PBZ samples from two processing facilities.

From this monitoring data, EPA calculated central tendency and high-end exposure estimates using the following methods:

- For Material Handlers, the ACC Consortium data contained five 12-hour TWA concentration samples with sample durations between 648 and 712 minutes. All five samples were detected samples above the method's LOD. For this subset of data, the median and maximum of the data set were used to represent a central tendency and high-end estimate, respectively. The 22 task-based samples provided by ACC ranged in concentrations between 0.18 to 1.7 ppm with sample durations between 14 to 55 minutes.
- For Process Field Operators, 26 samples were collected with durations between 580 to 714 minutes. Of the 26 samples, 24 were below the method's LOD (LOD 0.0041–0.03 ppm). EPA calculated the 50th and 95th percentile 12-hour TWA concentrations representing the central tendency and high-end estimate of potential occupational inhalation exposures, respectively. The 9 task-based samples ranged in concentrations between 0.13 to 0.32 ppm with sample durations between 14 to 23 minutes
- For Laboratory Technicians, the ACC Consortium data contained three 12-hour samples with durations between 594 to 705 minutes and six 8-hour samples with durations between 312 to 480 minutes. All samples were reported non-detects for *p*-dichlorobenzene (LOD 0.0042–0.057 ppm). Additionally, some of the Laboratory Technician 8-hour TWAs list task durations as 0.5 hours and one 8-hour TWA lists a task duration of 12 hours. Because of this, EPA assumes that exposure profiles are the same such that 8-hour TWAs are equal to 12-hour TWAs. For this

SEG, EPA assessed the LOD and half the LOD as the high-end and central tendency TWA exposure concentrations, respectively.

All 22 ONU samples (12-hour TWA) were reported non-detects for *p*-dichlorobenzene (LOD 0.0041–0.03 ppm) with sample durations between 595 to 745 minutes. Because of this, EPA assessed the LOD and half the LOD as the high-end and central tendency TWA exposure concentrations, respectively (ACC, 2023).

Using these 12-hour TWA exposure concentrations, EPA calculated the AC, IADC, and ADC as described in Appendix L. The results of these calculations are shown in and Table 8-13.

Table 8-13. Summary of Inhalation 12-Hour TWA Exposure to *p*-Dichlorobenzene During Processing as a Reactant

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Material Handlers	12-hour TWA exposure concentrations	1.5E−02	0.31
	Acute exposure concentrations (AC) based on 12-hour TWA	1.5E−02	0.31
	Intermediate average daily concentration (IADC) based on 12-hour TWA	7.4E−03	0.15
	Average daily concentration (ADC) based on 12-hour TWA	8.2E−03	0.17
Process Field Operators	12-Hour TWA exposure concentrations	2.1E−03	1.2E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	2.1E−03	1.3E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	1.0E−03	6.2E−03
	Average daily concentration (ADC) based on 12-hour TWA	1.1E−03	6.9E−03
Lab Technicians	12-Hour TWA exposure concentrations	2.9E−02	5.7E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	2.9E−02	5.8E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	1.4E−02	2.8E−02
	Average daily concentration (ADC) based on 12-hour TWA	1.6E−02	3.2E−02
ONUs	12-Hour TWA exposure concentrations	1.5E−02	3.0E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.5E−02	3.1E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	7.5E−03	1.5E−02
	Average daily concentration (ADC) based on 12-hour TWA	8.4E−03	1.7E−02

8.2.3.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using a Monte Carlo simulation with 100,000 iterations. The Agency modeled dermal exposure using a fraction absorbed value of 0.04 for *p*-dichlorobenzene as a liquid and followed the processes discussed in Section 8.1.4 and Appendix M.2. The fraction absorbed value of 0.04 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more information). The study indicated that an estimate of 0.04 (or 4%) absorption should apply to all formulations with a greater than 50% concentration of *p*-dichlorobenzene. The concentration evaluated for this dermal exposure is 100%based on ACC data (ACC, 2023).

Table 8-14 summarizes the APDR, AAD, and CAD (non-cancer) for *p*-dichlorobenzene during processing as a reactant. The high-end exposures are the 95th percentiles of the respective simulation output, and the central tendency exposures are the 50th percentiles. The SEGs included in the "Average Adult Worker" category include material handlers and process field operators. These SEGs were grouped for the purposes of modeling as they are expected to have similar risks of dermal exposure. Dermal exposures for ONUs are expected to be negligible as they do not directly handle the chemical. OES-specific parameters for dermal exposures are described in Appendix M.

Table 8-14. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene for Processing as a Reactant

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	27	68
	Acute absorbed dose (AAD) (mg/kg-day)	0.34	0.84
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	0.25	0.62
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	0.19	0.49

Note that *p*-dichlorobenzene is a solid at room temperature, and so for transport within this system as a neat liquid it must be heated above its melting point. Section 2.2.3 states that the melting point of *p*-dichlorobenzene is 53.1 °C. ACC reports that at a processing facility, neat *p*-dichlorobenzene is stored and transported at greater than 65.6°C (EPA-HQ-OPPT-2018-0446-0073). According to EPA's Chemical Engineering Branch manual for the preparation of engineering assessments, contact is expected to be negligible for materials that are above 140°F (60°C) because contact with the skin at this temperature will cause burns (CEB, 1991). Although the melting point of *p*-dichlorobenzene is lower than this temperature threshold, heating to a temperature above the melting point would be expected at industrial facilities to prevent solidification during temperature fluctuations within the lines at a facility. The temperature reported by ACC exceeds the melting point of *p*-dichlorobenzene by 12.5°C, and exceeds the temperature threshold to consider dermal exposure by 5.6°C. It is unknown whether all facilities that handle neat liquid *p*-dichlorobenzene heat their streams to a temperature above the 60°C threshold, which is an uncertainty to this dermal assessment.

8.2.3.5 Exposure Controls and PPE

The report provided by ACC described the following typical PPE for each SEG:

- ***Material Handlers:*** flame resistant clothing, chemical resistant jacket, safety glasses, face shield, steel toe shoes, gloves, hearing protection;
- ***Process Field Operators:*** flame resistant clothing, hard hat, safety glasses, steel toe shoes, gloves, face shield, and hearing protection; the process field operator, tasked with drumming out the process equipment, was reported to wear SCBA for respiratory protection; and
- ***Lab Technicians:*** flame resistant clothing, lab coat, safety glasses, steel toe shoes, gloves.

Workers wear chemically resistant gloves with specific application training, which ACC reports equates to a protection factor of 20 (ACC, 2023). See the *Draft Occupational Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026v) for more information about protection factors.

8.2.4 Incorporation into Air Care Products

As listed in Table 4-1, this OES includes the following COU subcategory: Soap, cleaning compound, and toilet preparation manufacturing.

8.2.4.1 Worker Activities

Willert Home Products provided a study report in response to a test order that detailed worker activities at sites that processed *p*-dichlorobenzene into air care products. EPA assumes that the activities detailed by Willert Home Products are applicable to facilities throughout the country that process *p*-dichlorobenzene into similar products. See Section 4.3.6.1 for a full incorporation into air care products process description.

At the Willert Home Products site, it is estimated that approximately 10 million lb annually of *p*-dichlorobenzene is received in solid form and mixed into various household products such as moth balls and toilet bowl deodorizer (SCI Engineering, 2024). The site is one large building, but *p*-dichlorobenzene is only used in certain areas where these products are manufactured. Workers in these *p*-dichlorobenzene areas were designated as workers in "Para Production". One area of the site, located 830 feet away from the area that processes *p*-dichlorobenzene, is only used for processes that don't directly involve *p*-dichlorobenzene; however, Willert Home Products still included inhalation exposure samples for workers in this area, called the "Bluewater" area, as there is a possibility of indirect exposure to *p*-dichlorobenzene as these employees may enter other process areas to gather materials or during breaks. EPA included these workers in this assessment as ONUs and identified them with the label "other production area" although they are described in the test order report as workers in the "Bluewater" area.

Based on the study provided by Willert Home Products and stated worker activities, EPA developed SEG groups for workers and ONUs that are at the site where *p*-dichlorobenzene is incorporated into air care products. These SEG groups, the SEGs from the Willert study report that they contain, and the activities associated with each SEG that may result in exposures are defined in Table 8-15 below.

Table 8-15. SEG Groups Assessed for the Incorporation into Air Care Products OES

SEG Group	SEGs from Willert Home Products Contained in Group	Exposure Activities
Worker – Para Production (Direct Handling)	Para Production – 2nd Floor Lead	Inhalation exposure to dust or vapors or dermal exposure to solids while handling chemicals.
Worker – Para Production (Cleaning and Maintenance)	Para Production – Porter Para Production – Ball Press Cleaning Para Production – Cleaning Feed Gate Para Production – Shaker Screen Cleaning Para Production – Production Maintenance	Inhalation exposure to dust or vapors or dermal exposure to solids during container cleaning, equipment cleaning, material handling, and maintenance.
Worker – Para Production (Manufacturing)	Para Production – Packer Para Production – Production Line Leader Para Production –Production Supervisor Para Production – Stockperson	Inhalation exposure to dust or vapors or dermal exposure to solids during material handling, mixing, and packaging of formulation into containers.
ONU – Para Production (Inventory & Shipping	Para Production – Maintenance – Tool Crib Para Production – UPS Lead	Inhalation of dust or vapors while in an area where the chemical is present or dermal contact with settled dust.
ONU – Other Production Area (Packers & Leaders)	Other Chemical Manufacturing – Warehouse Lead Other Chemical Manufacturing – Line Lead Other Chemical Manufacturing – Packer	Inhalation of dust or vapors while in an area where the chemical is present or dermal contact with settled dust.

SEG Group	SEGs from Willert Home Products Contained in Group	Exposure Activities
ONU – Other Production Area (Utility and Maintenance)	Other Chemical Manufacturing – Porter Other Chemical Manufacturing – Preventative Maintenance Other Chemical Manufacturing – Production Maintenance Other Chemical Manufacturing – Utility	Inhalation of dust or vapors while in an area where the chemical is present or dermal contact with settled dust.
ONU – Other Production Area (Mixers)	Other Chemical Manufacturing – Mix	Inhalation of dust or vapors while in an area where the chemical is present or dermal contact with settled dust.
ONU – Maintenance	Preventative Maintenance	Inhalation of dust or vapors while in an area where the chemical is present or dermal contact with settled dust.
ONU – Office	Operations Office Accounting Sales Product Development Human Resources IT Owner Reception Maintenance – Office	Inhalation of dust or vapors while in an area where the chemical is present or dermal contact with settled dust.
ONU – Shipping	Shipping – Material Handler and Lead Shipping – Shipping Shipping – Driver	Inhalation of dust or vapors while in an area where the chemical is present or dermal contact with settled dust.

8.2.4.2 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 *p*-dichlorobenzene during incorporation into air care products (U.S. BLS, 2023a; U.S. Census Bureau, 2017). This approach involved first identifying the relevant NAICS codes for the OES. EPA identified only two OES-specific data for the number of sites that incorporate *p*-dichlorobenzene into air care products. Therefore, EPA assessed a bounding estimate of 1,442 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this OES. The next step is the identification of relevant SOC codes within the BLS data for the identified NAICS codes. From there total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per. Appendix J includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 325612 – Polish and Other Sanitation Good Manufacturing; and
- 325620 – Toilet Preparation Manufacturing.

Table 8-16 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.2.2.

Table 8-16. Estimated Average Number of Workers per Site Potentially Exposed to *p*-Dichlorobenzene During Incorporation into Air Care Products

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site[a]	Potentially Exposed ONUs per Site[a]
1,442	325612 – Polish and Other Sanitation Good Manufacturing	21	10
	325620 – Toilet Preparation Manufacturing		

[a] Number of workers and ONUs per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.

8.2.4.3 Occupational Inhalation Exposure Results

Occupational inhalation monitoring data for use of *p*-dichlorobenzene during incorporation into air care products were provided via a Test Order submission from Willert Home Products, which operates a single site that uses *p*-dichlorobenzene in the manufacture of products such as moth balls and toilet bowl deodorizer (SCI Engineering, 2024).

Table 8-17 below identifies the number of full-shift (8- and 10-hour) TWA data points identified for each SEG group and the methodologies used to generate central tendency and high-end TWA exposure estimates. Sample durations ranged between 462 to 525 minutes for 8-hour samples and 547 to 578 minutes for 10-hr samples. The data contained 4 task-based samples with concentrations ranging between 4 to 30 ppm and durations between 10 to 40 minutes. To differentiate between 8-hour and 10-hour shift durations, EPA used the days per week that Willert Home Products provided for each sample. Those that work four days per week were classified as 10-hour workers and those that work five days per week were classified as 8-hour workers. Note that there were cases where sample durations were less than or greater than the assigned shift time. These cases were considered as infrequent anomalies in shift duration and the datapoints were included in their sorted exposure estimates without modification.

Table 8-17. Inhalation TWA Assessment Methods for the Incorporation into Air Care Products OES

SEG Group	# of Full-Shift TWA PBZ Monitoring Data Points (# ND); LOD Concentration Range Min-Max in ppm Assessed		Estimation Method to Generate TWA Exposure Estimates	
	8-Hour	10-Hour	8-Hour	10-Hour
Worker – Para Production (Direct Handling)	12 (0)	0	Central Tendency: 50th percentile High-End: 95th percentile	Not assessed
Worker – Para Production (Cleaning and Maintenance)	16 (0)	0	Central Tendency: 50th percentile High-End: 95th percentile	Not assessed
Worker – Para Production (Manufacturing)	47 (0)		Central Tendency: 50th percentile High-End: 95th percentile	Not assessed

SEG Group	# of Full-Shift TWA PBZ Monitoring Data Points (# ND); LOD Concentration Range Min-Max in ppm Assessed		Estimation Method to Generate TWA Exposure Estimates	
	8-Hour	10-Hour	8-Hour	10-Hour
ONU – Para Production (Packers & Leaders)	0	23 (5); 0.10 – 0.16	Not assessed	Central Tendency: 50th percentile High-End: 95th percentile
ONU – Para Production Area (Inventory & Shipping)	9 (0)	0	Central Tendency: 50th percentile High-End: 95th percentile	Not assessed
ONU – Other Production Area (Utility and Maintenance)	1 (0)	20 (4); 0.12 – 0.17	Single value used to calculate central tendency and high-end	Central Tendency: 50th percentile High-End: 95th percentile
ONU – Other Production Area (Mixers)	0	16 (4); 0.11 – 0.14	Not assessed	Central Tendency: 50th percentile High-End: 95th percentile
ONU – Maintenance	4 (0)	2 (1); < 0.17	Central Tendency: 50th percentile High-End: Maximum	Central tendency: Midpoint of two values High-end: Higher of the two values
ONU – Office	46 (1); < 0.18	0	Central Tendency: 50th percentile High-End: 95th percentile	Not assessed
ONU – Shipping	24 (1); < 0.14	0	Central Tendency: 50th percentile High-End: 95th percentile	Not assessed

Using these 8- and 10-hour TWA exposure concentrations, EPA calculated the AC, IADC, and ADC as described in Appendix L. The results of these calculations are shown in Table 8-18 and Table 8-20.

Table 8-18. Inhalation Exposures to *p*-Dichlorobenzene During Incorporation into Air Care Products for 8-Hour TWA

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Worker – Para Production (Direct Handling)	8-Hour TWA exposure concentrations	9.8	14
	Acute exposure concentrations (AC) based on 8-hour TWA	6.7	9.8
	Intermediate average daily concentration (IADC) based on 8-hour TWA	4.9	7.2
	Average daily concentration (ADC) based on 8-hour TWA	4.6	6.7

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Worker – Para Production (Cleaning and Maintenance)	8-Hour TWA exposure concentrations	6.4	17
	Acute exposure concentrations (AC) based on 8-hour TWA	4.4	12
	Intermediate average daily concentration (IADC) based on 8-hour TWA	3.2	8.5
	Average daily concentration (ADC) based on 8-hour TWA	3.0	7.9
Worker – Para Production (Manufacturing)	8-Hour TWA exposure concentrations	9.8	30
	Acute exposure concentrations (AC) based on 8-hour TWA	6.7	20
	Intermediate average daily concentration (IADC) based on 8-hour TWA	4.9	15
	Average daily concentration (ADC) based on 8-hour TWA	4.6	14
ONU – Para Production (Inventory & Shipping)	8-Hour TWA exposure concentrations	2.0	3.3
	Acute exposure concentrations (AC) based on 8-hour TWA	1.4	2.2
	Intermediate average daily concentration (IADC) based on 8-hour TWA	1.0	1.6
	Average daily concentration (ADC) based on 8-hour TWA	0.93	1.5
ONU – Other Production Area (Utility and Maintenance)	8-Hour TWA exposure concentrations	0.98	
	Acute exposure concentrations (AC) based on 8-hour TWA	0.67	0.67
	Intermediate average daily concentration (IADC) based on 8-hour TWA	0.49	0.49
	Average daily concentration (ADC) based on 8-hour TWA	0.46	0.46
ONU – Maintenance	8-Hour TWA exposure concentrations	3.2	5.9
	Acute exposure concentrations (AC) based on 8-hour TWA	2.1	4.0
	Intermediate average daily concentration (IADC) based on 8-hour TWA	1.6	2.9
	Average daily concentration (ADC) based on 8-hour TWA	1.5	2.7
ONU – Office	8-Hour TWA exposure concentrations	0.92	2.6
	Acute exposure concentrations (AC) based on 8-hour TWA	0.63	1.8
	Intermediate average daily concentration (IADC) based on 8-hour TWA	0.46	1.3
	Average daily concentration (ADC) based on 8-hour TWA	0.43	1.2
ONU – Shipping	8-Hour TWA exposure concentrations	0.42	1.4
	Acute exposure concentrations (AC) based on 8-hour TWA	0.29	0.94
	Intermediate average daily concentration (IADC) based on 8-hour TWA	0.21	0.69
	Average daily concentration (ADC) based on 8-hour TWA	0.20	0.65

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Table 8-19. Inhalation Exposures to *p*-Dichlorobenzene During Incorporation into Air Care Products for 10-Hour TWA

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
ONU – Other Production Area (Packers & Leaders)	10-Hour TWA exposure concentrations	0.24	0.73
	Acute exposure concentrations (AC) based on 10-hour TWA	0.20	0.62
	Intermediate average daily concentration (IADC) based on 10-hour TWA	0.12	0.36
	Average daily concentration (ADC) based on 10-hour TWA	0.14	0.42
ONU – Other Production Area (Utility and Maintenance)	10-Hour TWA exposure concentrations	0.32	1.0
	Acute exposure concentrations (AC) based on 10-hour TWA	0.27	0.85
	Intermediate average daily concentration (IADC) based on 10-hour TWA	0.16	0.50
	Average daily concentration (ADC) based on 10-hour TWA	0.19	0.58
ONU – Other Production Area (Mixers)	10-Hour TWA exposure concentrations	0.28	0.84
	Acute exposure concentrations (AC) based on 10-hour TWA	0.24	0.71
	Intermediate average daily concentration (IADC) based on 10-hour TWA	0.14	0.42
	Average daily concentration (ADC) based on 10-hour TWA	0.16	0.49
ONU – Maintenance	10-Hour TWA exposure concentrations	0.26	0.40
	Acute exposure concentrations (AC) based on 10-hour TWA	0.22	0.34
	Intermediate average daily concentration (IADC) based on 10-hour TWA	0.13	0.20
	Average daily concentration (ADC) based on 10-hour TWA	0.15	0.23

8.2.4.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using a Monte Carlo simulation with 100,000 iterations. The Agency modeled dermal exposure using a fraction absorbed value of 0.04 for *p*-dichlorobenzene as a solid powder and followed the processes discussed in Section 8.1.4 and Appendix M. The fraction absorbed value of 0.04 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more information). The study indicated that an estimate of 0.04 (or 4%) absorption should apply to all formulations with a greater than 50% concentration of *p*-dichlorobenzene. EPA acknowledges the possibility that workers will be handling the solid product, which would be an infinite dose scenario of dermal exposure (where chemical

permeability into the skin may be a greater factor in dermal exposure than a fraction absorbed value), however EPA did not have enough knowledge about the process and specific worker activities to obtain inputs for this kind of model. As a result, the fractional absorbed method was chosen as the most probable representation of exposure. The concentration evaluated for this dermal exposure is represented by a uniform distribution with a lower bound of 90%and an upper bound of 100% based on upstream concentrations from the repackaging OES and the U.S. EPA Locating and Estimating Air Emissions from Sources of Chlorobenzenes technical report (U.S. EPA, 1994b).

Table 8-20 summarizes the APDR, AAD, and CAD (non-cancer) for *p*-dichlorobenzene during incorporation into air care products. The high-end exposures are the 95th percentiles of the respective simulation output, and the central tendency exposures are the 50th percentiles. The SEG areas included in the "Average Adult Worker" category include employees in Bluewater, Para Production, and Shipping. These SEGs were grouped for the purposes of modeling as they are expected to have similar risks of dermal exposure. ONUs include employees who do not directly handle the chemical but may come into contact with dust that settles on surfaces in the process area. For this reason, ONU dermal exposure to *p*-dichlorobenzene as a solid is assessed using central tendency values from worker exposure. OES-specific parameters for dermal exposures are described in Appendix M.

Table 8-20. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene for Incorporation into Air Care Products

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	61	129
	Acute absorbed dose (AAD) (mg/kg-day)	0.76	1.6
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	0.56	1.2
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	0.46	1.0
ONU	Acute potential dose rate (APDR) (mg/day)	6.3	8.4
	Acute absorbed dose (AAD) (mg/kg-day)	7.9E−02	0.11
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	5.8E−02	7.7E−02
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	4.8E−02	7.0E−02

8.2.4.5 Exposure Controls and PPE

At the Willert Home Products site, engineering controls such as air circulation fans were employed. In the production areas there was an air filtration system and exhaust vent fans, as well as a vacuum system observed in areas where employees dumped raw *p*-dichlorobenzene. Garage doors were also opened as needed to help with air flow

Production area employees at Willert Home Products including all "Worker" SEG groups as well as all ONU groups besides "ONU Office" wore PPE including closed toe shoes/boots, disposable gloves, safety glasses, coveralls, lab coats, medical masks, and hairnets for dermal protection. Mixers wore N95 masks and heavy-duty chemical gloves for dermal and respiratory protection (SCI Engineering, 2024).

8.2.5 Incorporation into Formulation, Mixture, or Reaction Product

As listed in Table 4-1, this OES includes the following COU subcategory: Solvents (which become part of product formulation or mixture).

8.2.5.1 Worker Activities

EPA did not identify occupational exposure data that was relevant to processing or use of *p*-dichlorobenzene during incorporation into formulation, mixture, or reaction products. Due to this lack of data, EPA assumed worker activities for employees at incorporation facilities to be similar to activities for workers during incorporation into air care products.

Willert Home Products provided a study report in response to a test order that detailed worker activities at sites that processed *p*-dichlorobenzene into air care products. EPA assumes that the activities detailed by Willert Home Products are applicable to facilities throughout the country that process *p*-dichlorobenzene into similar products. See Section 4.3.4.1 for a full incorporation into formulation process description.

At the Willert Home Products site, it is estimated that approximately 10 million lb annually of *p*-dichlorobenzene is received in solid form and mixed into various household products such as moth balls and toilet bowl deodorizer (SCI Engineering, 2024). The site is one large building, but *p*-dichlorobenzene is only used in certain areas where these products are manufactured. Workers in these *p*-dichlorobenzene areas were designated as workers in "Para Production". Other areas at the site are only used for processes that don't directly involve *p*-dichlorobenzene; however, Willert Home Products still included inhalation exposure samples for workers in these areas as there is a possibility of indirect exposure to *p*-dichlorobenzene as these employees may enter other process areas to gather materials or during breaks. EPA included these workers in this assessment as ONUs and identified them as working in "Other Chemical Manufacturing" although they are described in the test order report as workers in the "Bluewater" area.

Based on the study provided by Willert Home Products and stated worker activities, EPA developed SEG groups for workers and ONUs that are at the site where *p*-dichlorobenzene into air care products. These SEG groups, the SEGs from the Willert study report that they contain, and the activities associated with each SEG that may result in exposures are defined in Table 8-15.

8.2.5.2 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 *p*-dichlorobenzene during incorporation into formulation, mixture, or reaction product (U.S. BLS, 2023a; U.S. Census Bureau, 2017). 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 there total number of workers can be determined. This number is divided by the number of sites identified to obtain the exposed workers per. Appendix J includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 324199 – All Other Petroleum and Coal Products Manufacturing;
- 325130 – Synthetic Dye and Pigment Manufacturing;
- 325510 – Paint and Coating Manufacturing;
- 325520 – Adhesive Manufacturing;
- 325612 – Polish and Other Sanitation Good Manufacturing;
- 325620 – Toilet Preparation Manufacturing; and
- 325910 – Printing Ink Manufacturing.

Table 8-21 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.3.4.2.

Table 8-21. Estimated Average Number of Workers per Site Potentially Exposed to *p*-Dichlorobenzene During Incorporation into Formulation, Mixture, or Reaction Product

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site[a]	Potentially Exposed ONUs per Site[a]
106	324199 – All Other Petroleum and Coal Products Manufacturing	12	8
	325130 – Synthetic Dye and Pigment Manufacturing		
	325510 – Paint and Coating Manufacturing		
	325520 – Adhesive Manufacturing		
	325612 – Polish and Other Sanitation Good Manufacturing		
	325910 – Printing Ink Manufacturing		

[a] Number of workers and ONUs per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.

8.2.5.3 Occupational Inhalation Exposure Results

Occupational inhalation exposure for *p*-dichlorobenzene during incorporation into formulation, mixture, or reaction product was assessed using data provided via a Test Order submission from Willert Home Products, which uses *p*-dichlorobenzene in the manufacture of products such as moth balls and toilet bowl deodorizers (SCI Engineering, 2024). Table 8-17 identifies the number of full-shift (8- and 10-hour) TWA data points identified for each SEG group and the methodologies used to generate central tendency and high-end TWA exposure estimates. Based on expected formulations of *p*-dichlorobenzene outside of air care products, EPA assumes that the central tendency inhalation exposure TWA estimates generated for the incorporation into air care products OES are more representative of the potential exposures for this OES. However, high-end inhalation exposure TWA estimates are still presented for consistency with other OES, as a "worst-case" estimate.

Using these 8- and 10-hour central tendency TWA exposure concentrations, EPA calculated the AC, IADC, and ADC as described in Appendix L. The results of these calculations are shown in Table 8-22 and Table 8-23.

Table 8-22. Inhalation Exposures to *p*-Dichlorobenzene During Incorporation into Formulation, Mixture, or Reaction Products for 8-Hour TWA

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Worker – Para Production (Direct Handling)	8-Hour TWA exposure concentrations	9.8	14
	Acute exposure concentrations (AC) based on 8-hour TWA	6.7	9.8
	Intermediate average daily concentration (IADC) based on 8-hour TWA	4.9	7.2

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
	Average daily concentration (ADC) based on 8-hour TWA	4.6	6.7
Worker – Para Production (Cleaning and Maintenance)	8-Hour TWA exposure concentrations	6.4	17
	Acute exposure concentrations (AC) based on 8-hour TWA	4.4	12
	Intermediate average daily concentration (IADC) based on 8-hour TWA	3.2	8.5
	Average daily concentration (ADC) based on 8-hour TWA	3.0	7.9
Worker – Para Production (Manufacturing)	8-Hour TWA exposure concentrations	9.8	30
	Acute exposure concentrations (AC) based on 8-hour TWA	6.7	20
	Intermediate average daily concentration (IADC) based on 8-hour TWA	4.9	15
	Average daily concentration (ADC) based on 8-hour TWA	4.6	14
ONU – Para Production (Inventory & Shipping)	8-Hour TWA exposure concentrations	2.0	3.3
	Acute exposure concentrations (AC) based on 8-hour TWA	1.4	2.2
	Intermediate average daily concentration (IADC) based on 8-hour TWA	1.0	1.6
	Average daily concentration (ADC) based on 8-hour TWA	0.93	1.5
ONU – Other Production Area (Utility and Maintenance)	8-Hour TWA exposure concentrations	0.98	0.98
	Acute exposure concentrations (AC) based on 8-hour TWA	0.67	0.67
	Intermediate average daily concentration (IADC) based on 8-hour TWA	0.49	0.49
	Average daily concentration (ADC) based on 8-hour TWA	0.46	0.46
ONU – Maintenance	8-Hour TWA exposure concentrations	3.2	5.9
	Acute exposure concentrations (AC) based on 8-hour TWA	2.1	4.0
	Intermediate average daily concentration (IADC) based on 8-hour TWA	1.6	2.9
	Average daily concentration (ADC) based on 8-hour TWA	1.5	2.7
ONU – Office	8-Hour TWA exposure concentrations	0.92	2.6

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
	Acute exposure concentrations (AC) based on 8-hour TWA	0.63	1.8
	Intermediate average daily concentration (IADC) based on 8-hour TWA	0.46	1.3
	Average daily concentration (ADC) based on 8-hour TWA	0.43	1.2
ONU – Shipping	8-Hour TWA exposure concentrations	0.42	1.4
	Acute exposure concentrations (AC) based on 8-hour TWA	0.29	0.94
	Intermediate average daily concentration (IADC) based on 8-hour TWA	0.21	0.69
	Average daily concentration (ADC) based on 8-hour TWA	0.20	0.65

Table 8-23. Inhalation Exposures to *p*-Dichlorobenzene During Incorporation into Formulation, Mixture, or Reaction Products for 10-Hour TWA

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
ONU – Other Production Area (Packers & Leaders)	10-Hour TWA exposure concentrations	0.24	0.73
	Acute exposure concentrations (AC) based on 10-hour TWA	0.20	0.62
	Intermediate average daily concentration (IADC) based on 10-hour TWA	0.12	0.36
	Average daily concentration (ADC) based on 10-hour TWA	0.14	0.42
ONU – Other Production Area (Utility and Maintenance)	10-Hour TWA exposure concentrations	0.32	1.0
	Acute exposure concentrations (AC) based on 10-hour TWA	0.27	0.85
	Intermediate average daily concentration (IADC) based on 10-hour TWA	0.16	0.50
	Average daily concentration (ADC) based on 10-hour TWA	0.19	0.58
ONU – Other Production Area (Mixers)	10-Hour TWA exposure concentrations	0.28	0.84
	Acute exposure concentrations (AC) based on 10-hour TWA	0.24	0.71

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
	Intermediate average daily concentration (IADC) based on 10-hour TWA	0.14	0.42
	Average daily concentration (ADC) based on 10-hour TWA	0.16	0.49
ONU – Maintenance	10-Hour TWA exposure concentrations	0.26	0.40
	Acute exposure concentrations (AC) based on 10-hour TWA	0.22	0.34
	Intermediate average daily concentration (IADC) based on 10-hour TWA	0.13	0.20
	Average daily concentration (ADC) based on 10-hour TWA	0.15	0.23

8.2.5.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using a Monte Carlo simulation with 100,000 iterations. The Agency modeled dermal exposure using a fraction absorbed value of 0.04 for *p*-dichlorobenzene as a liquid and followed the processes discussed in Section 8.1.4 and Appendix M. The fraction absorbed value of 0.04 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more information). The study indicated that an estimate of 0.04 (or 4%) absorption should apply to all formulations with a greater than 50% concentration of *p*-dichlorobenzene. The concentration evaluated for this dermal exposure is represented by a uniform distribution with a lower bound of 90% and an upper bound of 100%based on upstream concentrations from import and repackaging and the U.S. EPA Locating and Estimating Air Emissions from Sources of Chlorobenzenes technical report (U.S. EPA, 1994b).

Table 8-24 summarizes the APDR, AAD, and CAD (non-cancer) for *p*-dichlorobenzene during incorporation into formulation, mixture, or reaction product. The high-end exposures are the 95th percentiles of the respective simulation output, and the central tendency exposures are the 50th percentiles. The SEGs included in the "Average Adult Worker" category include operators that perform the following tasks: dumping crystals, mixing, loading, pulverizing, wheel-forming, reactor, mechanic, and control operation, and crystal and moth line employees. These SEGs were grouped for the purposes of modeling as they are expected to have similar risks of dermal exposure. Dermal exposures for ONUs are expected to be negligible as they do not directly handle the chemical. OES-specific parameters for dermal exposures are described in Appendix M.

Table 8-24. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene for Incorporation into Formulation, Mixture, or Reaction Product

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	26	64
	Acute absorbed dose (AAD) (mg/kg-day)	0.32	0.80
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	0.24	0.59
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	0.20	0.50

8.2.5.5 Exposure Controls and PPE

At the Willert Home Products site, engineering controls such as air circulation fans were employed. In the production areas there was an air filtration system and exhaust vent fans, as well as a vacuum system observed in areas where employees dumped raw *p*-dichlorobenzene. Garage doors were also opened as needed to help with air flow Production area employees at Willert Home Products including all "Worker" SEG groups as well as all ONU groups besides "ONU Office" wore PPE including closed toe shoes/boots, disposable gloves, safety glasses, coveralls, lab coats, medical masks, and hairnets for dermal protection. Mixers wore N95 masks and heavy-duty chemical gloves for dermal and respiratory protection (SCI Engineering, 2024).

8.2.6 Plastic Compounding

As listed in Table 4-1, this OES includes the following COU subcategory: Plastics compounding.

8.2.6.1 Worker Activities

In the ACC report "*p*-Dichlorobenzene (*p*-DCB) Occupational Inhalation Exposure Study Conducted During Polyphenylene Sulfide Manufacture and Compounding", the ACC gathered inhalation exposure data and worker activity descriptions for sites that compound polyphenylene sulfide (PPS) polymers. At a separate facility, *p*-dichlorobenzene is reacted with sodium sulfide in a polar solvent to manufacture PPS. After this process, compounding facilities receive the PPS polymers and blend them with additives and extrude the mixture into pellets. Unreacted *p*-dichlorobenzene may remain in the compounded plastic as an impurity (ACC, 2023). See Table 4-1 and Section 4.3.5.1 for a full plastics compounding process description.

The ACC report describes one SEG involved in the PPS compounding: Compounding – Extrusion Operators, as well as ONUs which include Board Operator, DCS Engineer, Packaging/Warehouse, and Warehouse Technician. Activities associated with the SEG that may result in exposures are provided below:

- Extrusion Operator – Inhalation of dust or vapors and dermal exposure to solids containing *p*-dichlorobenzene during operation of the extruder machines.
- ONU – Inhalation of dust to solids in areas where the chemical is present.

Based on the concentration of *p*-dichlorobenzene in the manufactured PPS polymers (<100 ppm), the ACC report states that ONU exposure during compounding is not expected. However, EPA assumes ONUs may be exposed to *p*-dichlorobenzene via inhalation of dusts while in areas where the polymers are present.

8.2.6.2 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 *p*-dichlorobenzene during plastics compounding (U.S. BLS, 2023a; U.S. Census Bureau, 2017). This approach involved first identifying the relevant NAICS codes for the OES. The potential number of sites for this OES was then estimated based on the number of reporting sites from SUSB for the identified NAICS codes. 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 J 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; and
- 325991 – Custom Compounding of Purchased Resins.

Table 8-25 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.2.2.

Table 8-25. Estimated Average Number of Workers per Site Potentially Exposed to *p*-Dichlorobenzene During Plastics Compounding

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site[a]	Potentially Exposed ONUs per Site[a]
35	325211 – Plastics Material and Resin Manufacturing	20	13
	325991 – Custom Compounding of Purchased Resins		

[a] Number of workers and ONUs per site calculated by dividing the exposed number of workers or ONUs by the number of establishments.

8.2.6.3 Occupational Inhalation Exposure Results

Occupational inhalation data for *p*-dichlorobenzene during plastics compounding were provided via a data submission from the ACC Consortium, which includes compounding of polymers containing *p*-dichlorobenzene (ACC, 2023). EPA estimated inhalation exposures using 7 worker full-shift PBZ samples (durations between 681 to 690 minutes) and 22 ONU PBZ samples (durations between 595 to 745 minutes).

All collected samples (12-hour TWA) reported non-detects for *p*-dichlorobenzene (the LOD was 0.026 ppm for workers and ranged from 0.0041 and 0.03ppm for ONUs). Because of this, EPA assessed the LOD and half of the LOD as the high-end and central tendency TWA exposure concentrations, respectively (ACC, 2023). This method may result in ONU exposure estimates that have higher estimated exposures than workers due to the difference in reported LODs.

Using these 12-hour TWA exposure concentrations, EPA calculated the AC, IADC, and ADC as described in Appendix L. The results of these calculations are shown in Table 8-26.

Table 8-26. Summary of Inhalation 12-Hour TWA Exposure to *p*-Dichlorobenzene During Plastics Compounding

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Extrusion Operators	12-Hour TWA exposure concentrations	1.3E−02	2.6E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.3E−02	2.7E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	6.5E−03	1.3E−02
	Average daily concentration (ADC) based on 12-hour TWA	7.3E−03	1.5E−02
ONU	12-Hour TWA exposure concentrations	1.5E−02	3.0E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.5E−02	3.1E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	7.5E−03	1.5E−02
	Average daily concentration (ADC) based on 12-hour TWA	8.4E−03	1.7E−02

8.2.6.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using a Monte Carlo simulation with 100,000 iterations. The Agency modeled dermal exposure using a fraction absorbed value of 0.02 for *p*-dichlorobenzene as a liquid and followed the processes discussed in Section 8.1.4 and Appendix M. The fraction absorbed value of 0.02 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more information). The study indicated that an estimate of 0.02 (or 2%) absorption should apply to all formulations with a less than 50% concentration of *p*-dichlorobenzene. The concentration evaluated for this dermal exposure is 0.01% based on ACC test order data (Charles River Laboratories, 2025).

Table 8-27 summarizes the APDR, AAD, $ADD_{intermediate}$, and CAD (non-cancer) for *p*-dichlorobenzene during plastics compounding. The high-end exposures are the 95th percentiles of the respective simulation output, and the central tendency exposures are the 50th percentiles. The SEGs included in the "Average Adult Worker" category include operators that work on compounding tasks. Dermal exposures for ONUs are expected to be negligible as they do not directly handle the chemical. OES-specific parameters for dermal exposures are described in Appendix M.

Table 8-27. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene for Plastics Compounding

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker[a]	Acute potential dose rate (APDR) (mg/day)	1.4E−03	3.4E−03
	Acute absorbed dose (AAD) (mg/kg-day)	1.7E−05	4.2E−05
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	1.3E−05	3.1E−05
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	9.4E−06	2.3E−05

8.2.6.5 Exposure Controls and PPE

The data provided by the ACC Consortium describes the following PPE for extrusion operators: Hard hat, safety glasses, gloves, steel toe shoes, and hearing protection. Workers also wear chemically resistant gloves with specific application training (ACC, 2023).

8.2.7 Plastic Converting

As listed in Table 4-1, this OES includes the following COU subcategory: Plastic product manufacturing.

8.2.7.1 Worker Activities

EPA did not identify occupational exposure data that was relevant to use of *p*-dichlorobenzene in the plastics converting industry. Due to this lack of data, EPA assumed worker activities for employees at plastic converting facilities to be similar to activities for workers at plastics compounding facilities. Therefore, EPA used the ACC report "*p*-Dichlorobenzene (*p*-DCB) Occupational Inhalation Exposure Study Conducted During Polyphenylene Sulfide Manufacture and Compounding" to also describe worker activities for the Plastics Converting OES. In the ACC report, the ACC gathered inhalation exposure data and worker activity descriptions for sites that compound PPS polymers. At a separate facility, *p*-dichlorobenzene is reacted with sodium sulfide in a polar solvent to manufacture PPS. After this process, compounding facilities receive the PPS polymers, and they are blended with additives and extruded into pellets. Unreacted *p*-dichlorobenzene may remain in the compounded plastic as an impurity (ACC, 2023). See Table 4-1 and Section 4.3.7.1 for a full plastics converting process description.

The ACC report describes one SEG involved in the PPS compounding: Compounding – Extrusion Operators, as well as ONUs which include Board Operator, DCS Engineer, Packaging/Warehouse, and Warehouse Technician. Activities associated with the SEG that may result in exposures are provided below:

- Extrusion Operator – Inhalation of dust or vapors and dermal exposure to solids containing *p*-dichlorobenzene during operation of the extruder machines.
- ONU – Inhalation of dust to solids in areas where the chemical is present.

Based on the concentration of *p*-dichlorobenzene in the manufactured PPS polymers (<100 ppm), the ACC report states that ONU exposures during compounding are not expected. However, EPA assumes ONUs may be exposed to *p*-dichlorobenzene via inhalation of dust while in areas where the polymers are present.

8.2.7.2 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 *p*-dichlorobenzene during plastics converting (U.S. BLS, 2023a; U.S. Census Bureau, 2017). This approach involved first identifying the relevant NAICS codes for the OES. EPA identified only 12 facilities relevant to this OES from the release databases. Since this may be an underestimation, EPA assessed a bounding estimate of 11,194 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this OES. The next step is the identification of relevant SOC codes within the BLS data for the 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 A includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 326100 – Plastics Product Manufacturing; and

- 325199 – All Other Basic Organic Chemical Manufacturing.

Table 8-28 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.2.2.

Table 8-28. Estimated Average Number of Workers per Site Potentially Exposed to *p*-Dichlorobenzene During Plastics Converting

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site[a]	Potentially Exposed ONUs per Site[a]
11,194	326100 – Plastics Product Manufacturing	47	7
	325199 – All Other Basic Organic Chemical Manufacturing		

[a] Number of workers and ONUs per site calculated by dividing the exposed number of workers or ONUs by the number of establishments.

8.2.7.3 Occupational Inhalation Exposure Results

Occupational inhalation data for *p*-dichlorobenzene during plastics converting were assessed using inhalation exposure estimates from the plastics compounding OES as analogous as the processes are expected to include activities that generate similar levels of worker exposure, such as mixing and extrusion of plastic materials. The inhalation estimates for plastics compounding were assessed using a data submission from the ACC Consortium, which includes compounding of polymers containing *p*-dichlorobenzene (ACC, 2023). EPA estimated inhalation exposures using 7 worker full-shift PBZ samples (durations between 681–690 minutes) and 22 ONU PBZ samples (durations between 595–745 minutes).

All collected samples (12-hour TWA) reported non-detects for *p*-dichlorobenzene (LOD 0.026 ppm for workers and ranged from 0.0041–0.03 ppm for ONUs). Because of this, EPA assessed the LOD and half the LOD as the high-end and central tendency TWA exposure concentrations, respectively (ACC, 2023). This method may result in ONU exposure estimates with higher estimated exposures due to the difference in reported LODs.

Using these 12-hour TWA exposure concentrations, EPA calculated the AC, IADC, and ADC as described in Appendix L. The results of these calculations are shown in Table 8-29.

Table 8-29. Summary of Inhalation 12-Hour TWA Exposure to *p*-Dichlorobenzene During Plastics Converting

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Extrusion Operators	12-Hour TWA exposure concentrations	1.3E−02	2.6E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.3E−02	2.7E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	6.5E−03	1.3E−02
	Average daily concentration (ADC) based on 12-hour TWA	6.1E−03	1.2E−02
ONU	12-Hour TWA exposure concentrations	1.5E−02	3.0E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.5E−02	3.1E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	7.5E−03	1.5E−02
	Average daily concentration (ADC) based on 12-hour TWA	7.0E−03	1.4E−02

8.2.7.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using a stochastic Monte Carlo simulation with 100,000 iterations. The Agency modeled dermal exposure using a fraction absorbed value of 0.02 for *p*-dichlorobenzene as a solid in an article and followed the processes discussed in Section 8.1.4 and Appendix M. The fraction absorbed value of 0.02 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more information). The study indicated that an estimate of 0.02 (or 2%) absorption should apply to all formulations with a less than 50% concentration of *p*-dichlorobenzene. The concentration evaluated for this dermal exposure is 0.01% based on the data provided by ACC (Charles River Laboratories, 2025).

Table 8-30 summarizes the APDR, AAD, $ADD_{intermediate}$, and CAD (non-cancer) for *p*-dichlorobenzene during plastics converting. The high-end exposures are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. The SEGs included in the "Average Adult Worker" category include operators that work on compounding/converting tasks. ONUs include employees who do not directly handle the chemical but may come into contact with dust that settles on surfaces in the process area. For this reason, ONU dermal exposure to *p*-dichlorobenzene as a solid is assessed using central tendency values for worker exposure. OES-specific parameters for dermal exposures are described in Appendix M.

Table 8-30. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene for Plastics Converting

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	1.1E−03	1.8E−03
	Acute absorbed dose (AAD) (mg/kg-day)	1.3E−05	2.3E−05
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	9.7E−06	1.7E−05
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	6.1E−06	1.1E−05
ONU	Acute potential dose rate (APDR) (mg/day)	1.7E−04	2.2E−04
	Acute absorbed dose (AAD) (mg/kg-day)	2.2E−06	2.8E−06
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	1.6E−06	2.0E−06
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	1.0E−06	1.3E−06

8.2.7.5 Exposure Controls and PPE

The data provided by the ACC Consortium describes the following PPE for extrusion operators: Hard hat, safety glasses, gloves, steel toe shoes, and hearing protection. Workers also wear chemically resistant gloves with specific application training, which ACC reports equates to a protection factor of 20 (ACC, 2023). See *Draft Occupational Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026v) for more information about protection factors.

8.2.8 Incorporation into Abrasive Grinding Wheels

As listed in Table 4-1, this OES includes the following COU subcategory within the CO category of Processing – Incorporation into article: Other.

8.2.8.1 Worker Activities

EPA gathered information from OSHA CEHD pertaining to the incorporation of *p*-dichlorobenzene into abrasive grinding wheels. Two facilities (Bay State Abrasives Inc. and Norton Company) provided data for worker inhalation exposure (OSHA, 2019). EPA expects *p*-dichlorobenzene to be incorporated into grinding wheels as a pore producing material (ECHA, 2004). Workers are employees that are expected to directly handle *p*-dichlorobenzene or *p*-dichlorobenzene containing materials. ONUs include employees who work in the process area/room in the vicinity of chemical-related activities and may be indirectly exposed to the chemical as part of their employment. Worker exposure to *p*-dichlorobenzene may occur via inhalation of particulates or vapors as well as dermal contact to solids during container cleaning and unloading, equipment cleaning, material handling, mixing, and packaging.

As OSHA CEHD data does not include worker descriptions to allow for more granular insight into the types of tasks being conducted during this use, EPA evaluated the data for two SEGs, Average Adult Worker and ONU. Since ONU data were not specified, it was assumed that worker central tendency exposure was representative of ONU exposure and used to generate estimates for ONUs. The "Average Adult Worker" category includes employees directly handling *p*-dichlorobenzene during the production of abrasive grinding wheels. ONUs include employees who do not directly handle the chemical but may inhale dust from process operations.

See Section 4.3.8.1 for a full incorporation into abrasive grinding materials reactant process description.

8.2.8.2 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 *p*-dichlorobenzene during incorporation into abrasive grinding wheels (U.S. BLS, 2023a; U.S. Census Bureau, 2017). This approach involved first identifying the relevant NAICS codes for the OES. EPA did not identify any OES-specific data for the number of sites that incorporate *p*-dichlorobenzene into abrasive grinding wheels. Therefore, EPA assessed a bounding estimate of 3,894 sites for this OES based on the number of sites listed under the identified NAICS codes, representing a maximum number of theoretical sites using *p*-dichlorobenzene. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this OES. The next step is the identification of relevant SOC codes within the BLS data for the NAICS codes. This number is divided by the number of sites identified to obtain the exposed workers per site. Appendix J includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 327910 – Abrasive Product Manufacturing; and
- 332999 – All Other Miscellaneous Fabricated Metal Product Manufacturing

Table 8-31 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.2.2.

Table 8-31. Estimated Average Number of Workers per Site Potentially Exposed to *p*-Dichlorobenzene During Incorporation into Abrasive Grinding Wheels

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site[a]	Potentially Exposed ONUs per Site[a]
3,894	327910 – Abrasive Product Manufacturing	6	2
	332999 – All Other Miscellaneous Fabricated Metal Product Manufacturing		

[a] Number of workers and ONUs per site are calculated by dividing the exposed number of workers or ONUs by the number of establishments.

8.2.8.3 Occupational Inhalation Exposure Results

Occupational inhalation data for *p*-dichlorobenzene during incorporation into abrasive grinding wheels were provided via OSHA CEHD data (OSHA, 2019). EPA estimated inhalation exposures using 4 worker full-shift PBZ samples taken in June and July 1985 from two sites under the SIC code 3291 – Manufacture of Abrasive Products.

From this monitoring data, EPA calculated the 50th percentile and maximum 8-hour TWA concentrations representing the central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. Using these 8-hour TWA exposure concentrations, EPA calculated the AC, IADC, and ADC as described in Appendix L. In absence of data specific to ONU exposure, the Agency assumed that worker central tendency exposure was representative of ONU exposure and used to generate estimates for ONUs. The results of these calculations are shown in Table 8-32.

Table 8-32. Inhalation Exposures to *p*-Dichlorobenzene During Incorporation into Abrasive Grinding Wheels

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Average Adult Worker	8-Hour TWA exposure concentrations	2.1	4.9
	Acute exposure concentrations (AC) based on 8-hour TWA	1.4	3.3
	Intermediate average daily concentration (IADC) based on 8-hour TWA	1.0	2.4
	Average daily concentration (ADC) based on 8-hour TWA	0.98	2.3
ONU	8-Hour TWA exposure concentrations	2.1	
	Acute exposure concentrations (AC) based on 8-hour TWA	1.4	
	Intermediate average daily concentration (IADC) based on 8-hour TWA	1.0	
	Average daily concentration (ADC) based on 8-hour TWA	0.98	

8.2.8.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using a Monte Carlo simulation with 100,000 iterations. The Agency modeled dermal exposure using a fraction absorbed value of 0.04 for *p*-dichlorobenzene as a solid powder following the processes discussed in Section 8.1.4 and Appendix M. The fraction absorbed value of 0.04 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more information). The study indicated that an estimate of 0.04 (or 4%) absorption should apply to all formulations with a greater than 50% concentration of *p*-dichlorobenzene. Due to a lack of chemical specific information, EPA assumed workers may be receiving the chemical in its pure solid form, and thus be exposed, via dermal contact, to *p*-dichlorobenzene up to 100%.

Table 8-33 summarizes the APDR, AAD, $ADD_{intermediate}$, and CAD (non-cancer) for *p*-dichlorobenzene during incorporation into abrasive grinding wheels. The high-end exposures are the 95th percentiles of the respective simulation output, and the central tendency exposures are the 50th percentiles. ONUs include employees who do not directly handle the chemical but may come into contact with dust that settles on surfaces in the process area. OES-specific parameters for dermal exposures are described in Appendix M.

Table 8-33. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene for Incorporation into Abrasive Grinding Wheels

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	64.0	135
	Acute absorbed dose (AAD) (mg/kg-day)	0.80	1.7
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	0.59	1.2
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	0.55	1.2
ONU	Acute potential dose rate (APDR) (mg/day)	6.7	8.8
	Acute absorbed dose (AAD) (mg/kg-day)	8.3E−02	0.11
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	6.1E−02	8.1E−02
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	5.7E−02	7.5E−02

8.2.8.5 Exposure Controls and PPE

No engineering controls or documented PPE were available from the data.

8.2.9 Use in Functional Fluids

As listed in Table 4-1, this OES includes the following COU: Functional fluids (closed systems).

8.2.9.1 Worker Activities

Worker activities during use of functional fluids containing *p*-dichlorobenzene were evaluated based on worker exposure data provided by the ACC Consortium for sites that process *p*-dichlorobenzene. Worker inhalation samples were taken from these data sets for workers performing activities such as disconnecting/connecting chemical transfer lines, or packing/unpacking shipping containers of *p*-dichlorobenzene-containing materials, which EPA assumed are the primary activities that may lead to exposures during use of functional fluid in a closed system. These data points were analyzed and used as analogous data for sites that use *p*-dichlorobenzene in functional fluids (ACC, 2023). See Table 4-1 and Section 4.3.10.1 for a full functional fluids process description.

ACC included job titles and brief worker activity descriptions; which EPA used to group the data into two SEGs: "workers" and "ONUs". All workers performed material loading and unloading, disconnecting, or connecting railcars. ONUs were listed as "ONU" in the ACC data (Charles River Laboratories, 2025). Activities associated with each SEG are provided below:

- Workers – Inhalation of vapors and dermal contact with liquids during container unloading, container cleaning, equipment cleaning, or loading of repackaged containers.
- ONUs – Inhalation of vapors while in an area where the chemical is present.

8.2.9.2 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 *p*-dichlorobenzene during use in functional fluids processes (U.S. BLS, 2023a; U.S. Census Bureau, 2017). This approach involved first identifying the relevant NAICS codes for the OES. EPA identified only one facility relevant to this OES from the releases databases. Since this may be an underestimation, EPA assessed a bounding estimate of 841 sites for this OES based on the number of sites listed under the identified NAICS code. Using a bounding estimate will likely

overestimate the true number of sites that use *p*-dichlorobenzene for this 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 J 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

Table 8-34 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.2.2.

Table 8-34. Estimated Average Number of Workers per Site Potentially Exposed to *p*-Dichlorobenzene During Use of Functional Fluids

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site[a]	Potentially Exposed ONUs per Site[a]
841	333415 – Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	74	18
[a] Number of workers and ONUs per site calculated by dividing the exposed number of workers or ONUs by the number of establishments.			

8.2.9.3 Occupational Inhalation Exposure Results

EPA did not find occupational exposure data directly relevant to this OES. EPA estimated the inhalation exposure due to this OES using loading and unloading exposure data from the ACC Consortium dataset. Exposure data from loading and unloading tasks were chosen for this OES because it is assumed that a majority of exposure from this OES would come from the loading and unloading of the chemical as it is put into and removed from the system. ACC's dataset was chosen due to the matching physical state; this OES has *p*-dichlorobenzene in a liquid form, and the processes at the ACC Consortium facilities also handle liquid *p*-dichlorobenzene. The ACC Consortium data was preferred over liquid loading and unloading test order data from Westlake due to the possibility for higher concentrations (≈25%) of *p*-dichlorobenzene within the functional fluid.

The data used in this assessment included worker job titles and activity descriptions that matched activities relevant to this OES. In total, the data provided by ACC included 74 full-shift worker PBZ air samples taken between September and October 2024 and 31 occupational task-based worker PBZ air samples. Of these, 16 full-shift samples (five 10-hour TWAs and eleven 12-hour TWAs) and 22 task-based samples were deemed to be relevant and were included in this OES. These exposure data came from two processing sites (ACC, 2023).

For 12-hour TWA concentrations for workers, the ACC Consortium data only contained five samples with zero non-detects, and durations between 648 to 712 minutes. For this subset of data, the median and maximum were used to represent a central tendency and high-end estimate, respectively. However, all 11 ONU samples (10- and 12-hour full shift) were reported non-detects for *p*-dichlorobenzene, with the LOD ranging from 0.0041 to 0.026 ppm and sample durations between 626 to 712 minutes. Because of this, EPA assessed the LOD as the high-end and half the LOD as the central tendency TWA exposure

concentrations. Task-based samples had concentrations that ranged between 0.9 to 10.2 ppm with durations between 14 to 55 minutes (ACC, 2023).

Using these 10- and 12-hour TWA estimates, EPA calculated the AC, IADC, and ADC as described in Appendix K. The results of these calculations are shown in Table 8-35 below.

Table 8-35. Summary of Worker Inhalation 10- and 12-Hour TWA Exposure to *p*-Dichlorobenzene for Functional Fluids (Closed System)

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Average Adult Worker – 12-hour TWA	12-Hour TWA exposure concentrations	1.5E−02	0.38
	Acute exposure concentrations (AC) based on 12-hour TWA	1.5E−02	0.39
	Intermediate average daily concentration (IADC) based on 12-hour TWA	5.1E−04	1.3E−02
	Average daily concentration (ADC) based on 12-hour TWA	2.5E−04	1.3E−02
ONU – 10-hour TWA	10-Hour TWA exposure concentrations	1.3E−02	2.6E−02
	Acute exposure concentrations (AC) based on 10-hour TWA	1.1E−02	2.2E−02
	Intermediate average daily concentration (IADC) based on 10-hour TWA	6.5E−03	1.3E−02
	Average daily concentration (ADC) based on 10-hour TWA	6.1E−03	1.2E−02
ONU – 12-hour TWA	12-Hour TWA exposure concentrations	2.4E−03	4.7E−03
	Acute exposure concentrations (AC) based on 12-hour TWA	2.4E−03	4.8E−03
	Intermediate average daily concentration (IADC) based on 12-hour TWA	8.2E−05	1.6E−04
	Average daily concentration (ADC) based on 12-hour TWA	4.0E−05	1.6E−04

8.2.9.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using a Monte Carlo simulation with 100,000 iterations. The Agency modeled dermal exposure using a fraction absorbed value of 0.02 for *p*-dichlorobenzene as a liquid and followed the processes discussed in Section 8.1.4. The fraction absorbed value of 0.02 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more information). The study indicated that an estimate of 0.02 (or 2%) absorption should apply to all formulations with a less than 50% concentration of *p*-dichlorobenzene. The concentration evaluated for this dermal exposure is 25%, per company correspondence (U.S. EPA, 2026aa).

Table 8-36 summarizes the APDR, AAD, $ADD_{intermediate}$, and CAD (non-cancer) for *p*-dichlorobenzene in functional fluids (closed system). The high-end exposures are the 95th percentiles of the respective simulation output, and the central tendency exposures are the 50th percentiles. The SEG represented by the "Average Adult Worker" was the Material Handler SEG, as defined in the ACC Consortium data. Dermal exposures for ONUs are expected to be negligible as they do not directly handle the chemical. OES-specific parameters for dermal exposures are described in Appendix M.

Table 8-36. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene for Functional Fluids (Closed System)

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	3.4	8.4
	Acute absorbed dose (AAD) (mg/kg-day)	4.3E−02	0.11
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	7.8E−03	2.6E−02
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	6.5E−04	2.2E−03

8.2.9.5 Exposure Controls and PPE

The exposure data provided by ACC described the following PPE for material handlers, which is the SEG that was used as analogous in this assessment: flame resistant clothing, chemical resistant jacket, safety glasses, face shield, steel toe shoes, gloves, hearing protection. ACC also reports that workers wear chemically resistant gloves with specific application training, which ACC reports equates to a protection factor of 20 (ACC, 2023). See *Risk Calculator for Occupational Exposures for* p-*Dichlorobenzene* (U.S. EPA, 2026v) for more information about protection factors.

8.2.10 Use in Solid Air Care Products

As listed in Table 4-1, this OES includes the following COU: Air care products

8.2.10.1 Worker Activities

EPA conducted a quantitative analysis of commercial workers in public spaces that handle urinal cakes containing *p*-dichlorobenzene. Worker exposures to *p*-dichlorobenzene are primarily expected to occur via the inhalation route from installation of urinal cakes and toilet deodorizers and inhalation of vapors during the cleaning of bathrooms during shifts. The magnitude of inhalation exposure depends upon the concentration of *p*-dichlorobenzene in the product, worker activity patterns (including frequency and duration of shifts) and product application methods. EPA's assumptions for these parameters are described in Section 8.2.10.3.1.

8.2.10.2 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 *p*-dichlorobenzene during use of solid air care products (U.S. BLS, 2023a; U.S. Census Bureau, 2017). This approach involved first identifying the relevant NAICS codes for the OES. EPA didn't identify OES-specific data for the number of sites that use *p*-dichlorobenzene in solid air care products. Therefore, EPA assessed a bounding estimate of 69,698 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this 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 A includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 561720 – Janitorial Services;
- 424690 – Other Chemical and Allied Products Merchant Wholesalers

Table 8-37 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.2.2.

Table 8-37. Estimated Average Number of Workers per Site Potentially Exposed to *p*-Dichlorobenzene During Use in Solid Air Care Products

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site[a]	Potentially Exposed ONUs per Site[a]
69,698	561720 – Janitorial Services	1	1
	424690 – Other Chemical and Allied Products Merchant Wholesalers		

[a] Number of workers and ONUs per site calculated by dividing the exposed number of workers or ONUs by the number of establishments.

8.2.10.3 Occupational Inhalation Exposure Results

IECCU Version 1.1 (U.S. EPA, 2019c) was selected to model worker inhalation exposures to *p*-dichlorobenzene for the use of the toilet bowl deodorizer products, in line with the consumer exposure assessment for toilet bowl deodorizer products. For more information and details on the model, see the user guide.[12]

As a conservative assumption, EPA selected to model a worker whose job is to clean a single bathroom during an entire 8-hour shift, such as at a large venue. Due to the availability of bathroom statistics at airports (number of toilets per concourse), EPA selected an airport as the venue and created a low- and high- exposure intensity scenario based on assumptions for a mid-size and large-size airport. As national level statistics on airport building characteristics are not available, EPA developed inputs based on a concourse from a sample mid-size airport (Raleigh-Durham International – Terminal 2) for the low exposure scenario and a sample large size airport (Denver International) for the high exposure scenario. The model inputs and results are described below.

8.2.10.3.1 Model Inputs

Source Model and Emission Inputs

EPA used the same emission profile as used for consumer exposure assessment for toilet bowl deodorizer in residential homes. Briefly, EPA used an exponential decay function fit to experimental data for a solid toilet bowl deodorizer product containing 99% or more *p*-dichlorobenzene (Guerrero and Corsi, 2012). The function was optimized until the total amount emitted did not exceed the original mass of the product and the difference between the experimental and modeled average emission across the first three days was minimized. Correspondently, the First-Order decay empirical model was selected in IECCU, using an initial emission rate (E_o) of 500 mg/h or 5.00×10^5 µg/h and a decay constant (k) of 0.00471 h^{-1} (based on 4% of product remaining after 30 days). The source area was set to 1 m^2 as it is not a necessary input because the total mass of chemical in the test product is assumed to be the same as the modeled product. As mass of product is not a parameter of the first-order decay model equation, the direct IEECU outputs represent the use of one toilet bowl deodorizer product (in a toilet or urinal fixture) in the bathroom. Outside of IECCU in a spreadsheet, the direct IECCU outputs were adjusted for use of multiple toilet bowl deodorizer products in a restroom, along with adjustments for the worker activity pattern. Refer to Section 8.2.10.3.2 for a description of these adjustments.

Air Zone Volume and Ventilation

The scenarios were modeled using two-zones, where zone 1 represents a single restroom in the airport concourse and zone 2 represents the rest of the airport concourse associated with a set of restrooms (men's and women's). This approach of modeling a concourse segment was selected for ease of

[12] https://www.epa.gov/tsca-screening-tools/users-guide-and-download-ieccu-indoor-environmental-concentrations-buildings (accessed June 17, 2026)

modeling due to the availability of data supporting assumptions and to simplify unknown airflow dynamics in extremely large commercial buildings. EPA notes an airport is not a worst-case scenario when considering the large size of a terminal, high air-exchange rate of bathrooms, and standardized density of bathrooms. Exposures would likely be higher for smaller commercial buildings or with more toilets per bathroom (*e.g.,* an arena or stadium).

Based on data from the sample airports and other assumptions, the zone volumes and ventilation parameters used in modeling are shown in Table 8-38. Derivation of these inputs is described below the table.

Table 8-38. Air Zone Volume and Ventilation Inputs for IECCU – Commercial Toilet Bowl Deodorizers

Scenario	Zone 1 Volume (m^3)	Zone 2 Volume (m^3)	Air Exchange Flow Rate for Zone 0–1 (m^3/h)	Air Exchange Flow Rate for Zone 0–2 (m^3/h)	Air Exchange Flow Rate for Zone 1–2 (m^3/h)
Mid-Size Airport	235	18,997	353	28,496	1,189
Large Airport	336	31,043	504	46,564	2,379

Restroom Volume (Number of Fixtures and Floor Area Per Fixture)

The volume of the restroom (Zone 1), 235 m^3 for the low exposure scenario and 336 m^3 for the high exposure scenario, was derived using an assumed number of fixtures (toilets or urinals) per bathroom, assumed area of floor space per fixture, and assumed ceiling height.

Number of Fixtures: The number of fixtures was set to 10 and 20 for the low and high exposure scenarios, respectively, based on information obtained from the Airport Passenger Terminal Planning and Design, Volume I Guidebook (https://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_025v1.pdf) which recommends a minimum of 10 to 12 fixture (toilets and urinals) per sex in each restroom for domestic O&D airport concourses and 15 to 20 fixtures for concourses with domestic hubbing.

Area Per Fixture: The floor space per fixture was assumed to be 70 ft^2 for the low exposure scenario based on the Airport Passenger Terminal Planning and Design, Volume I Guidebook which states that a typical restroom module of 10 to 12 fixtures/sex (including a companion care restroom and janitor closet) will average 60 to 70 ft^2. For the high exposure level, the area per fixture was assumed to be 50 ft^2 based on professional judgement considering the minimum area needed for a stall, sink, and circulation. This area approximately corresponds to ADA requirements.

Height: The ceiling height was assumed to be 12 ft, the typical height of ceilings for some types of commercial buildings according to EFH (2018), Chapter 19.

Terminal Volume

Zone 2 volumes, 18,997 m^3 for the low exposure scenario and 31,043 m^3 for the high exposure scenario, were derived from concourse dimensions associated with one bathroom set.

Length: First the number of bathroom sets in the whole concourse was determined from airport specific concourse maps (8 for both airports). Then the total length of the concourse was measured using Google Earth (2,175 ft for the mid-size airport and 3,175 ft for the large size airport). With these values, the linear feet of concourse per bathroom set was determined to be 275 ft for the mid-size airport and 400 ft for the large size airport.

Width: The width of the concourse was also measured from Google Earth; 275 ft for the mid-size airport and 141 ft for the large size airport.

Height: The airport-specific heights were not available, thus the ceiling height was assumed to be 20 ft, the typical height of ceilings for warehouses and enclosed malls according to EFH (2018), Chapter 19.

The length, width, and heights were multiplied to obtain the total concourse volume for a restroom set. These values were then adjusted to Zone 2 only volumes by subtracting out the volume of two restrooms (one for men's and one for women's). For contextual purposes, the total concourse values were calculated as 271,875 ft^2 and 468,095 ft^2 and correspond to 4.5 to 4.75 gates per bathroom sets, respectively, for the mid-size and large-size airports.

Air Exchange Flow Rates

Air exchange flow rates (m^3/h) from the outside (Zone 0) to Zone 1 and from Zone 0 to Zone 2 are calculated from an indoor air change rate of 1.5 per hour for commercial buildings (EFH, Chapter 19) and the corresponding Zone 1 and Zone 2 volumes discussed above.

Air exchange flow rates (m^3/h) between Zone 1 and Zone 2 are not available for an airport scenario which has a large Zone 2 volume. Therefore, EPA assumed a bathroom exhaust rate of 70 cubic feet per minute per fixture, based on recommended exhaust rates for heavy use areas.

Simulation Conditions

IECCU was set to run a duration of 5,000 hours (6 months) and for 5,000 data points. This produces a time series of concentrations at 1-hour intervals which is sufficient to evaluate product use over the 30-day period (the length of time which the toilet bowl deodorizer is expected to last before fully sublimating).

8.2.10.3.2 Exposure Calculations

Outside of IECCU, the resulting zone concentrations were scaled to reflect the number of bathrooms per concourse segment and the amount of product used in the bathroom. These adjustments were possible by scaling because mass of chemical has a linear relationship in the modeling equations. Additionally, a time series of concentrations for the worker over the 30-day exposure period was produced by simulating the worker's activity pattern. These adjustments are described below.

Number of Restrooms Per Concourse Segment

Zone 2 concentration from the IECCU modeling reflects only the presence of one restroom as the worker will only be present in one restroom during the work-shift. The Zone 2 concentrations were scaled up by two to reflect the presence of a men's and women's restroom in a concourse segment.

Worker Activity Pattern

The modeling was conducted assuming an 8-hour work shift for 5 days in a row, followed by two days off work. This pattern was repeated for 30 days. For the 8-hour work shift it was assumed that worker would be in the bathroom for 3 hours (Zone 1), the rest of the terminal for 1 hour (Zone 2), and finally in the bathroom for another 4 hours (Zone 1).

Amount of Product Per Restroom

As concentrations from IECCU are for one product, the worker concentrations were scaled up to reflect 10 products (one per fixture) in the low exposure scenario and 20 products (1 per fixture) in the high exposure scenario.

8.2.10.3.3 Results

The acute exposure concentrations were calculated as a maximum 24-hr average based on the modeled worker concentrations in the first 30 days of exposure. The 24-hour average is 0.97 mg/m^3 for the low exposure scenario (mid-size airport) and 0.97 mg/m^3 for the high exposure scenario (large size airport).

The chronic exposure concentrations were calculated as a 30-day average based on the modeled worker concentration in the first 30 days of exposure. The 30-day average is 0.24 mg/m^3 for the low exposure scenario (mid-size airport) and 0.26 mg/m^3 for the high exposure scenario (large size airport).

For detailed outputs and concentrations, see *Draft Commercial Inhalation and Dermal Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026q).

Table 8-39. Air Exchange Flow Rates (m^3/h) to and from Different Zones

	To Zone 1	To Zone 2
From Zone 0 (ambient environment)	769.5	7,084.5
From Zone 1 (restroom)	N/A	2,564.6
From Zone 2 (rest of airport terminal)	2,564.6	N/A

Generally, the "First-order decay" model within IECCU was selected as the appropriate model to determine the decay rate of the *p*-dichlorobenzene emission rate from toilet bowl deodorizers. The initial emission factor, toilet bowl deodorizer source area, and first order decay constant were assumed to be the same as the consumer product. See the user guide for more information on the first-order decay equation and input information (U.S. EPA, 2019c).

Since the IECCU outputs for one toilet bowl deodorizer, the concentration in Zone 1 was multiplied by 10 or 20 to represent an airport terminal bathroom with multiple toilets with each toilet containing one toilet bowl deodorizer.

Table 8-40. Inhalation Acute and Chronic Exposure Concentrations for Airport Commercial Scenarios

Exposure Intensity	Acute		Chronic	
	Exposure Metric	Exposure Concentration (mg/m^3)	Exposure Metric	Exposure Concentration (mg/m^3)
Low	Max 24-hour TWA	0.97	30-day TWA	0.24
High		1.05		0.26
Low = Midsize airport, 10 toilets/bathroom High = Large airport, 20 toilets/bathroom				

8.2.10.4 Occupational Dermal Exposure Results

EPA obtained the occupational dermal exposure estimates by using the same permeability equation described in Section 7.1.5.2 as consumer dermal exposure as for occupational. The inputs are the same also, except for frequency of events. For acute, the frequency of events is 600 and for chronic is 1200 times a year. Calculations were made for workers aged 21 and older. The dermal dose rates for acute exposure range from 0.28 mg/kg/day to 29.1 mg/kg/day and 9.21×10^{-3} mg/kg/day to 0.952 mg/kg/day to for chronic. See Table 8-41 for all acute and chronic doses for all exposure scenarios.

Table 8-41. Dermal Exposure Results for Commercial Use of Solid Air Care Products

Surface Area	Urinal Cakes Placed per Month	Time Holding Urinal Cake	Acute Exposure Dose mg/kg/day	Intermediate/Chronic Exposure Dose mg/kg/day
Inside both hands	50	5 min	1.45E1	4.78E−01
Inside 1 hand	50	5 min	7.27E0	2.39E−01
Two fingers	50	5 min	2.81E0	9.25E−02
Inside both hands	50	1 min	2.96E0	9.75E−02
Inside 1 hand	50	1 min	1.48E0	4.87E−02
Two fingers	50	1 min	5.74E−01	1.89E−02
Inside both hands	50	30 sec	1.45E0	4.76E−02
Inside 1 hand	50	30 sec	7.24E−01	2.38E−02
Two fingers	50	30 sec	2.80E−01	9.21E−03
Inside both hands	100	5 min	2.91E1	9.52E−01
Inside both hands	100	5 min	1.45E1	4.76E−01
Two fingers	100	5 min	5.63E0	1.84E−01
Inside both hands	100	1 min	5.93E0	1.95E−01
Inside both hands	100	1 min	2.96E0	9.75E−02
Two fingers	100	1 min	1.15E0	3.77E−02
Inside both hands	100	30 sec	2.89E0	9.52E−02
Inside both hands	100	30 sec	1.45E0	4.76E−02
Two fingers	100	30 sec	5.60E−01	1.84E−02

EPA conducted an alternate approach, where it was assumed that *p*-dichlorobenzene must first migrate into a thin film of moisture on the surface of the skin, and that solubility of *p*-dichlorobenzene by the moisture layer limits absorption. Equation 2-2 was used to determine the effective flux through the skin, where the chemical is assumed to migrate to an aqueous sweat layer. This equation is provided in the *Superfund Risk Assessment Guidance, Part E* (U.S. EPA, 2004c). It assumes the aqueous chemical is available for absorption.

Equation 8-1. Equation for Aqueous Transfer of Chemical When in Direct Contact with Article

$$DA = 2 \times SC \times K_p \times S_w \times \sqrt{\frac{6 \times t_{lag} \times Dur}{\pi}} \times SA$$

Where:

DA = Mass of chemical absorbed per event (mg/cm^2)
SC = Effect of the stratum corneum on quantity absorbed
K_p = Permeability coefficient (cm/h)
S_w = Water solubility (mg/L)

t_{lag} = Time for the chemical migration to reach equilibrium in the skin (h)
Dur = Average duration of each event (h/event)
SA = Surface area of skin being exposed (cm^2)

(U.S. EPA, 2004c) stipulates that Equation 8-1 is only relevant when t_{lag} (the time for the chemical to reach a steady flux through the stratum corneum) is much greater than the duration of the event. To estimate t_{lag}, a quantitative structure-activity relationship (QSAR) method is shown in Equation 8-2. It assumes the thickness of the stratum corneum is 10^{-3} cm (U.S. EPA, 2004c).

Equation 8-2. QSAR Equation to Determine Chemical Steady State Flux Lag Time

$$t_{lag} = 0.105 \times 10^{0.0056 \times MW}$$

Where:

t_lag = Lag time for chemical entering the stratum corneum
MW = Molecular weight of *p*-dichlorobenzene, 147 g/mol

The molecular weight (MW) of *p*-dichlorobenzene is 147 g/mol. The lag time is thus estimated to be 0.7 hours. EPA assumed the exposure duration for commercial exposure to the product is either 1 or 5 minutes per event. These durations of 0.017 hour and 0.083 hour respectively, are much lower than 0.7 hours. Equation 8-1 is therefore relevant for estimating aqueous transfer when in direct contact with the product.

Removal in the Stratum Corneum

The variable SC accounts for the fact that the stratum corneum cells regenerate approximately every 14 days. For long exposure times, a chemical in the stratum corneum can be removed due to sloughing and regeneration. Exhibit A-5 of the *Superfund Risk Assessment Guidance, Part E* (U.S. EPA, 2004c) with the PlotDigitizer.com digitizer was used to determine the fractional removal effect of the stratum corneum. Given the lag time, the fractional removal by the stratum corneum is 0.994. Thus, this variable has little to no impact for this COU.

Permeability Coefficient and Solubility

The permeability coefficient for aqueous absorption was estimated based on the value in Exhibit B-2 on page 113 of the RAGS document, which provides and estimated value of 4.2×10^{-2} cm/h (U.S. EPA, 2004c).

Duration

The duration of each event (placing the deodorizer into the urinal or toilet) is assumed to last 1 minute or 5 minutes.

Frequency of Events

For the commercial scenario, as in the main dermal analysis, EPA assumed that the commercial user deposits new toilet bowl deodorizers once per month in 5 bathrooms, where each bathroom had either 10 or 20 toilets. For this calculation, depositing of all deodorizers in a bathroom was considered 1 event. Therefore, duration in Equation 8-1 refers to the total duration for depositing deodorizers in every toilet within a single bathroom.

Surface Area of Body in Contact with the Article

For this scenario, three different surface areas were assumed to capture the full range. EPA assumed inside of both hands, inside one hand, and 10% of hand (to represent two fingers).

Table 8-42. Key Parameters Used to Model Dermal Uptake from Toilet Bowl Deodorizers in the Alternate Dermal Method

Article	Lag Time (hour)	Effect of Stratum Corneum	Permeability Coefficient (cm/h)	Solubility (mg/cm^3)	Duration of Each Event	Skin Contact Area
Toilet Bowl Deodorizer	0.7	0.99	4.20E−02	0.141	1 or 5 minutes	Inside of both hands Inside of 1 hand 10% of hand (to represent 2 fingers)

See Table 8-43 for all acute and chronic dermal doses for all exposure scenarios using the RAGS equation (U.S. EPA, 2004c). For acute, the frequency of events listed is 50 for the low-end and 100 urinal cakes placed per month for the high-end and for chronic is 600 for the low-end and 1200 times per year for the high-end. Calculations were made for workers aged 21 and older. The dermal dose rates for acute exposure range from 3.33×10^{-02} mg/kg/day to 0.054 mg/kg/day and 1.10×10^{-03} mg/kg/day to 1.79×10^{-02} mg/kg/day to for chronic.

In Equation 8-1, exposure duration is under a square root, so DA is not linear with duration. As a consequence, the results differ by several fold based on whether an "event" is considered the placing of all deodorizers in a single bathroom (*e.g.,* for 20 toilets in a bathroom, 5 min per cake, duration = 100 minutes, multiplied by the number of bathrooms [5] as independent events), as opposed to each toilet being counted as a single event (*e.g.,* duration = 5 min per event, multiplied by the total number of toilets [100] as independent events). The results for these two varying assumptions are presented below in Table 8-43 and Table 8-44. The estimated exposure doses differ by 3 to 4.5-fold (*i.e.,* $\sqrt{10}$ to $\sqrt{20}$) between the two assumptions. When also considering the uncertainty associated with the use of modeling estimates compared to the empirical results in Table 8-41 and that the RAGS equation was intended for dilute chemicals in aqueous solution, EPA determined that these modeled estimates are too uncertain for use in risk estimation.

Table 8-43. Exposure Results Using RAGS Dermal Commercial Exposure Scenarios for Solid Air Care Products (1 Event = 1 Bathroom)

Surface Area	Urinal Cakes Placed per Month	Time Holding Urinal Cake	Acute Exposure Dose (mg/kg/day)	Intermediate/Chronic Exposure Dose (mg/kg/day)
Inside both hands	100	5	5.44E−01	1.79E−02
Inside one hand	100	5	2.72E−01	8.95E−03
Two fingers	100	5	1.05E−01	3.46E−03
Inside both hands	100	1	2.43E−01	8.00E−03
Inside1 hand	100	1	1.22E−01	4.00E−03
Two fingers	100	1	4.71E−02	1.55E−03
Inside both hands	50	5	3.85E−01	1.27E−02
Inside 1 hand	50	5	1.92E−01	6.33E−03

Surface Area	Urinal Cakes Placed per Month	Time Holding Urinal Cake	Acute Exposure Dose (mg/kg/day)	Intermediate/Chronic Exposure Dose (mg/kg/day)
Two fingers	50	5	7.45E−02	2.45E−03
Inside both hands	50	1	1.72E−01	5.66E−03
Inside 1 hand	50	1	8.61E−02	2.83E−03
Two fingers	50	1	3.33E−02	1.10E−03

Table 8-44. Exposure Results Using RAGS Dermal Commercial Exposure Scenarios for Solid Air Care Products (1 Event = 1 Toilet)

Surface Area	Urinal Cakes Placed per Month	Time Holding Urinal Cake	Acute Exposure Dose (mg/kg/day)	Intermediate/Chronic Exposure Dose (mg/kg/day)
Inside both hands	100	5	2.43E0	8.00E−02
Inside 1 hand	100	5	1.22E0	4.00E−02
Two fingers	100	5	4.71E−01	1.55E−02
Inside both hands	100	1	1.09E0	3.58E−02
Inside 1 hand	100	1	5.44E−01	1.79E−02
Two fingers	100	1	2.11E−01	6.93E−03
Inside both hands	50	5	1.22E0	4.00E−02
Inside 1 hand	50	5	6.09E−01	2.00E−02
Two fingers	50	5	2.36E−01	7.74E−03
Inside both hands	50	1	5.44E−01	1.79E−02
Inside 1 hand	50	1	2.72E−01	8.95E−03
Two fingers	50	1	1.05E−01	3.46E−03

8.2.10.5 Exposure Controls and PPE

No engineering controls or documented PPE were available from the data. However, the product manufacturer recommends the user wear protective gloves/clothing (Willert Home Products, 2019).

8.2.11 Use of Lubricants and Greases

8.2.11.1 Worker Activities

EPA assumes that *p*-dichlorobenzene may be used in liquids or sprays that reduce friction, heat generation, and wear between surfaces after it has been incorporated into the product or mixture. EPA identified a single lubricant product for air-driven motors (Marvel Oil Company, 2017). Although the SDS indicates that *p*-dichlorobenzene is present in amount less than 0.1%, the company informed EPA in a public comment that the *p*-dichlorobenzene within this product exists only as a contaminant of *o*-

dichlorobenzene, which is present in the products at 0.12% (EPA-HQ-OPPT-2018-0446-0028). The comment states that there are no test results that indicate the presence of *p*-dichlorobenzene in the products, and it is included as a possible component out of an abundance of caution. EPA found no evidence from other sources of *p*-dichlorobenzene's presence in lubricants and greases. Thus, due to the low amounts of *p*-dichlorobenzene expected in these products, EPA has determined that releases and exposures due to this use are negligible.

8.2.11.2 Occupational Inhalation and Dermal Exposure Results

Occupational inhalation and dermal assessments were not conducted for this OES due to evidence that *p*-dichlorobenzene is present only in low, residual amounts. Therefore, occupational exposures are considered negligible. See Section 4.3.15.1 for additional details about this use.

8.2.12 Use of Fuels and Related Products

As listed in Table 4-1, this OES includes the following COU: Fuels and related products.

8.2.12.1 Worker Activities

CDR reported use of *p*-dichlorobenzene in consumer and commercial automotive care products. EPA has identified a single fuel additive product that contains *p*-dichlorobenzene, and it contains less than 0.1% by weight of *p*-dichlorobenzene, as per its SDS (Marvel Oil Company, 2017). Although the SDS indicates that *p*-dichlorobenzene is present in amount less than 0.1%, the manufacturer informed EPA in a public comment that the *p*-dichlorobenzene within this product exists only as a contaminant of *o*-dichlorobenzene, which is present in the products at 0.12% (EPA-HQ-OPPT-2018-0446-0028). The comment expresses that there are no test results that indicate the presence of *p*-dichlorobenzene in the product, and it is included as a possible component out of an abundance of caution. EPA found no evidence from other sources of *p*-dichlorobenzene's presence in fuels and related products, and so due to the low amounts of *p*-dichlorobenzene expected in these products, EPA has determined that releases and exposures due to this use are negligible.

8.2.12.2 Occupational Inhalation and Dermal Exposure Results

Occupational inhalation and dermal assessments were not conducted for this OES due to evidence that *p*-dichlorobenzene is present only in low, residual amounts. Therefore, occupational exposures are considered negligible. See Section 4.3.15.1 for additional details about this use.

8.2.13 Use of Laboratory Chemicals

As listed in Table 4-1, this OES includes the following COU: Other Use – Laboratory Chemicals.

8.2.13.1 Worker Activities

EPA identified several SDSs that indicate that *p*-dichlorobenzene is used as a laboratory chemical in solution or in solid form (Sigma Aldrich, 2025; Supelco, 2026). Westlake Corporation documents laboratory technician worker activities such as preparing and running samples for gas chromatography/mass spectrometry, collecting samples from the cooling tower, and spiking samples (Exponent, 2024). ACC documents laboratory technician worker activities as sample preparation and analysis (ACC, 2023). Worker exposures to *p*-dichlorobenzene may occur through the inhalation of solid particulates or vapor, and dermal contact with solids or liquids during the worker activities described by Westlake Corporation and ACC above (U.S. EPA, 2023d).

Test order data submitted by Westlake Corporation and the ACC Consortium include inhalation exposure data for the Laboratory Technicians SEG (Exponent, 2024; ACC, 2023).

ONUs include supervisors, managers, and workers present in the laboratory but do not directly handle *p*-dichlorobenzene. Therefore, EPA expects ONUs to have lower inhalation exposures than workers who handle *p*-dichlorobenzene as a laboratory chemical and no expected dermal exposure to liquid *p*-dichlorobenzene.

See Section 4.3.12.1 for a full use of laboratory chemicals process description.

8.2.13.2 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 *p*-dichlorobenzene during use of laboratory chemicals (U.S. BLS, 2023a; U.S. Census Bureau, 2017). This approach involved first identifying the relevant NAICS codes for the OES. EPA identified only two facilities from the release databases that use *p*-dichlorobenzene in laboratory chemicals. Since this may be an underestimation, EPA assessed a bounding estimate of 10,490 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this 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 J includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 541380 – Testing Laboratories; and
- 541714 – Research and Development in Biotechnology (except Nanobiotechnology).

Table 8-45 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.2.2.

Table 8-45. Estimated Average Number of Workers per Site Potentially Exposed to *p*-Dichlorobenzene During Use of Laboratory Chemicals

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site[a]	Potentially Exposed ONUs per Site[a]
10,490	541380 – Testing Laboratories; and 541714 – Research and Development in Biotechnology (except Nanobiotechnology)	3	7

[a] Number of workers and ONUs per site calculated by dividing the exposed number of workers or ONUs by the number of establishments.

8.2.13.3 Occupational Inhalation Exposure Results

For the assessment of exposures to *p*-dichlorobenzene vapors generated from the use of liquid *p*-dichlorobenzene, EPA used exposure data provided by ACC and Westlake Corporation in response to a test order. From the ACC Consortium report, the data included a worker job title of "Laboratory Technician" at two *p*-dichlorobenzene processing facilities, which EPA determined as relevant to this OES. As the data are for laboratory technicians in a processing setting, rather than a commercial setting, the representativeness of the dataset towards workers in a commercial setting is uncertain. In total, the data provided by ACC included nine full-shift worker PBZ air samples taken between September and October 2020. ACC data for laboratory technicians included both 8- and 12-hour TWAs. Per the data, some of the Laboratory Technician 8-hour TWAs list task durations as 0.5 hours, and one 8-hour TWA lists a task duration of 12 hours. EPA assumed that exposure profiles are the same such that 8-hour

TWAs are equal to 12-hour TWAs. The data provided from Westlake Corporation included nine full-shift samples (four 8- and five 12-hour TWAs) taken at one facility between April and July 2024 along with three occupational task-based worker PBZ air samples. Task based samples had concentrations that ranged between 0.043 to 1.1 ppm with durations between 14 to 353 minutes.

All full-shift samples were below the limit of detection (with LOD ranges of 0.0042 and 0.057 ppm) and were reported as non-detects for *p*-dichlorobenzene. Sample durations ranged between 312 to 705 minutes. Because of this, EPA assessed the LOD as the high-end and half the LOD as the central tendency TWA exposure concentrations (Exponent, 2024; ACC, 2023).

To estimate worker and ONU inhalation exposure to dust for the use of solid laboratory chemicals, EPA used the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* (U.S. EPA, 2021b) which estimates an 8-hour TWA for particulate concentrations by assuming exposures outside the sample duration are zero. The model does not determine exposures during individual worker activities. EPA used a subset of the model data that came from facilities with the NAICS code starting with 54 – Professional, Scientific, and Technical Services – to estimate *p*-dichlorobenzene-containing particulate concentrations in the air. EPA used the highest expected concentration of *p*-dichlorobenzene to estimate the concentration of *p*-dichlorobenzene in particulates. For the Use of laboratory chemicals OES, the highest expected concentration of *p*-dichlorobenzene is 100% by mass based on identified lab-grade chemicals in solid form. The estimated exposures assume that *p*-dichlorobenzene is present in particulates at this fixed concentration throughout the working shift.

For both vapor and dust exposures EPA used the number of operating days estimated in the release assessment for this OES to estimate exposure frequency, which is the expected maximum number of working days. EPA assessed the exposure frequency as 250 days/year (for 8-hour shifts) or 167 days/yr (for 12-hour shifts) for both high-end and central tendency exposures based on the expected operating days for the OES and accounting for off days for workers. In absence of data specific to ONU exposure, EPA assumed that worker central tendency exposure is representative of ONU exposure and was used to generate estimates for ONUs.

Using these 8-, and 12-hour TWA estimates, EPA calculated the AC, IADC, and ADC as described in Appendix K. The results of these calculations are shown in Table 8-46 and Table 8-47 below.

Table 8-46. 8-Hour Duration of Inhalation Exposures to *p*-Dichlorobenzene During Use in Lab Chemicals Based on the Westlake Corporation Test Order Data, Data Provided by ACC and PNOR Modeling

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Average Adult Worker (Liquid) – 8 hour TWA (Monitoring Data)	8-Hour TWA exposure concentrations	2.9E−02	5.7E−02
	Acute exposure concentrations (AC) based on 8-hour TWA	1.9E−02	3.9E−02
	Intermediate average daily concentration (IADC) based on 8-hour TWA	6.5E−04	1.3E−03
	Average daily concentration (ADC) based on 8-hour TWA	1.3E−02	2.7E−02
Average Adult Worker (Solid) – 8 hour TWA (PNOR Model)	8-Hour TWA exposure concentrations	3.2E−02	0.45
	Acute exposure concentrations (AC) based on 8-hour TWA	2.2E−02	0.31
	Intermediate average daily concentration (IADC) based on 8-hour TWA	1.6E−02	0.22
	Average daily concentration (ADC) based on 8-hour TWA	1.5E−02	0.21
ONU (Solid) – 8 hour TWA (PNOR Model)	8-Hour TWA exposure concentrations	3.2E−02	3.2E−02
	Acute exposure concentrations (AC) based on 8-hour TWA	2.2E−02	2.2E−02
	Intermediate average daily concentration (IADC) based on 8-hour TWA	1.6E−02	1.6E−02
	Average daily concentration (ADC) based on 8-hour TWA	1.5E−02	1.5E−02

Table 8-47. 12-Hour Duration of Inhalation Exposures to *p*-Dichlorobenzene During Use in Lab Chemicals Based on the Westlake Corporation Test Order Data

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High-End
Average Adult Worker (Liquid) – 12 hour TWA	12-Hour TWA exposure concentrations	1.2E−02	2.4E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.2E−02	2.4E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	6.0E−03	1.2E−02
	Average daily concentration (ADC) based on 12-hour TWA	5.6E−03	1.1E−02

8.2.13.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using a Monte Carlo simulation with 100,000 iterations.

For *p*-dichlorobenzene in a liquid formulation, the Agency modeled dermal exposure using a fraction absorbed value of 0.02 for *p*-dichlorobenzene and followed the processes discussed in Section 8.1.4 and Appendix M. The fraction absorbed value of 0.02 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more

information). The study indicated that an estimate of 0.02 (or 2%) absorption should apply to all formulations with a less than 50% concentration of *p*-dichlorobenzene. The concentration evaluated for this dermal exposure is represented as a triangular distribution with a lower bound of 0.002%, an upper bound of 1%, and a mode of 0.2% based on compiled SDS information for liquid lab chemical products containing *p*-dichlorobenzene. The lower and upper bounds represent the minimum and maximum reported concentrations in the SDSs. The mode represents the median of all range endpoints reported in the SDSs. The SDSs contributing to these values can be found in *Draft Dermal Modeling Results (liquid) for p-Dichlorobenzene* (U.S. EPA, 2026k).

For *p*-dichlorobenzene as a solid powder in the Use of laboratory chemicals OES, the Agency modeled dermal exposure using a fraction absorbed value of 0.04 and followed the processes discussed in Section 8.1.4 and Appendix M. The fraction absorbed value of 0.04 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more information). The study indicated that an estimate of 0.04 (or 4%) absorption should apply to all formulations with a greater than 50% concentration of *p*-dichlorobenzene. The concentration evaluated for this dermal exposure is represented as a static value of 100% based on an identified product SDS (Sigma Aldrich, 2025).

Table 8-48 and Table 8-46 summarize the APDR, AAD, $ADD_{intermediate}$, and CAD (non-cancer) for *p*-dichlorobenzene during the use of laboratory chemicals. Dermal exposures for ONUs are expected to be negligible for *p*-dichlorobenzene as a liquid as they do not directly handle the chemical. The high-end exposures are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. ONUs included in the assessment for *p*-dichlorobenzene as a solid include employees who do not directly handle the chemical but may come into contact with dust that settles on surfaces. For modeling ONU dermal exposures to solids, EPA changed the distribution for dermal load. Here, the worker distribution maximum was replaced by the mode to ensure a lesser exposure load. In addition, EPA used a static value of 268 cm^2 for surface area of dermal exposure, so there are no separate high end and central tendency estimates, only a single exposure estimate for ONUs. OES-specific parameters for dermal exposures are described in Appendix M.

Table 8-48. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene as a Liquid for Use of Laboratory Chemicals

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	4.3E−02	0.17
	Acute absorbed dose (AAD) (mg/kg-day)	5.4E−04	2.2E−03
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	4.0E−04	1.6E−03
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	3.0E−04	1.3E−03

Table 8-49. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene as a Solid for Use of Laboratory Chemicals

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	64	135
	Acute absorbed dose (AAD) (mg/kg-day)	0.80	1.7
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	0.59	1.2
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	0.44	1.0
ONU	Acute potential dose rate (APDR) (mg/day)	6.7	8.8
	Acute absorbed dose (AAD) (mg/kg-day)	8.3E−02	0.11
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	6.1E−02	8.1E−02
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	4.5E−02	7.4E−02

8.2.13.5 Exposure Controls and PPE

Westlake Corporation documented that laboratory technicians used PPE such as nitrile gloves, thermal gloves, safety glasses, face shields, fire resistant clothing, and boots for dermal protection. Westlake Corporation did not have records of respiratory protection for laboratory technicians. The ACC Consortium data provided information from two companies. Laboratory technicians used dermal PPE such as fire-resistant clothing, safety glasses, boots, gloves, and lab coats. Respiratory protection information was not provided.

8.2.14 Use of Adhesives and Sealants

8.2.14.1 Worker Activities

EPA conducted a quantitative analysis of commercial workers, such as contractors, that use foam sealant containing *p*-dichlorobenzene for large scale projects. Worker exposures to *p*-dichlorobenzene are primarily expected to occur via the inhalation and dermal routes from use of the product. The magnitude of inhalation exposure depends upon the concentration of *p*-dichlorobenzene in the product, worker activity patterns (including frequency and duration of work) and product application methods.

8.2.14.2 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 *p*-dichlorobenzene during use of adhesives and sealants (U.S. BLS, 2023a; U.S. Census Bureau, 2017). This approach involved first identifying the relevant NAICS codes for the OES. Refer to Section 4.3.13.1 for the process description that informed the selection of NAICS for this OES. EPA didn't identify OES-specific data for the number of sites that use *p*-dichlorobenzene in adhesives and sealants. Therefore, EPA assessed a bounding estimate of 2,023 sites for this OES based on the number of sites listed under the identified NAICS codes. Using a bounding estimate will overestimate the true number of sites that use *p*-dichlorobenzene for this 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. Table 8-2 includes further details regarding methodology for estimating the number of workers and ONUs per site.

EPA assigned the following NAICS codes for this OES:

- 335300 – Electrical Equipment Manufacturing

Table 8-50 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.2.2.

Table 8-50. Estimated Average Number of Workers per Site Potentially Exposed to *p*-Dichlorobenzene During Use of Adhesives and Sealants

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site[a]	Potentially Exposed ONUs per Site[a]
2,023	335300 – Electrical Equipment Manufacturing	41	10
[a] Number of workers and ONUs per site calculated by dividing the exposed number of workers or ONUs by the number of establishments.			

8.2.14.3 Occupational Inhalation Exposure Results

CEM Version 3.2 (U.S. EPA, 2023b) was used to evaluate occupational exposure based on the available data for foam insulation containing *p*-dichlorobenzene. Although CEM is intended for consumer uses, occupational exposure can be modeled by adjusting inputs specific for a worker scenario. See Section 7.1.4.1for more information about the CEM model.

The following presents a crosswalk between the occupational COU category with a generic scenario in CEM. The model was generated to reflect specific use conditions as well as physical and chemical properties of the foam sealant. The emissions model for each exposure scenario was selected based upon physical and chemical properties of the product and application use method for the products. Exposure pathways were selected to reflect the anticipated use of each product.

- ***Occupational COU Category:*** Building and Construction Products
- ***Product:*** Touch N Foam Mouse Shield Can Foam Sealant & Blocker (https://hdsupplysolutions.com/wcsstore/ExtendedSitesCatalogAssetStore/product/fm/additional/11/114797_SDS.pdf), 7% *p*-dichlorobenzene
- ***Emission Model:*** E2
- ***CEM Scenario:*** Generic product E2

Within CEM, the E2 model was selected as appropriate for the foam sealant. The model is applicable for products applied to a surface that dry or cure over time, where there is an initial fast release of the chemical governed by evaporation and a later slower release. Based on the physical-chemical properties of the chemical, the model assumes that a certain amount of the applied mass is released because a substantial fraction of the mass becomes trapped in the cured substrate when it dries. Section 7.1.4.1 also describes the E2 model in more detail.

8.2.14.3.1 Key Parameters for Products Modeled in CEM

All products were assessed using the highest reported weight fraction identified in SDS or other literature that went through EPA's systematic review. For acute exposure, the high-end frequency of use and duration of product use were used, representing the highest exposure within 24 hours. For chronic exposure, the median frequency of use and duration of product use were selected because these values represent the central tendency of exposure within a year. For model input parameters that were not identified, EPA relied upon default values within CEM (either directly or calculated using physical-chemical properties) or used professional judgement to define missing model inputs for the product. Product density was obtained from the product-specific technical specifications.

8.2.14.3.2 Mass of Product Used

EPA used the following equations to calculate the mass of product used for acute and chronic scenarios. The reported mass of the product is a 12 oz can (0.75 lbs) and yield per can (410 feet) is provided by the manufacturer's Technical Data Sheet (TDS) (DAP Products, 2026). The speed of testing in tensile mode of 5 mm/s (59.06 ft/h) for silicones in their use as sealants and structural adhesives in construction and building applications was used as an estimate of the assumed rate of application (de Buyl, 2001). The results are 49.15 g/use for acute and 8.19 g/use for chronic scenarios.

Equation 8-3. Amount of Product Per Foot Used

$$Amount\ of\ product\ per\ foot\ use = \frac{Total\ mass\ of\ product}{Yield\ per\ can}$$

Equation 8-4. Mass of Product Per Use

$$Mass\ of\ product\ per\ use = Amount\ of\ product\ per\ foot\ use\ x\ Assumed\ rate\ of\ application\ x\ CF_1\ x\ CF_2\ x\ ED$$

Where:

Total mass of product	=	12 oz (0.75 lbs)
Yield per can	=	410 feet
Assumed rate of application	=	59.06 ft/hour
CF_1	=	0.0167 hour/min
CF_2	=	454 g/lb
ED	=	Exposure Duration

- Acute: 60 min
- Chronic: 10 min

8.2.14.3.3 Duration, Frequency of Use, and Environmental Parameters

The EFH was consulted to obtain duration of uses for acute and chronic exposures for commercial use of foam insulation. For acute duration, the 95th percentile of 60 minutes and the 75th percentile for chronic of 10 minutes were used. Although for consumer use the 50th percentile was used for chronic, EPA determined that 75th percentile is reasonable for a worker as they would spend more time doing a larger project. For frequency of use, EPA used an assumption that a worker spends an hour in the room of use and goes to 8 different houses a day for acute. Assuming 250 workdays, this results in 2,000 uses per year for chronic.

The use environment was based on the expected room where a given product may be used, and EPA used utility room in this scenario. The room volume of 20 m^3 was based on CEM defaults and interzone flow rate calculated using the methods in Section 7.1.4.2.4.

8.2.14.3.4 Commercial Foam Sealant Results

This section summarizes the air concentrations from inhalation exposure to *p*-dichlorobenzene in foam sealant. The *Draft Commercial Inhalation and Dermal Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026q) shows the inputs, models, and calculations for inhalation and exposures.

The 1-hour TWA is 8.3×10^{-1} mg/m^3 for a worker one time use in a home. This assumes a continuous 60-minute application time. It is assumed that the worker goes to 8 different homes in a day, working in the same conditions in all homes. Thus, the 1-hour TWA was multiplied by 8 and divided by 24 to give the 24-hour TWA of 2.00×10^{-1} mg/m^3. The chronic ADC is 5.4×10^{-2} mg/m^3.

These results were used as a screening-level assessment, and since they did not show risk, further refinement was not made to the assessment of inhalation exposure for this OES.

8.2.14.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using a Monte Carlo simulation with 100,000 iterations. The Agency modeled dermal exposure using a fraction absorbed value of 0.02 for *p*-dichlorobenzene as a liquid and followed the processes discussed in Section 7.1.5. The fraction absorbed value of 0.02 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more information). The study indicated that an estimate of 0.02 (or 2%) absorption should apply to all formulations with a less than 50% concentration of *p*-dichlorobenzene. The concentration evaluated for this dermal exposure is represented as a uniform distribution with a lower bound of 5% and an upper bound of 10% based on the concentration range reported in an SDS for a sealant product containing *p*-dichlorobenzene (Convenience Products, 2016).

Table 8-51 summarizes the APDR, AAD, $ADD_{intermediate}$, and CAD (non-cancer) for *p*-dichlorobenzene during use in adhesives and sealants. The high-end exposures are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. Workers include employees who directly handle adhesive and sealant products containing *p*-dichlorobenzene. Dermal exposures for ONUs are expected to be negligible as they do not directly handle the chemical. OES-specific parameters for dermal exposures are described in Appendix M.

Table 8-51. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene for Use in Adhesives and Sealants

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	0.99	2.6
	Acute absorbed dose (AAD) (mg/kg-day)	1.2E−02	3.3E−02
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	9.1E−03	2.4E−02
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	5.9E−03	1.8E−02

Along with this fractional absorbed method, EPA also used a flux-based permeability dermal model for occupational exposure to the foam sealant/insulation. The flux-based method was also identified as appropriate for this scenario as it considers a nondepletable source of *p*-dichlorobenzene with little to no evaporation of the chemical in the area contacting the skin over the duration of the exposure. This scenario applies to products comprised of a solid *p*-dichlorobenzene foam insulation, where absorption is driven by the duration of dermal contact. This scenario assumes that when the user is handling the product there is enough *p*-dichlorobenzene in the product to be continuously absorbed into the skin during the contact time. See Section 7.1.5.2 for more information about the model.

As described in Section 7.1.5.2, EPA used the same permeability equation as consumer dermal exposure as for occupational. The inputs are the same also, except for frequency of events. For acute, the frequency of events is 8 and chronic is 2,000. EPA also calculated an intermediate scenario for occupational dermal, where the frequency of events is 22 times a month. Table 8-52 shows the results of the dermal exposure doses. Calculations were made for workers aged 21 and older.

Table 8-52. Foam Insulation Dermal Dose Results

Duration	Dose Rate (mg/kg/d)
Acute	2.00E−01
Intermediate	2.36E−01
Chronic	1.25E−02

See the *Draft Commercial Inhalation and Dermal Risk Calculator for p-Dichlorobenzene* (U.S. EPA, 2026q) which shows the inputs, models, and calculations for the dermal exposures.

8.2.14.5 Exposure Controls and PPE

No engineering controls or documented PPE were available from the data. However, the product manufacturer recommends the use of nitrile, neoprene, or natural rubber gloves that are solvent impervious. Goggles or safety glasses with side shields are also recommended. No personal respiratory protective equipment is normally required (Convenience Products, 2016).

8.2.15 Disposal

As listed in Table 4-1, this OES includes the following COU: Disposal.

8.2.15.1 Worker Activities

For disposal of *p*-dichlorobenzene, EPA was provided with inhalation monitoring data from a non-dedicated disposal site (Westlake Corporation) for two SEGs: waste treatment operators, classified as workers, and waste treatment supervisors, classified as ONUs. Activities associated with each SEG that may result in exposures are provided below:

- Workers – Inhalation of vapors and dermal contact with liquids during container unloading, container cleaning, and equipment cleaning.
- ONUs – Inhalation of vapors while in an area where the chemical is present.

ONUs do not directly handle the chemical and are therefore expected to have lower inhalation exposures than workers that engage in tasks related to the handling or treatment of waste containing *p*-dichlorobenzene, and no dermal exposures through contact with liquids.

See Section 4.3.14.1 for a full disposal process description.

8.2.15.2 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 *p*-dichlorobenzene during disposal (U.S. BLS, 2023a; U.S. Census Bureau, 2017). 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 J includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 562211 – Hazardous Waste Treatment and Disposal;
- 562212 – Solid Waste Landfill;

- 562213 – Solid Waste Combustors and Incinerators; and
- 562219 – Other Nonhazardous Waste Treatment and Disposal.

Table 8-53 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 4.2.2.

Table 8-53. Estimated Average Number of Workers per Site Potentially Exposed to *p*-Dichlorobenzene During Disposal

Potential Number of Sites	NAICS Code	Potentially Exposed Workers per Site[a]	Potentially Exposed ONUs per Site[a]
816	562211 – Hazardous Waste Treatment and Disposal;	3	8
	562212 – Solid Waste Landfill;		
	562213 – Solid Waste Combustors and Incinerators; and		
	562219 – Other Nonhazardous Waste Treatment and Disposal		

[a] Number of workers and ONUs per site calculated by dividing the exposed number of workers or ONUs by the number of establishments.

8.2.15.3 Occupational Inhalation Exposure Results

For disposal of *p*-dichlorobenzene, EPA was provided with inhalation monitoring data from Westlake Corporation for waste treatment operators and waste treatment supervisors at one facility. EPA identified 13 worker full-shift PBZ samples (durations between 386–683 minutes) and 6 ONU occupational full-shift PBZ samples (durations between 463–510 minutes and between 492–580 minutes for 8- and 12-hour TWA, respectively) from the Westlake dataset to estimate inhalation exposures for this OES. The samples were collected from waste treatment operators (workers) and waste treatment supervisors (ONUs). The Westlake data also included 3 task-based samples for workers that were all below the LOD (ranged between 0.13–1.5 ppm) with durations between 10 to 120 minutes.

From this monitoring data, EPA calculated the 50th and 95th percentile 8- and 12-hour TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. Using these TWA exposure concentrations, EPA calculated the AC, IADC, and ADC as described in Appendix K. The results of these calculations are shown in Table 8-54.

Table 8-54. 8- and 12-Hour Duration of Inhalation Exposures to *p*-Dichlorobenzene During Disposal Based on the Westlake Corporation Test Order Data

SEG	Exposure Concentration Type	Worker Inhalation Estimates (ppm)	
		Central Tendency	High End
Average Adult Worker – 12-hour TWA	12-Hour TWA exposure concentrations	2.0E−02	4.0E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	2.0E−02	4.1E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	1.0E−02	2.0E−02
	Average daily concentration (ADC) based on 12-hour TWA	9.3E−03	1.9E−02
ONU – 8-hour TWA	8-Hour TWA exposure concentrations	1.7E−02	3.3E−02
	Acute exposure concentrations (AC) based on 8-hour TWA	1.1E−02	2.2E−02
	Intermediate average daily concentration (IADC) based on 8-hour TWA	8.2E−03	1.6E−02
	Average daily concentration (ADC) based on 8-hour TWA	7.7E−03	1.5E−02
ONU – 12-hour TWA	12-Hour TWA exposure concentrations	1.6E−02	3.1E−02
	Acute exposure concentrations (AC) based on 12-hour TWA	1.6E−02	3.2E−02
	Intermediate average daily concentration (IADC) based on 12-hour TWA	7.7E−03	1.5E−02
	Average daily concentration (ADC) based on 12-hour TWA	7.2E−03	1.4E−02

8.2.15.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using a Monte Carlo simulation with 100,000 iterations. The Agency modeled dermal exposure using a fraction absorbed value of 0.02 for *p*-dichlorobenzene as a liquid and followed the processes discussed in Section 8.1.4 and Appendix M. The fraction absorbed value of 0.02 was obtained from data submitted to satisfy EPA's Order to conduct an *in vitro* dermal absorption study on *p*-dichlorobenzene (see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b) for more information). The study indicated that an estimate of 0.02 (or 2%) absorption should apply to all formulations with a less than 50% concentration of *p*-dichlorobenzene. The concentration evaluated for this dermal exposure is represented by a uniform distribution with a minimum of 5.6% and a maximum of 8.0% based on literature identified during systematic review (Midwest Research Institute, 1984).

Table 8-55 summarizes the APDR, AAD, $ADD_{intermediate}$, and CAD (non-cancer) for *p*-dichlorobenzene during disposal. The high-end exposures are the 95th percentiles of the respective simulation output and the central tendency exposures are the 50th percentiles. The SEGs included in the "Average Adult Worker" category include waste treatment operators. These SEGs were grouped for the purposes of modeling as they are expected to have similar risks of dermal exposure. Dermal exposures for ONUs are expected to be negligible as they do not directly handle the chemical. OES-specific parameters for dermal exposures are described in Appendix M.

Table 8-55. Summary of Dermal Exposure Doses to *p*-Dichlorobenzene for Disposal

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	Acute potential dose rate (APDR) (mg/day)	0.92	2.3
	Acute absorbed dose (AAD) (mg/kg-day)	1.2E−02	2.9E−02
	Intermediate Average Daily Dose ($ADD_{intermediate}$), non-cancer (mg/kg-day)	8.4E−03	2.1E−02
	Chronic absorbed dose (CAD), non-cancer (mg/kg-day)	6.3E−03	1.7E−02

8.2.15.5 Exposure Controls and PPE

Westlake Corporation documented waste treatment operators wearing dermal PPE such as nitrile gloves, glasses, face shields, boots, aprons, and fire-retardant clothing. Waste treatment operators did not use respiratory protection. The work area had general ventilation present as an engineering control. Most ONUs wore glasses and boots as dermal PPE, and one ONU was documented to wear nitrile gloves and fire-retardant clothing during their shift.

8.3 Weight of Scientific Evidence Conclusions for Occupational Exposure Assessment

For each OES, EPA considered the assessment approach, the quality of the data and models; and the strengths, limitations, assumptions, and key sources of uncertainties in the assessment results to determine a WOSE 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 EPA's Draft Systematic Review Protocol (U.S. EPA, 2021a). For example, EPA used moderate to categorize measured data from a limited number of sources such that there is a limited number of data points that may not cover most or all the sites within the OES. EPA used slight to describe limited information that does not sufficiently cover all sites within the OES, and for which the assumptions and uncertainties are not fully known or documented. See the Draft Systematic Review Protocol (U.S. EPA, 2021a) for additional information on weight of scientific evidence conclusions.

WOSE 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 monitoring data, however the sources used the most in this assessment were inhalation exposure monitoring studies submitted to EPA by Westlake Corporation, Willert Home Products, and the American Chemistry Council in response to a Test Order (Exponent, 2024; SCI Engineering, 2024; ACC, 2023) and (SCI Engineering, 2024). These data were determined to have overall data quality ratings of high through EPA's systematic review process. Other literature studies with monitoring data had data quality ratings of high or medium. OSHA CEHD data has a data quality rating of medium.

Number of Workers

There are several uncertainties surrounding the estimated number of workers potentially exposed to *p*-dichlorobenzene, as outlined below. Most are unlikely to result in a systematic underestimate or overestimate but could lead to some inaccuracies in the final estimates.

CDR data are used to estimate the number of workers associated with manufacturing. *p*-Dichlorobenzene is only manufactured in the United States as a byproduct of VCM production, so EPA assessed the number of workers using VCM manufacturers that reported to CDR in 2020 (U.S. EPA, 2020c). To calculate the number of workers and ONUs, EPA used a per-site average based on all VCM manufacturers that reported to CDR in 2020. There are inherent limitations to the use of CDR data as they are reported by manufacturers. Manufacturers are only required to report if they manufactured or imported VCM in excess of 25,000 lb at a single site during any calendar year; as such, CDR may not capture all sites and workers associated with any given chemical.

There are also uncertainties with BLS data, which are used to estimate the number of workers for the remaining COUs. First, BLS' Occupational Employment Statistics employment data for each industry/occupation combination are only available at the 3-, 4-, or 5-digit NAICS level, rather than the full 6-digit NAICS level. This lack of granularity 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 *p*-dichlorobenzene for the assessed applications. EPA addressed this issue by refining the OES estimates using total employment data from the U.S. Census' SUSB. However, this approach assumes that the distribution of occupation types (SOC codes) in each 6-digit NAICS is equal to the distribution of occupation types at the parent 5-digit NAICS level. If the distribution of workers in occupations with *p*-dichlorobenzene exposure differs from the overall distribution of workers in each NAICS, then this approach will result in inaccuracy.

Finally, EPA's judgments about which industries (represented by NAICS codes) and occupations (represented by SOC codes) are associated with the uses assessed in this report are based on the Agency's understanding of how *p*-dichlorobenzene is used in each industry. Designations of which industries and occupations have potential exposures is nevertheless subjective, and some industries/occupations with few exposures might erroneously be included, or some industries/occupations with exposures might erroneously be excluded. This would result in inaccuracy but would be unlikely to systematically either overestimate or underestimate the number of exposed workers.

Analysis of Exposure Monitoring Data

For most of the OESs, *p*-dichlorobenzene test order monitoring data were used to estimate inhalation exposures. The primary strength of these data is the use of personal and directly applicable data, and the number of samples available for workers and ONUs. The primary limitation is that EPA assumed either 167, 200, or 250 exposure days per year based on shift length and provided worker schedules; it is uncertain whether this captures actual worker schedules and exposures. In some cases, there is also uncertainty in the representativeness of the data. Where few data are available, the assessed exposure levels may not be representative of worker exposure across the entire job category or industry. Differences in work practices and engineering controls across sites can introduce variability and limit the representativeness of monitoring data.

For several other OES, a subset of test order monitoring data was used as analogous. For example, any data from the three test orders pertaining to loading or unloading of *p*-dichlorobenzene was compiled to assess the Repackaging and Functional fluids (closed system) OESs. For Plastics Converting, analogous data from the Plastics Compounding OES was used. For the Use of Laboratory Chemicals OES, any monitoring data from the SEG, "Laboratory Technician" was used. Finally, For the Disposal OES, any data from the test orders pertaining to waste handing was used. While these analogous options are likely to be applicable to most workers, a limitation is that this analogous test order data from one site may overestimate or underestimate inhalation exposures across the entire job category or industry.

For one OES, OSHA CEHD data was used to assess inhalation exposures. One limitation is that OSHA CEHD data does not include worker descriptions. EPA assessed the default average adult worker and ONU categories and assumed that worker central tendency exposure was representative of ONU exposure and used to generate estimates for ONUs.

For both inhalation and dermal, Table 8-56 summarizes the assessment method and weight of scientific evidence ratings for each OES.

Dermal Loading and Absorption

Dermal loading is uncertain as it can vary across not only COUs and OESs, but also SEGs and even individual workers. EPA has not identified reasonably available information providing data on dermal loading. Therefore, the Agency has accounted for the variability and uncertainty in this estimate for workers by incorporating a wide range of skin surface area variability into the Monte Carlo model. The modeling estimate assumes an even distribution of skin surface exposed ranging from a surface area of 0 cm^2 to 1,070 cm^2, the upper bound of which is equivalent to the surface area of two full hands but also accounts for exposure to arms or other body regions. For ONUs, when *p*-dichlorobenzene is present in a solid state, exposure to settled dust from surfaces is assumed, and for these cases EPA applied a static skin surface area based on the mean value for one palm, 268 cm^2. EPA believes that the Monte Carlo model captures the full range of potential surface area exposures for workers while the surface area of one palm is accurately representative of exposure to dust settled on a solid surface that ONUs may be exposed to.

For dermal absorption, EPA primarily used data from a test order that measured fractional absorption over a range of scenarios covering durations up to a full workday, at various concentrations (including as neat solid), and in two different solvents (Charles River Laboratories, 2025). Despite the range of scenarios tested, the data cannot account for all the variability that would be expected across workers performing different tasks and in different environments. Day-to-day variability may also impact absorption through factors such as the amount of sweat and how many times hands were washed (*e.g.,* such as from bathroom visits). The test order was unable to account for handwashing and was an *in vitro* system, however it did use human skin and simulated unoccluded exposure. Absorption estimates were pretty narrow, ranging from 2 to 4% for neat *p*-dichlorobenzene and 1 to 2% for *p*-dichlorobenzene in solution at 50% or lower concentration (solubility was limited above 40–50%). For simplifying the number of scenarios to consider and in order to be health-protective, EPA applied 4% fractional absorption for any formulation greater than 50% concentration and 2% for any solution less than 50% concentration. Uncertainty remains for whether high-concentration solutions would absorb differently and absorption of solid *p*-dichlorobenzene powder is likely highly variable as it requires sweat or some other moisture on skin as a carrier. Despite these uncertainties, EPA's approach represents the best available science considering the available data. For comparison, EPA also modeled dermal absorption using the IHSkinPerm Model (accessed March 19, 2026). This model has several parameter options and variables, but for the model of deposition over 8 hours and observed for 24 hours (matching the test order parameters) at the default dermal rate of 1 $mg/cm^2/h$ for 1,000 cm^2 surface area, the fractional absorption for neat (100%) *p*-dichlorobenzene is 4.09% (essentially identical to the empirical result). This further supports the validity of the test order results for use in risk assessment.

For Use of Solid Air Care Products, EPA determined that a permeability approach was most appropriate because exposure was based on contact with a large supply of *p*-dichlorobenzene in the form of a solid block that did not result in a measurable amount deposited on the skin. For this scenario, EPA used the K_p value from (CPA, 2005). This study used "infinite" loading (meaning more solution was applied than could ever be absorbed for the duration of the experiment) of *p*-dichlorobenzene as a 10% concentration

in solution, in an occluded setup to minimize the effect of volatility. Under these conditions, absorption rate was fastest over 10 minutes compared to both 1 hour and steady-state absorption over a full day. Since exposure to solid air care products occurs over the course of minutes, the 10-minute K_p value of 3.75×10^{-4} cm/h was applied to apply the most relevant experimental value. There is remaining uncertainty however because data was not reasonably available for quantifying permeability from solid *p*-dichlorobenzene, which may have a slower lag time considering it must migrate both out of the product and into the skin.

Table 8-56. Summary of Assumptions, Uncertainty, and Overall Confidence in Occupational Inhalation Exposure Estimates by OES

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates
Manufacturing	For this OES, EPA used inhalation monitoring data provided via a Test Order submission from Westlake Corporation (Exponent, 2024). EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8- and 12-hour TWA inhalation exposure estimates for the Manufacturing OES. The primary strength is the use of personal breathing zone (PBZ) and directly applicable monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs, as well as the presence of samples taken across a variety of SEGs and sampling periods. EPA used 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 was submitted in response to a test order issued by EPA specifically designed to be fit-for-purpose for TSCA risk evaluations. The data included 77 full-shift personal air samples and 12 occupational task-based personal air samples. Of the full-shift samples taken, 32 samples were classified as 8-hour TWAs while the remaining 45 samples were classified as 12-hour TWAs. The primary limitation of the data is that it is from a single site that manufactures *p*-dichlorobenzene as a byproduct and may not be representative of all current sites manufacturing *p*-dichlorobenzene as a byproduct. Although the exposure concentrations used in the assessment are based on measured workplace monitoring data collected under EPA-reviewed test order protocols and are considered representative of the monitored OES, uncertainty remains when applying a finite dataset to characterize potential exposures across all facilities, operating conditions, and work practices within the industry. Finally, EPA assumed either 167 exposure days/year for 12-hour shifts or 250 exposure days/year for 8-hour shifts based on a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is robust.
Repackaging	For this OES, EPA used inhalation monitoring data provided via test order submissions from Westlake Corporation, Willert Home Products, and data provided by the American Chemistry Council (Exponent, 2024; SCI Engineering, 2024; ACC, 2023). EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-, 10-, and 12-hour TWA inhalation exposure estimates for the Repackaging OES. The primary strength is the use of PBZ and monitoring data directly applicable to the tasks that are expected to occur during this OES, which are preferrable to other assessment approaches such as modeling or the use of OELs, as well as the presence of samples taken across a variety of SEGs, sites, and sampling periods. EPA used 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 was submitted in response to a test order issued by EPA specifically designed to be fit-for-purpose for TSCA risk evaluations. The Willert Home Products test order data included 220 full-shift personal air samples and 4 occupational task-based personal air samples. Of these, 75 full-shift samples were deemed by EPA to be relevant and included under this OES. ACC test order data included 74 full-shift personal air samples and 31 occupational task-based personal air samples. Of these, 16 full-shift samples and 22 task-based samples were deemed to be relevant and were included in this OES.

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates
	The primary limitation of the data is that it is not from dedicated repackaging sites. Rather, the data are from workers performing tasks similar to those EPA expects to take place at repackaging sites, such as loading and unloading containers. EPA expects that the exposures are representative of those at repackaging sites. Another limitation, specific to the ONU inhalation exposure to neat liquid formulations, all monitoring data were non-detects and EPA assessed the maximum LOD and half the maximum LOD as the high-end and central tendency, respectively. Consequently, the inhalation exposure estimates are upper-bound estimates and therefore, the central tendency estimates are expected to be more reflective of the range. Although there is uncertainty in the exposure estimate since it is based on samples that are all below the LOD, EPA is confident that the true exposure value is below the LOD. Finally, EPA assumed 167 exposure days/year for 12-hour shifts, 200 exposure days/yr for 10-hour shifts, or 250 exposure days/year for 8-hour shifts based on a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate to robust.
Processing as Reactant	For this OES, EPA used inhalation monitoring data provided from the ACC Consortium (ACC, 2023). EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 12-hour TWA inhalation exposure estimates for the Processing as reactant OES. The primary strength is the use of PBZ and directly applicable monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs, as well as the presence of samples taken across a variety of SEGs and sites. EPA used 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 53 full-shift personal air samples and 31 occupational task-based personal air samples. The primary limitation of the data is that it is from two sites that process *p*-dichlorobenzene as a reactant and may not be representative of all current sites. Another limitation is for two SEGs (Process Field Operators and ONUs), all samples were below the samples' LODs which causes uncertainty as to the actual exposure levels. Finally, EPA assumed 200 exposure days/year for 12-hour shifts based on information provided from ACC; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is robust.
Incorporation into Air Care Products	For this OES, EPA used inhalation monitoring data provided via a Test Order submission from Willert Home Products (SCI Engineering, 2024). EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8- and 10-hour TWA inhalation exposure estimates for the Incorporation into air care products OES. The primary strength is the use of PBZ and directly applicable monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs, as well as the presence of samples taken across a variety of SEGs and sampling periods. EPA

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates
	used 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 was submitted in response to a test order issued by EPA specifically designed to be fit-for-purpose for TSCA risk evaluations. The data included 220 full-shift personal air samples and 4 occupational task-based personal air samples. Of the full-shift samples taken, 150 samples were classified as 8-hour TWAs while the remaining 70 samples were classified as 10-hr TWAs. The primary limitation of the data is that it is from a single site that incorporates *p*-dichlorobenzene into air care products. Although the exposure concentrations used in the assessment are based on measured workplace monitoring data collected under EPA-reviewed test order protocols and are considered representative of the monitored OES, uncertainty remains when applying a finite dataset to characterize potential exposures across all facilities, operating conditions, and work practices within the industry. Finally, EPA assumed either 200 exposure days/year for 10-hour shifts or 250 exposure days/year for 8-hour shifts based on a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is robust.
Incorporation into Formulation, Mixture, or Reaction Product	For this OES, EPA used inhalation monitoring data provided via a Test Order submission from Willert Home Products (SCI Engineering, 2024). EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8- and 10-hour TWA inhalation exposure estimates for the Incorporation into formulation, mixture or reaction product OES. The primary strength is the use of PBZ and directly applicable monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs, as well as the presence of samples taken across a variety of SEGs and sampling periods. EPA used 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 was submitted in response to a test order issued by EPA specifically designed to be fit-for-purpose for TSCA risk evaluations. The data included 220 full-shift personal air samples and 4 occupational task-based personal air samples. Of the full-shift samples taken, 150 samples were classified as 8-hour TWAs while the remaining 70 samples were classified as 10-hr TWAs. The primary limitation of the data is that it is from a single site that incorporates *p*-dichlorobenzene into air care products. Although the exposure concentrations used in the assessment are based on measured workplace monitoring data collected under EPA-reviewed test order protocols and are considered representative of the monitored OES, uncertainty remains when applying a finite dataset to characterize potential exposures across all facilities, operating conditions, and work practices within the industry. Finally, EPA assumed either 200 exposure days/year for 10-hour shifts or 250 exposure days/year for 8-hour shifts based on a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is robust.

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates
Plastics Compounding	For this OES, EPA used inhalation monitoring data provided from the ACC Consortium (ACC, 2023). EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 12-hour TWA inhalation exposure estimates for the Plastics compounding OES. The primary strength is the use of PBZ and directly applicable monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. EPA used 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 full-shift (12-hour TWA) personal air samples. The primary limitation of the data is that it is from one site that compounds plastics and may not be representative of all current sites. Next, all collected samples reported non-detects for *p*-dichlorobenzene, so EPA assessed the LOD and half of the LOD as the high-end and central tendency TWA exposure concentrations, respectively. Finally, EPA assumed 200 exposure days/year for 12-hour shifts based on information provided from ACC; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is robust.
Plastics Converting	For this OES, EPA did not identify relevant inhalation monitoring data. Due to expected similarities in process descriptions, the Agency used analogous monitoring data from the Plastics compounding OES. EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 12-hour TWA inhalation exposure estimates for the Plastics converting OES. The primary strength is the use of PBZ monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs, as well as the similarity in worker activities between the analogous data and this OES. EPA used 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 full-shift (12-hour TWA) personal air samples. The primary limitation of the data is that it is from one site that conducts plastics compounding and may not be representative of current plastics converting sites. Next, all collected samples reported non-detects for *p*-dichlorobenzene, so EPA assessed the LOD and half of the LOD as the high-end and central tendency TWA exposure concentrations, respectively. Finally, EPA assumed 167 exposure days/year for 12-hour shifts based on a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate.
Incorporation into Abrasive Grinding Wheels	For this OES, EPA used inhalation monitoring data from OSHA's CEHD (OSHA, 2019). EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates for the Incorporation into abrasive grinding wheels OES.

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates
	The primary strength is the use of PBZ and directly applicable monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. EPA used PBZ air concentration data to assess inhalation exposures with the data having a high/medium data quality rating from the systematic review process. The data included 4 full-shift (8-hour TWA) personal air samples. A primary limitation of these data includes uncertainty in the representativeness of the monitoring data in capturing the true distribution of inhalation concentrations for this OES, since the dataset is only comprised of four samples. Additionally, two use sites are represented by the data, but these may not represent the overall abrasive grinding wheel industry. The samples were taken in 1985 and may not be reflective of current operations. Finally, EPA assumed 8 exposure hours per day and 250 exposure days per year based on continuous exposure during each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. EPA also notes that the chemical exposure information in the CEHD represents samples for airborne contaminants as collected by industrial hygienists as part of a compliance monitoring program. When the compliance officers collect these data, it is key to emphasize that they do not: • routinely visit every business that uses chemicals known to be toxic; • take representative samples of every employee and every activity on every day; and • always obtain a sample for an entire 8-hour period or shift. Historically, slightly more than half of all inspections are complaints, injuries/fatalities, and referrals. The remainder are programmed inspections as part of national, regional, or local emphasis programs monitoring for known hazards (e.g., chemical processing, respirable silica, combustible dust, ship-breaking, heat, falls in construction). The prevalence of bias in exposure monitoring across the dataset due to unprogrammed inspections is uncertain but may result in a dataset that includes monitoring from places that are more likely to have exposures of concern. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is slight-to-moderate.
Functional Fluids (Closed System)	For this OES, EPA did not identify relevant inhalation monitoring data. Due to expected similarities in worker activities, the Agency used analogous neat liquid monitoring data from the Repackaging OES. EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 10-, and 12-hour TWA inhalation exposure estimates for the Functional fluids (closed system) OES. The primary strength is the use of PBZ monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs, as well as the similarity in worker activities between the analogous data and this OES. EPA used PBZ air concentration data to assess inhalation exposures with the data source having a high data quality rating from the systematic review process. The analogous data included 16 full-shift samples and 22 task-based samples were deemed to be relevant and were included in this OES.

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates
	The primary limitation of the data is that it isn't from dedicated sites that use functional fluids. Rather, the data are from workers performing tasks similar to those EPA expects to take place at such sites, such as connecting and disconnecting hoses. EPA expects that the exposures are representative of those at sites that use functional fluids. Next, all collected ONU samples reported non-detects for *p*-dichlorobenzene, so EPA assessed the LOD and half of the LOD as the high-end and central tendency TWA exposure concentrations, respectively. Finally, EPA assumed between 1–12 exposure days/year representing annual to monthly fluid changeouts; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate to robust.
Use in Solid Air Care Products	For this OES, EPA used IECCU Version 1.1 to model the inhalation exposure to workers for the Use in solid air care products OES. This method is typically used to assess consumer exposure but used in this case for occupational exposure as well due to the similarities in the exposures expected by each group. EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the inhalation exposure estimates (note that due to the nature of the model used, where the use occurs once a month and the remainder of the month has decreasing exposures over time, there was no 8-hour TWA found for this use). The primary limitation of the data is that multiple inputs were obtained from EFH defaults, rather than from information that is specific to the chemical. However, EPA expects that the exposures are representative of sites that have workers handling solid air care products. Overall confidence in this inhalation exposure estimate is moderate.
Use of Lubricants and Greases	Occupational inhalation and dermal assessments were not conducted for this OES due to evidence that *p*-dichlorobenzene is present only in low, residual amounts. Therefore, occupational exposures are considered negligible.
Use of Fuels and Related Products	Occupational inhalation and dermal assessments were not conducted for this OES due to evidence that *p*-dichlorobenzene is present only in low, residual amounts. Therefore, occupational exposures are considered negligible.
Use of Laboratory Chemicals	For this OES, EPA used inhalation monitoring data provided via a test order submission from Westlake Corporation (Exponent, 2024), and data provided by the American Chemistry Council for liquids (ACC, 2023), and the PNOR Model (U.S. EPA, 2021b) for solids. EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-, and 12-hour TWA inhalation exposure estimates for the Use of laboratory chemicals OES. The primary strength is the use of PBZ and directly applicable monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. For liquids, EPA used PBZ air concentration data to assess inhalation exposures with the data source having a high data quality rating from the systematic review process. The liquid data included 18 full-shift personal air samples and 3 occupational task-based personal air samples. Of the full-shift samples taken, ten samples were classified as 8-hour TWAs while the remaining 8 samples were classified as 12-hour TWAs. EPA also used the PNOR Model to estimate worker inhalation exposure to solid particulate. The model data are based on OSHA CEHD data. EPA used a subset of the respirable particulate data from the generic model identified with the Professional, Scientific,

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates
	and Technical Services NAICS code (NAICS code 54) to assess this OES, which the Agency expects to be the most representative subset of the particulate data for use of laboratory chemicals in the absence of *p*-dichlorobenzene-specific data. For the Use of laboratory chemicals OES, the highest expected concentration of *p*-dichlorobenzene is 100% by mass based on the identified lab-grade chemicals. The primary limitation of this approach is uncertainty in the representativeness of the monitoring data and the PNOR Model in capturing the true distribution of inhalation concentrations for this OES. The monitoring data are not from a dedicated laboratory. Rather, the data are from an on-site laboratory at a manufacturing site. EPA expects that the exposures are representative of those at dedicated laboratories. Next, all collected samples in the monitoring data set reported non-detects for *p*-dichlorobenzene, so EPA assessed the LOD and half of the LOD as the high-end and central tendency TWA exposure concentrations, respectively. Further, the OSHA CEHD dataset used in the PNOR Model is not specific to *p*-dichlorobenzene. Finally, EPA assumed 167 exposure days/year for 12-hour shifts, or 250 exposure days/year for 8-hour shifts based on a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate.
Use of Adhesives and Sealants	For this OES, EPA used CEM to model the inhalation exposure to workers for the Use of adhesive sand sealants OES. Although CEM is intended for consumer uses, occupational exposure can be modeled by adjusting inputs specific for a worker scenario. EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the inhalation exposure estimates. The maximum reported weight fraction found in a product was used as inputs in this model, along with inputs from EFH and CEM default values. The primary limitation of the data is that multiple inputs were obtained from EFH defaults, rather than from information that is specific to the chemical, such as the frequency, duration of use, and mass of product. However, EPA expects that the exposures are representative of sites that have workers handling solid air care products. Overall confidence in this COU inhalation exposure estimate is moderate.
Disposal	For this OES, EPA used inhalation monitoring data provided via a Test Order submission from Westlake Corporation (Exponent, 2024). EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8- and 12-hour TWA inhalation exposure estimates for the Disposal OES. The primary strength is the use of PBZ and directly applicable monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs, as well as the presence of samples taken across a variety of SEGs and sampling periods. EPA used 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 was submitted in response to a test order issued by EPA specifically designed to be fit-for-purpose for TSCA risk evaluations. The data included 22 full-shift personal air samples and 3 occupational task-based personal air samples. Of the full-shift samples taken, four samples were classified as 8-hour TWAs while the remaining 18 samples were classified as 12-hour TWAs.

OES	Weight of Scientific Evidence Conclusion in Occupational Inhalation Exposure Estimates
	The primary limitation of the data is that it is from a single site that disposes of *p*-dichlorobenzene and may not be representative of all current disposal sites. Next, all collected samples reported non-detects for *p*-dichlorobenzene, so EPA assessed the LOD and half of the LOD as the high-end and central tendency TWA exposure concentrations, respectively. Finally, EPA assumed either 167 exposure days/year for 12-hour shifts or 250 exposure days/year for 8-hour shifts based on a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate.

7125

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 absorbed dose to liquids. For solids, EPA used the same equations as the Dermal Exposure to Volatile Liquids Model but adjusted the parameter for quantity of chemical on the skin based on identified literature for solids (Marquart et al., 2006; Lansink et al., 1996). 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. The primary limitation is the uncertainty in the representativeness of the input parameter values (dermal load, fractional absorption, concentration, skin surface area) toward the true distribution of potential dermal exposures. 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 from liquids, as EPA does not expect ONUs to directly handle *p*-dichlorobenzene as part of their duties, and thus ONUs are not expected to have routine dermal exposures to liquids during the course of their work. However, EPA addressed dermal exposures to ONUs from solids, as ONUs may come into contact with dust that settles on surfaces.

Table 8-57 summarizes EPA's overall confidence in the dermal exposure estimates for each OES.

Table 8-57. Summary of Assumptions, Uncertainty, and Overall Confidence in Occupational Dermal Exposure Estimates by OES

OES	Weight of Scientific Evidence Conclusion in Occupational Dermal Exposure Estimates
Manufacturing	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025) with ratings from medium to high. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Manufacturing OES.
Repackaging	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025; Marquart et al., 2006; Lansink et al., 1996) with ratings from moderate to robust. Note that *p*-dichlorobenzene is a solid at room temperature, and so for transport as a neat liquid it must be heated above its melting point. Section 2.2.3 states that the melting point of *p*-dichlorobenzene is 53.1 °C. ACC reports that at a processing facility, neat *p*-dichlorobenzene is stored and transported at greater than 65.6°C (EPA-HQ-OPPT-2018-0446-0073). According to EPA's Chemical Engineering Branch manual for the preparation of engineering assessments, contact is expected to be negligible for materials that are above 140°F (60°C) because contact with the skin at this temperature will cause burns (CEB, 1991). Although the melting point of *p*-dichlorobenzene is lower than this temperature threshold, heating to a temperature above the melting point would be expected at industrial facilities to prevent solidification during temperature fluctuations within the lines at a facility. The temperature reported by ACC exceeds the melting point of *p*-dichlorobenzene by 12.5°C, and exceeds the temperature threshold to consider dermal exposure by 5.6°C. It is unknown whether all facilities that handle neat liquid *p*-dichlorobenzene heat their streams to a temperature above the 60°C threshold, which is an uncertainty to this dermal assessment. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Repackaging OES.
Processing as Reactant	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025) with ratings from moderate to robust. Note that *p*-dichlorobenzene is a solid at room temperature, and so for transport through this system as a neat liquid it must be heated above its melting point. Section 2.2.3 states that the melting point of *p*-dichlorobenzene is 53.1 °C. ACC reports that at a processing facility, neat *p*-dichlorobenzene is stored and transported at greater than 65.6°C (EPA-HQ-OPPT-2018-0446-0073). According to EPA's Chemical Engineering Branch manual for the preparation of engineering assessments, contact is expected to be negligible for materials that are above 140°F (60°C) because contact with the skin at this temperature will cause burns (CEB, 1991).

OES	Weight of Scientific Evidence Conclusion in Occupational Dermal Exposure Estimates
	Although the melting point of *p*-dichlorobenzene is lower than this temperature threshold, heating to a temperature above the melting point would be expected at industrial facilities to prevent solidification during temperature fluctuations within the lines at a facility. The temperature reported by ACC exceeds the melting point of *p*-dichlorobenzene by 12.5°C, and exceeds the temperature threshold to consider dermal exposure by 5.6°C. It is unknown whether all facilities that handle neat liquid *p*-dichlorobenzene heat their streams to a temperature above the 60°C threshold, which is an uncertainty to this dermal assessment. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Processing as Reactant OES.
Incorporation into Air Care Products	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin, which were updated for solids dermal exposure. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025; Marquart et al., 2006; Lansink et al., 1996) with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Incorporation into Air Care Products OES.
Incorporation into Formulation, Mixture or Reaction Product	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025) with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Incorporation into Formulation, Mixture or Reaction Product OES.
Plastics Compounding	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025) with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Plastics Compounding OES.
Plastics Converting	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin, which were updated for solids dermal exposure. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025; Marquart et al., 2006; Lansink et al., 1996) with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Plastics Converting OES.

OES	Weight of Scientific Evidence Conclusion in Occupational Dermal Exposure Estimates
Incorporation into Abrasive Grinding Wheels	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin, which were updated for solids dermal exposure. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025; Marquart et al., 2006; Lansink et al., 1996) with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Incorporation into Abrasive Grinding Wheels OES.
Functional Fluids (Closed System)	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025) with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Functional Fluids (Closed System) OES.
Use in Solid Air Care Products	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin, which were updated for solids dermal exposure. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025; Marquart et al., 2006; Lansink et al., 1996) with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Use in Solid Air Care Products OES.
Use of Lubricants and Greases	Occupational dermal assessments were not conducted for this OES due to evidence that *p*-dichlorobenzene is present only in low, residual amounts. Therefore, occupational exposures are considered negligible.
Use of Fuels and Related Products	Occupational dermal assessments were not conducted for this OES due to evidence that *p*-dichlorobenzene is present only in low, residual amounts. Therefore, occupational exposures are considered negligible.
Use of Laboratory Chemicals	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin, which were updated for solids dermal exposure. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025) with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Use of Laboratory Chemicals OES.

OES	Weight of Scientific Evidence Conclusion in Occupational Dermal Exposure Estimates
Use of Adhesives and Sealants	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025) with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Use of Adhesives and Sealants OES.
Disposal	The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of *p*-dichlorobenzene through the skin. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015a) for standard exposure parameters, and identified literature (Charles River Laboratories, 2025) with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate for the Disposal OES.

7145

Table 8-58. Summary of the Weight of Scientific Evidence Ratings for Occupational Exposures

Occupational Exposure Scenario (OES)	Inhalation Exposure											Dermal Exposure	
	p-dichlorobenzene Monitoring					Analogous Monitoring [a]					Modeling		Modeling	
	Worker	# Data Points [b]	ONU	# Data Points [b]	Data Quality Ratings	Worker	# Data Points [b]	ONU	# Data Points [b]	Data Quality Ratings	Worker	ONU	Worker	ONU
Manufacturing	✓	50	✓	27	H	×	N/A	×	N/A	N/A	×	×	✓	×
Repackaging	✓	56	✓	41	H	×	N/A	×	N/A	N/A	×	×	✓	✓
Processing as Reactant	✓	31	✓	22	H	×	N/A	×	N/A	N/A	×	×	✓	×
Incorporation into Air Care Products	✓	75	✓	145	H	×	N/A	×	N/A	N/A	×	×	✓	✓
Incorporation into Formulation, Mixture or Reaction Product	✓	75	✓	145	H	×	N/A	×	N/A	N/A	×	×	✓	×
Plastics Compounding	✓	7	✓	22	H	×	N/A	×	N/A	N/A	×	×	✓	×
Plastics Converting	×	N/A	×	N/A	N/A	✓	7	✓	22	H	×	×	✓	✓
Incorporation into Abrasive Grinding Wheels	✓	4	×	N/A	M	×	N/A	×	N/A	N/A	×	×	✓	✓
Functional Fluids (Closed System)	×	N/A	×	N/A	N/A	✓	5	✓	11	H	×	×	✓	×
Use in Solid Air Care Products	×	N/A	×	N/A	N/A	×	N/A	×	N/A	N/A	✓	✓	✓	✓
Use of Lubricants and Greases	Due to the low amounts of *p*-dichlorobenzene in these products, EPA has determined that exposures due to this use are negligible.													
Use of Fuels and Related Products	Due to the low amounts of *p*-dichlorobenzene in these products, EPA has determined that exposures due to this use are negligible.													
Use of Laboratory Chemicals	✓	18	×	N/A	H	×	N/A	×	N/A	N/A	✓	✓	✓	✓
Use of Adhesives and Sealants	×	N/A	×	N/A	N/A	×	N/A	×	N/A	N/A	✓	✓	✓	×
Disposal	✓	19	✓	6	H	×	N/A	×	N/A	N/A	×	×	✓	×

H = high; L = low; m = medium
[a] "Analogous data" refers to data from the same chemical and similar OES.
[b] Only full-shift samples included in data point counts.

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APPENDICES

Appendix A CONSUMER INHALATION EXPOSURE MODELING

CEM predicts indoor air concentrations from consumer product use by implementing a deterministic, mass-balance calculation utilizing an emission profile determined by implementing appropriate emission scenarios. The model uses a two-zone representation of the building of use (*e.g.,* residence, school, office), with Zone 1 representing the room where the consumer product is used (*e.g.,* a utility room) and Zone 2 being the remainder of the building. The product user is placed within Zone 1 for the duration of use. Otherwise, product users and bystanders follow prescribed activity patterns throughout the simulated period. In some instances of product use, concentration of product is expected to be higher very near the product user; CEM addresses this by further dividing Zone 1 into near-field, with a default volume of 1 m^3, and far-field, which reflects the remainder of Zone 1. Each zone is considered well-mixed. Product users are exposed to airborne concentrations estimated within the near-field during the time of use and otherwise follow their prescribed activity pattern. Background concentrations can be set to a non-zero concentration if desired.

For acute exposure scenarios, emissions from each incidence of product usage are estimated over a period of 24 hours using the following approach that accounts for how a product is used or applied, the total applied mass of the product, the weight fraction of the chemical in the product, and the molecular weight and vapor pressure of the chemical.

The general steps of the calculation engine within the CEM model include the following:

- Introduction of the chemical (*i.e., p*-dichlorobenzene) into the room of use (Zone 1) through spray of the product
- Transfer of the chemical to the rest of the house (Zone 2) due to exchange of air between the different rooms
- Exchange of the house air with outdoor air; and
- Compilation of estimated air concentrations in each zone as the modeled occupant moves about the house per prescribed activity patterns.

As the user moves to Zone 2 after use, the associated zonal air concentrations at each 30 second time step were compiled to reflect the air concentrations the user would be exposed to throughout the simulation period. Time-weighted averages (TWAs) were then computed based on these user and bystander concentration time series per available human health hazard data. For *p*-dichlorobenzene, 24-hour TWAs were quantified for use in the draft risk evaluation based on alignment relevant acute human health hazard endpoints.

A.1 Description of Emission Equation for the Toilet Bowl Deodorizer COU

EPA used (Guerrero and Corsi, 2012) to determine the emission profile to use in the IECCU air modeling. In their experiments, the authors purchased a toilet bowl deodorizer product from "the largest manufacturer of such products in the United States" and EPA judged that the product was a suitable match to the COU being modeled here (99% *p*-dichlorobenzene or higher). The authors placed the product in an enclosed chamber at a height that simulated a toilet bowl and measured the subsequent emission rate every 3 to 7 days for 13 days in a set of 3 independent trials. The authors did not report the initial mass of the product; the initial surface area was 121 cm^2. EPA determined through product searches that typical product sizes are between 2.5 and 4 oz. Assuming a density of 1.46 g/cm^3 for the product and a 4 oz (113.6 g) mass gives a volume estimate of 77.9 cm^3. Further assuming that the product is a rectangular prism with the short side length of two-thirds the size of the long side length

gives a surface area estimate of 119.5 cm^2. Thus, EPA judged that the 121 cm^2 surface area reported in the paper is equivalent to a 4-ounce product, which was the mass assumed to determine the emission profile of the toilet bowl deodorizer.

The emission rate (mg/h) through time is available in Figure 1 of (Guerrero and Corsi, 2012), which shows the mean emission rate as well as error bars representing the standard deviation across the three trials. The shape of the emission curve is largely constant across the first two measurements (measured at ≈3 and 6 days) and then decreases approximately linearly across the remaining portion of the experiment. The error bars across the three trials are wide for the first measurement at 3 days, making the shape at the beginning of the experiment somewhat uncertain. EPA digitized the figure using PlotDigitizer.com.

The shape of the curve does not fit commonly used functional forms for the emission rate, including those available in IECCU (*e.g.,* first order or double-exponential decays). Since the experiment only started measuring the emission rate at 1.42 days and stopped at 13.5 days, EPA determined an appropriate emission profile based on the experimental data to derive an initial emission and decay rate. EPA first fit two different functional forms to the experimental data in a purely statistical fit:

1. Model 1: An exponential decay function, $E(t) = E_o e^{-kt}$.
2. Model 2: A linear decay function, $E(t) = E_o - mt$. This function was fit to the experimental data using the Excel Solver function to change E_o and m (the initial emission rate and the linear slope) until the sum of the squared differences between the experimental data and the model fit was minimized.

In each case, an initial guess at the emission parameters (E_o and k for Model 1 and E_o and m for Model 2) were generated, and the squared errors between the predicted and actual emissions rates at the time points in the experiment were calculated. Next, Excel's Solver function was used to generate the final model parameters. In this function, Solver iterated through additional guesses at the emission parameters in each model until the sum of the square errors for that model was minimized (see Figure_Apx A-1).

Model 1: Fit an Exponential

Use Excel's Solver function to find the Eo and k that minimize the squared error between predicted and empirical emission

$E(t) = E_o e^{-kt}$ | Eo= 471.526235 mg/hr | k= 0.002555 per hours

Time (days)	Time (hours)	Emission Rate (Paper)	Emission Rate (Estimated)	Squared Error	Sum of Squared Error	
1.42	34	403	432.3	858.295891	3503.902	<--- minimized using Excel Solver
4.42	106	393.7	359.7	1158.51026		function by changing Eo and k
7.42	178	324	299.2	613.391226		
13.42	322	177.8	207.1	860.104155		
10.50	252	244	247.7	13.6006198		

Figure_Apx A-1. Parameter and Associated Minimized Errors for Model 1 and Model 2

These models were fit based on statistical fits only. Next, these models were checked to determine whether they yield physically plausible estimates of total mass emitted. These products typically disappear after approximately 30 days, and the total mass emitted at that time must be less than the original mass of the product, taken here as 4 oz (116 g) (as discussed above).

The total mass emitted at 30 days can be found by integrating the emission rate functions in time between 0 and 30 days.

For the exponential model (Model 1):

$$M(t) = \int_0^t E_o e^{-kt}\, dt$$

$$M(30\ days) = \int_0^{30\ days} E_o e^{-kt}\, dt = -\frac{E_o e^{-k*30*24} - E_o e^{-k*0}}{k}$$

Using the parameters from Model 1,

$$M(30\ days) = 155.2\ g$$

Because 155.2 g is larger than the original mass of 116 g, this model yields unphysical results.

Similarly, for the linear model (Model 2), the emission equation yields a negative result beginning at 22.9 days, meaning all mass is emitted by that time point. Thus,

$$M(t) = \int_0^t E_o - mt\, dt$$

$$M(22.9\ days) = \int_0^{22\ days} E_o - mt\, dt = (E_o * 22.9 * 24 - \frac{m(22.9 * 24)^2}{2} - E_o * 0 + \frac{m(0)^2}{2})$$

$$M(22.9\ days) = 125.5\ g$$

Again, because 125.5 g is larger than the original mass of 116 g (and the mass is predicted to be emitted by 22.9 rather than closer to 30 days), this model also yields unphysical results.

Because the purely statistical fits yield unphysical results, EPA then fit an emission model using a hybrid empirical-physical approach using an exponential functional form:

1. Model 3: An exponential decay function, $E(t) = E_o e^{-kt}$.

In the study, measurements were taken every 3 days and were then plotted based on the midpoint of that range. Thus, for example, the first measurement taken at 3 days was used to estimate an average emission rate over the first 3 days and plotted at 1.5 days. Thus, EPA set the following constraints:

- ***Empirical:*** the average emissions should match the values from the study:
  - i. Average emission between 0 and 3 days = 403 mg/h
  - ii. Average emission rate between 3 and 6 days = 393.7 mg/h
- ***Physical:***
  - iii. The total mass emitted at the end of 30 days must be less than or equal to the total original mass of 116 g.

The emission parameters E_o and k were manually adjusted until the three constraints were best fit by visual inspection. By ensuring the emission equation is close to the initial two time points, EPA is

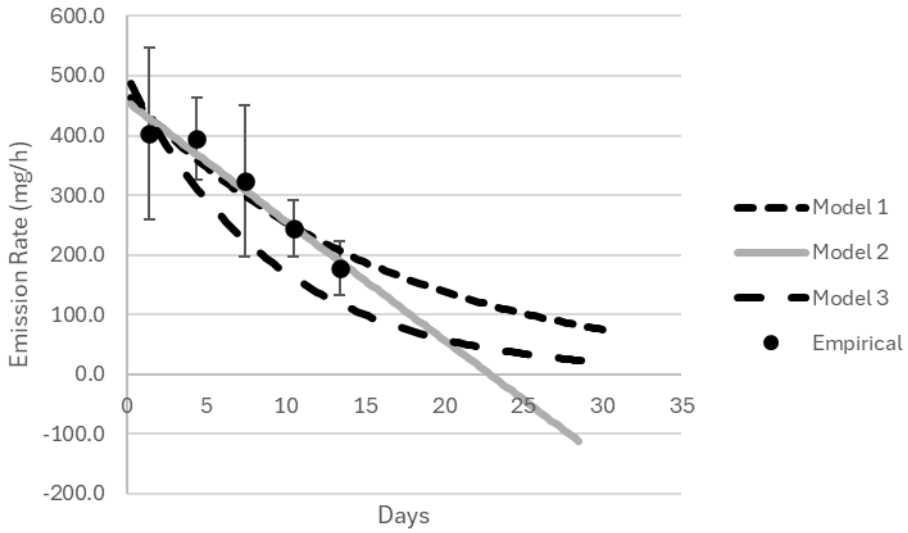
ensuring the acute exposure peak can be reasonably resolved by the exposure modeling. By ensuring the total mass emitted does not exceed the total mass, EPA is ensuring the chronic exposure estimates are not overestimates.

Figure_Apx A-2 below shows a comparison of Models 1, 2, and 3 with the data from the experiment. Model 3 is largely within one standard deviation from the experimental data and is judged to be the most appropriate model for the toilet bowl deodorizer COU. The final functional form is:

$$E(t) = E_o e^{-kt}$$

Where:

$E(t)$ = time varying emission rate in mg/h
E_o = initial emission rate in mg/h = 500 mg/h or 5E05 mg/h
k = decay constant in h^{-1} = 0.00471 h^{-1}



Figure_Apx A-2. Comparison of Models 1, 2, and 3 with the (Guerrero and Corsi, 2012) Experimental Data

Appendix B ACUTE AND NON-CANCER CHRONIC CONCENTRATION

The acute 24-hour and chronic average daily concentration were calculated with Equation_Apx B-1 below. The concentrations for zone 1 was used when the user was expected to be in the same room as the product, and zone 2 during non-use. It is important to note that CEM calculates chronic over 60 days, and extrapolates the concentrations to 1 year, assuming the same use every day over the year.

Equation_Apx B-1. Chronic Average Daily Concentration for Inhalation of Product Used in an Environment

$$ADC = \frac{C_{twa} \times ED}{AT}$$

Where:

ADC = Average Daily Concentration (mg/m^3)

C_{twa} = Time-weighted average air concentration (mg/m^3)

- Acute: Over 24 hours
- Chronic: Over 1 year

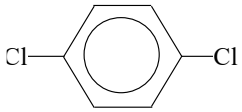
ED = Exposure duration (hours)

AT = Averaging time

- Acute: 24 hours
- Chronic: 1 years

Appendix C EPI SUITE™ MODEL INPUTS AND OUTPUTS

EPI Suite Results For CAS 000106-46-7



SMILES : c(ccc(c1)CL)(c1)CL
CHEM : Benzene, 1,4-dichloro-
MOL FOR: C6 H4 CL2
MOL WT : 147.00

---------- EPI SUMMARY (v4.11) ----------
Physical Property Inputs:
Log Kow (octanol-water): 3.23
Boiling Point (deg C) : 174.00
Melting Point (deg C) : 53.10
Vapor Pressure (mm Hg) : 1
Water Solubility (mg/L): 81.3
Henry LC (atm-m3/mole) : 0.00241

Log Octanol-Water Partition Coef (SRC):
Log Kow (KOWWIN v1.68 estimate) = 3.28
Log Kow (Exper. database match) = 3.44
Exper. Ref: HANSCH,C ET AL. (1995)

Boiling Pt, Melting Pt, Vapor Pressure Estimations (MPBPVP v1.43):
Boiling Pt (deg C): 174.69 (Adapted Stein & Brown method)
Melting Pt (deg C): -14.33 (Mean or Weighted MP)
VP(mm Hg,25 deg C): 0.646 (Modified Grain method)
VP (Pa, 25 deg C) : 86.1 (Modified Grain method)
MP (exp database): 52.09 deg C
BP (exp database): 174 deg C
VP (exp database): 1.74E+00 mm Hg (2.32E+002 Pa) at 25 deg C
Subcooled liquid VP: 1.9 mm Hg (25 deg C, user-entered VP)
: 253 Pa (25 deg C, user-entered VP)

Water Solubility Estimate from Log Kow (WSKOW v1.42):
Water Solubility at 25 deg C (mg/L): 109.5
log Kow used: 3.23 (user entered)
melt pt used: 53.10 deg C
Water Sol (Exper. database match) = 81.3 mg/L (25 deg C)
Exper. Ref: YALKOWSKY,SH & HE,Y (2003)

Water Sol Estimate from Fragments:
Wat Sol (v1.01 est) = 104.13 mg/L

ECOSAR Class Program (ECOSAR v1.11):
Class(es) found:
Neutral Organics

Henrys Law Constant (25 deg C) [HENRYWIN v3.20]:
Bond Method : 2.96E-003 atm-m3/mole (3.00E+002 Pa-m3/mole)
Group Method: 3.88E-003 atm-m3/mole (3.93E+002 Pa-m3/mole)
Exper Database: 2.41E-03 atm-m3/mole (2.44E+002 Pa-m3/mole)
For Henry LC Comparison Purposes:
User-Entered Henry LC: 2.410E-003 atm-m3/mole (2.442E+002 Pa-m3/mole)
Henrys LC [via VP/WSol estimate using User-Entered or Estimated values]:
HLC: 2.379E-003 atm-m3/mole (2.411E+002 Pa-m3/mole)
VP: 1 mm Hg (source: User-Entered)
WS: 81.3 mg/L (source: User-Entered)

Log Octanol-Air Partition Coefficient (25 deg C) [KOAWIN v1.10]:
Log Kow used: 3.23 (user entered)
Log Kaw used: -1.006 (user entered)
Log Koa (KOAWIN v1.10 estimate): 4.236
Log Koa (experimental database): 4.460

Probability of Rapid Biodegradation (BIOWIN v4.10):
Biowin1 (Linear Model) : 0.3127
Biowin2 (Non-Linear Model) : 0.0427
Expert Survey Biodegradation Results:
Biowin3 (Ultimate Survey Model): 2.4611 (weeks-months)
Biowin4 (Primary Survey Model) : 3.3050 (days-weeks)
MITI Biodegradation Probability:
Biowin5 (MITI Linear Model) : 0.3200
Biowin6 (MITI Non-Linear Model): 0.1576
Anaerobic Biodegradation Probability:
Biowin7 (Anaerobic Linear Model): -0.3502
Ready Biodegradability Prediction: NO

Hydrocarbon Biodegradation (BioHCwin v1.01):
Structure incompatible with current estimation method!

Sorption to aerosols (25 Dec C)[AEROWIN v1.00]:
Vapor pressure (liquid/subcooled): 253 Pa (1.9 mm Hg)
Log Koa (Exp database): 4.460
Kp (particle/gas partition coef. (m3/ug)):
Mackay model : 1.18E-008
Octanol/air (Koa) model: 7.08E-009
Fraction sorbed to airborne particulates (phi):
Junge-Pankow model : 4.28E-007
Mackay model : 9.47E-007
Octanol/air (Koa) model: 5.66E-007

Atmospheric Oxidation (25 deg C) [AopWin v1.92]:
Hydroxyl Radicals Reaction:
OVERALL OH Rate Constant = 0.4005 E-12 cm3/molecule-sec
Half-Life = 26.708 Days (12-hr day; 1.5E6 OH/cm3)
Ozone Reaction:
No Ozone Reaction Estimation
Fraction sorbed to airborne particulates (phi):
6.88E-007 (Junge-Pankow, Mackay avg)
5.66E-007 (Koa method)
Note: the sorbed fraction may be resistant to atmospheric oxidation

Soil Adsorption Coefficient (KOCWIN v2.00):
Koc : 375.3 L/kg (MCI method)
Log Koc: 2.574 (MCI method)
Koc : 635.2 L/kg (Kow method)
Log Koc: 2.803 (Kow method)
Experimental Log Koc: 2.65 (database)

Aqueous Base/Acid-Catalyzed Hydrolysis (25 deg C) [HYDROWIN v2.00]:
Rate constants can NOT be estimated for this structure!

Bioaccumulation Estimates (BCFBAF v3.01):
Log BCF from regression-based method = 1.798 (BCF = 62.83 L/kg wet-wt)
Log Biotransformation Half-life (HL) = 0.4722 days (HL = 2.966 days)
Log BCF Arnot-Gobas method (upper trophic) = 2.244 (BCF = 175.2)
Log BAF Arnot-Gobas method (upper trophic) = 2.248 (BAF = 176.9)
log Kow used: 3.23 (user entered)

Volatilization from Water:
Henry LC: 0.00241 atm-m3/mole (entered by user)
Half-Life from Model River: 1.532 hours
Half-Life from Model Lake : 118.4 hours (4.932 days)

Removal In Wastewater Treatment:
Total removal: 52.13 percent
Total biodegradation: 0.09 percent
Total sludge adsorption: 6.09 percent
Total to Air: 45.95 percent
(using 10000 hr Bio P,A,S)

Level III Fugacity Model:
Mass Amount Half-Life Emissions
(percent) (hr) (kg/hr)
Air 18.3 802 1000
Water 22.1 900 1000
Soil 59.2 1.8e+003 1000
Sediment 0.462 8.1e+003 0
Persistence Time: 384 hr

Appendix D PROCEDURES FOR MAPPING FACILITIES FROM STANDARD ENGINEERING SOURCES TO OCCUPATIONAL EXPOSURE SCENARIOS AND CONDITIONS OF USE

D.1 Standard Sources Requiring Facility Mapping

EPA utilizes release data from EPA programmatic databases and exposure data from standard sources to complete occupational exposure and environmental release assessments, which are described, with hyperlinks (all accessed August 11, 2025) below:

Chemical Data Reporting (CDR), to which import and manufacturing sites producing the chemical at or above a specified threshold must report. EPA uses CDR to identify COUs, OESs, 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), 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.

National Emissions Inventory (NEI), a compilation of air emissions of criteria pollutants, criteria precursors and hazardous air pollutants from point and non-point source air emissions. EPA uses NEI data to quantify air emissions of the chemical undergoing risk evaluation.

Discharge Monitoring Report (DMR), 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), 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), 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. There may be other sources of data for specific facilities that 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, generic scenarios, and process data that are usually not specific to an individual site; therefore, unlike the above sources, they do not involve the mapping of specific sites to an OES.

Mapping procedures for the above sources are discussed in detail in the subsequent sections; however, Table_Apx D-1 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 North American Industry Classification System (NAICS) and Standard Industrial Classification (SIC) system (both URLs accessed August 11, 2025). 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 D-1 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).

8306 **Table_Apx D-1. 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: 2020	- 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 transparency to the public.
TRI	- NAICS codes - Flags for uses and subuses 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: 2021	- Reporters must select from specific uses (*e.g.,* manufacture, import, processing) and subuses (*e.g.,* formulation additive, degreaser, lubricant). - Subuse information is only available in data sets starting in 2018. - Facilities may report with a Form A under certain circumstances; [a] Form A's do not require use/sub-use reporting.
NEI	- SCCs, which classify different types of activities that generate air emissions - Emissions Inventory System (EIS) Sectors, which classify industry sectors - NAICS codes - Process description free-text field (used for additional information about the process related to the emission unit) - Emission unit description free-text field	- Facilities must report to NEI every 3 years - New datasets take years to become publicly available - Latest reporting year with available date: 2020	- NEI contains specific SCC codes and industry sectors from which reporters select. - Free-text fields are not mandatory for the reporter to fill out.
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 (*e.g.,* remediation general permit).
OSHA	- NAICS or SIC codes	- OSHA conducts monitoring as-needed for site investigations	- CEHD includes data from 1984 and forward.

Source	Reported Information Useful for Mapping OES/COU	Reporting Frequency	Notes
		- Monitoring data are available in CEHD when the investigation and any subsequent litigation cases are closed - Latest year in CEHD with data: 2021	
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: 2023	- NIOSH HHEs generally include narrative descriptions of facility processes and worker activities, with specific information on how the chemical being monitored for is used.
[a] Facilities may report using 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.			

8307

D.2 OES Mapping Procedures

This section contains procedures for mapping facilities to OES for each source discussed in Section D.1.

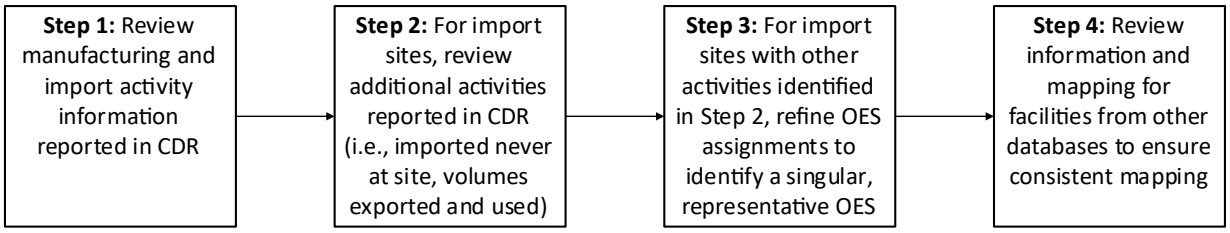
D.2.1 Chemical Data Reporting (CDR)

The only facilities required to report to CDR are those that manufacture or import specific chemicals at or above a specified threshold.[13] 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 four years. For risk evaluations conducted under the amended TSCA, EPA has primarily used 2016 and 2020 CDR. The procedures in this document are applicable to both 2016 and 2020 CDR data; however, there are some data elements that are only applicable to 2020 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 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 the published scope documents.

Figure_Apx D-1 depicts the steps that should be followed to map CDR reporting sites to OES. Each step is explained in the text below the figure.



Figure_Apx D-1. OES Mapping Procedures for CDR

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

[13] See 2020 CDR reporting instructions (accessed August 11, 2025) for further information, including descriptions on the information required to be reported.

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 versus 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]).

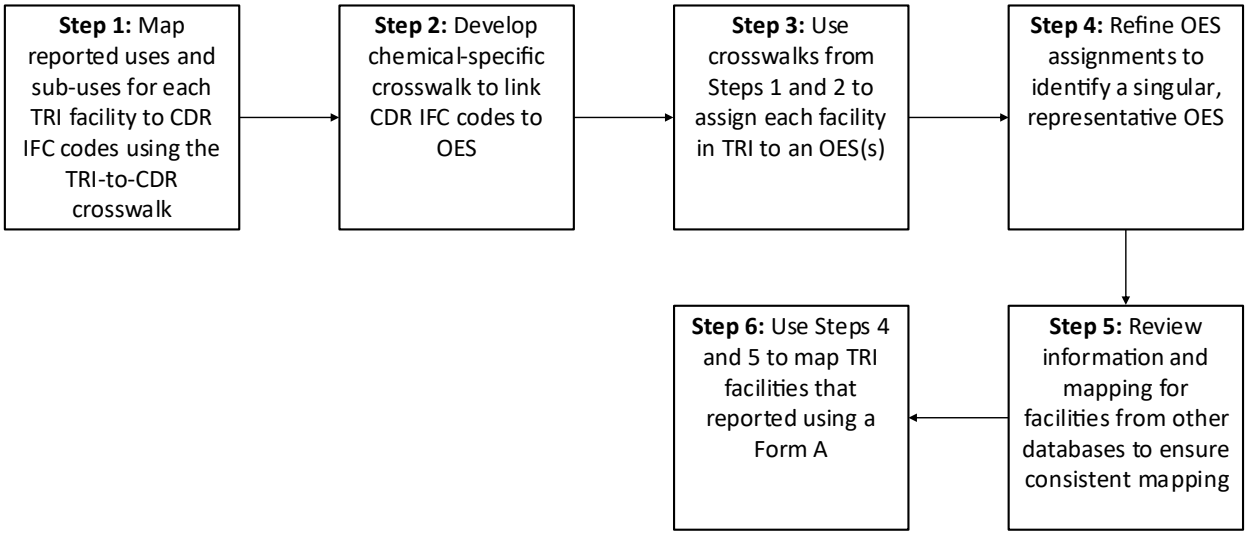
4. **Review Information from Other Databases:** Other databases/sources (such as TRI, NEI, and DMR) should be checked to see if the facility has reported to these. If so, the OES determined from the mapping procedures for those databases (discussed in other sections of this document) should also be used. 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, DMR, and NEI. 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.

D.2.2 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 D-2 depicts the steps that should be followed to map TRI reporting sites to OES. Each step is explained in the text below the figure.



Figure_Apx D-2. 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.[14] 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).

[14] IFC codes and their definitions can be found in Table 4-11 of the CDR reporting instructions: https://www.epa.gov/chemical-data-reporting/instructions-reporting-2016-tsca-chemical-data-reporting (accessed August 11, 2025).

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, DMR, and NEI.

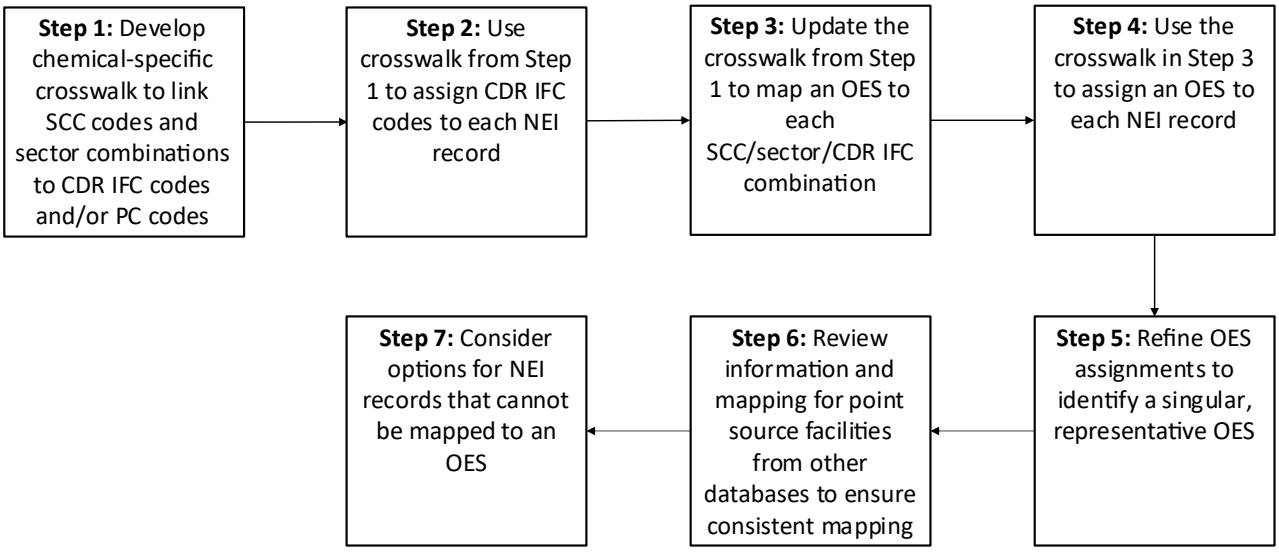
6. Note that facilities that submit using a TRI Form A do not report TRI uses/sub-uses. To determine the OES for these facilities, EPA will use information from Steps 4 and 5 above.

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.

D.2.3 National Emissions Inventory (NEI)

The NEI is a compilation of air emissions of criteria pollutants, criteria precursors, and hazardous air pollutants from point and non-point source air emissions. Air emissions data for the NEI are collected at the state, local, and tribal (SLT) level. The Air Emissions Reporting Requirement rule requires SLT air agencies to collect, compile, and submit criteria pollutant air emissions data to EPA. Many SLT air agencies also voluntarily submit data for pollutants on EPA's list of hazardous air pollutants. Major sources are required to report point source emissions data to their SLT air agency. Each SLT entity must, in turn, report point source emissions data to EPA every one to three years, depending upon the size of the source. Nonpoint estimates are typically developed by state personnel.

Figure_Apx D-3 depicts the steps that should be followed to map NEI reporting sites/records to OES. Each step is explained in the text below the figure.



Figure_Apx D-3. OES Mapping Procedures for NEI

To map sites reporting point source emissions and nonpoint emissions records for the chemical of interest to NEI, the following procedures should be used:

1. **Develop Crosswalks to Link NEI-Reported SCC and Sector Combinations to Chemical Data Reporting Codes:** The first step in mapping NEI data to potentially relevant OES is to develop a crosswalk to map each unique combination of NEI-reported Source Classification Code (SCC) (levels 1–4) and industry sectors to one or more CDR codes. This crosswalk is developed on a chemical-by-chemical basis rather than an overall crosswalk for all chemicals because SCCs correspond to emission sources rather than chemical uses such that the crosswalk to CDR codes may differ from chemical to chemical. In some cases, it may not be possible to assign all SCC sector combinations to CDR codes, in which case information from Step 5 can be used to help make OES assignments. Separate crosswalks are needed for point and nonpoint source records, as discussed below.
    a. For the point source NEI data, the crosswalk should map each unique combination of NEI-reported SCC and industry sectors to one or more CDR IFC codes.
    b. For nonpoint source NEI data, the crosswalk should link the SCC codes and sectors to both CDR IFC codes and/or commercial/consumer use PCs. This is because the nonpoint source data may include commercial operations, for which CDR PCs may be more appropriate.
2. **Use CDR Crosswalks to Assign CDR Codes:** Next, the chemical-specific CDR crosswalk developed in Step 1 should be used to assign CDR IFC codes to each point source NEI record and CDR IFC codes and/or commercial/consumer use PCs to each nonpoint source NEI record.
3. **Update CDR Crosswalks to Link CDR Codes to OESs:** The chemical-specific crosswalk developed in Step 1 is then used to link the SCCs, sectors, and CDR codes in the crosswalk to an OES. The OES will be assigned based on the chemical specific COU categories and subcategories and the OES mapped to them.
4. **Use CDR Crosswalks to Assign OESs:** The chemical-specific CDR crosswalks developed in Steps 1-3 are then used to assign OES to each point source and nonpoint source NEI data record (*i.e.,* each combination of facility-SCC-sector). Note that the individual facilities in the point source dataset may have multiple emission sources, described by different SCC and sector

combinations within NEI, such that multiple OES map to these NEI records. In such cases, a single, representative OES must be selected for each NEI record using the additional information described in Step 5. Similarly, the sectors reported by nonpoint sources may map to multiple CDR IFC or PC codes, such that multiple OES are applicable and must be refined to a single OES for each NEI record.

5. **Refine OES Assignments:** The initial OES assignments may need to be confirmed and/or refined to identify a single primary OES using the following information described below for point source and nonpoint source records.

    a. For point source records in NEI, use the following information to refine OES assignments:

        - Additional information available in NEI:
            - Facility name.
            - Primary NAICS code and description, populated from the EIS lookup tables.
            - Facility site description, which, when populated, is intended to describe the type of industry the facility operates (similar to a NAICS description).
            - Process description, which is a free-text field where reporters can provide additional information about the process related to their emission unit.
            - Emission unit description, which is a free-text field where reporters can provide additional information about their emission units.
        - 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).
        - Information from other reporting databases as described in Step 5b.
        - An evaluation of the OES that is most likely to result in a release (*e.g.,* facilities that map to both lubricant use and vapor degreasing may be assigned a vapor degreasing OES, because, in most cases, vapor degreasing results in higher air emissions).
        - Grouped OES for similar uses/sub-uses (*e.g.,* facilities that map to both general cleaning and vapor degreasing may be assigned a grouped OES that covers both cleaning and degreasing because the specific cleaning/degreasing operation cannot be determined from the NEI data).

    b. For nonpoint source records in NEI, use the following information to refine OES assignments (there is no additional data reported to NEI by nonpoint sources that can help refine the OES mapping):

        - General knowledge about the use of the chemical in the reported sector, such as from scope documents, public or stakeholder comments, process descriptions, professional judgement, or already-identified sources from systematic review.
        - Internet research of the uses of the chemical in the reported sector, if insufficient information is not already available per the previous bullet.

- An evaluation of the OES that is most likely to result in a release (*e.g.,* sectors that map to both lubricant use and vapor degreasing may be assigned a vapor degreasing OES, because, in most cases, vapor degreasing results in higher air emissions).
- Grouped OES for similar uses/sub-uses (*e.g.,* sectors that map to both general cleaning and vapor degreasing may be assigned a grouped OES that covers both cleaning and degreasing because the specific cleaning/degreasing operation cannot be determined from the NEI data).

6. **Review Information from Other Databases for Point Source Facilities:** Other databases/sources (including CDR, TRI, and DMR) should be checked to see if the point source facilities have 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, DMR, and NEI.
7. **Consider Options for NEI Records That Cannot be Mapped to an OES:** Given the number of records in NEI and the information available, it may not always be feasible to achieve mapping of 100% of the sites reporting to NEI to an OES. For example, there may be NEI records for restaurants or the commercial cooking sector, which do not map to an in-scope COU or OES. Additionally, NEI records may include emissions from combustion byproducts for the chemical, which does not correspond to a COU or 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 facility for clarification on the use of the chemical. ICR requirements also apply when contacting 10 or more facilities. Note that information requests such as these may require an Information Collection Request (ICR) if 10 or more entities are contacted.[15]

D.2.4 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 wastewater treatment plant or publicly owned treatment works) 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.

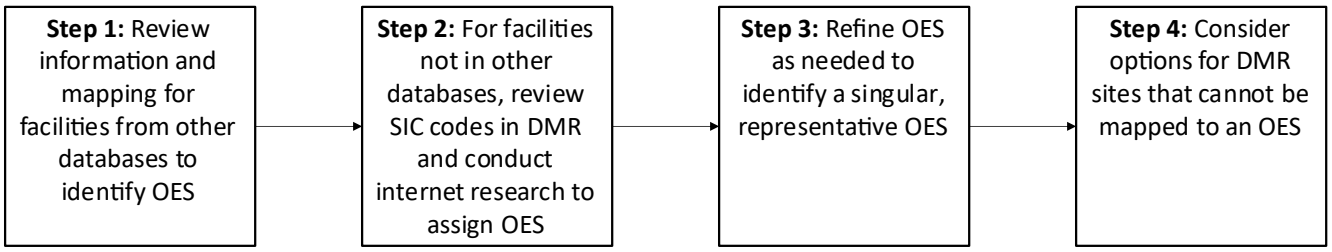
- **Technology-Based Guidelines:** If the facility falls within a certain industrial sector, it may be covered by a national effluent guideline. Effluent guidelines are industry-specific and contain treatment technology-based guidelines for discharges of specified pollutants (chemicals)

[15] More on Information Collection Requests can be found at https://www.epa.gov/icr/icr-basics (accessed August 11, 2025).

commonly found within that industry.[16] 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 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.[17]

- **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 D-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.



Figure_Apx D-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, TRI, and NEI). 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, DMR, and NEI.
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

[16] 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 August 11, 2025).
[17] 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.

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 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.[18] 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.

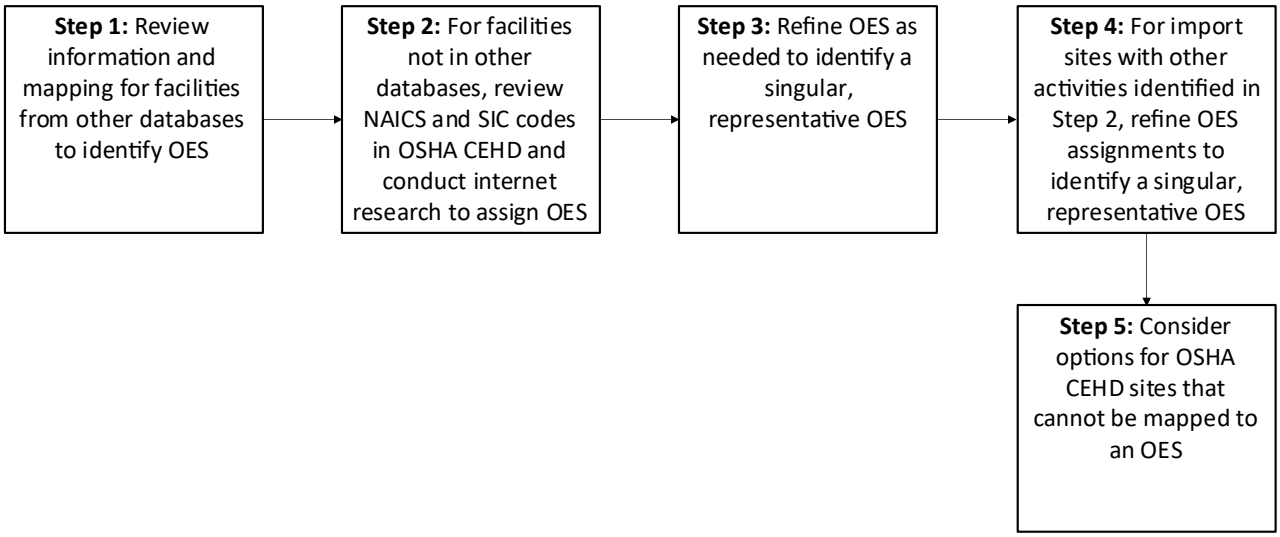
[18] Information on individual and general NPDES permits can be found at: https://www.epa.gov/npdes/npdes-permit-basics

b. Contacting the state government for the NPDES permit, permit applications, past inspection reports, and any available information on facility operations. Note that 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.

D.2.5 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.[19] OSHA conducts monitoring to compare against occupational health standards. Therefore, unlike CDR, TRI, NEI, 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 D-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.



Figure_Apx D-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, NEI, and TRI). If so, the OES determined from the mapping procedures

[19] More information on OSHA CEHD can be found at: https://www.osha.gov/opengov/health-samples (accessed August 11, 2025).

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 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 are non-detects for the chemical and for which there is no bulk data indicating the presence of the chemical <u>do not</u> need to be mapped to an OES. This is because the data do not provide evidence that the chemical is present at the site.

D.2.6 National Institute of Occupational Safety and Health (NIOSH) Health Hazard Evaluation (HHE)

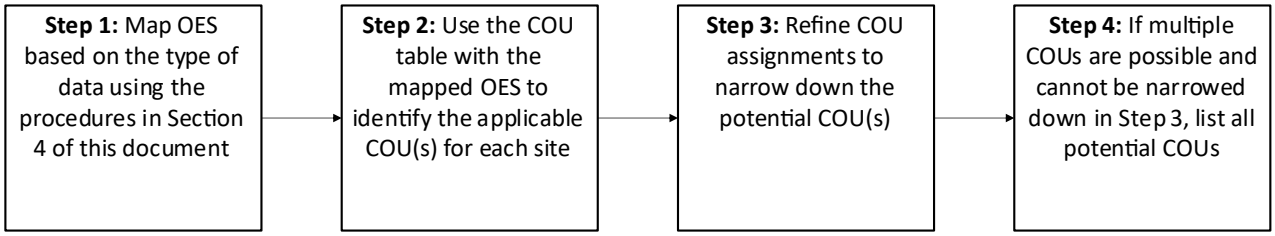
NIOSH conducts HHEs at facilities to evaluate current workplace conditions and to make recommendations to reduce or eliminate the identified hazards.[20] NIOSH conducts HHEs at the request of employers, unions, or employees in workplaces where employee health and wellbeing is affected by the workplace. Therefore, unlike CDR, TRI, NEI, 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.

D.3 COU Mapping Procedures

There is not always a one-to-one mapping between COUs and OESs.

Figure_Apx D-6 depicts the steps that should be followed to map sites from the standard sources discussed in this document to COUs, using the OES mapping completed in Appendix D.2. Each step is explained in the text below the figure.



Figure_Apx D-6. COU Mapping Procedures for Standard Sources Already Mapped to OES

To map facilities from standard sources (*i.e.,* CDR, TRI, NEI, 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 D.2).
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 should be used to identify the COU(s) for the facility using the OES mapped per Section D.2.

[20] More information about NIOSH HHEs is available at: https://www.osha.gov/opengov/health-samples (accessed August 11, 2025)https://www.cdc.gov/niosh/hhe/about.html.

3. **Refine the COU Assignment:** In some instances, more than one COU may map to the facility. In such cases, the following information should be used to try to narrow down the list of potentially applicable COUs:

    a. Information from the standard sources (*e.g.,* if EPA assigned a grouped OES like "Industrial Processing Aid" and the facility's NAICS code in TRI or NEI is related to battery manufacturing, the COU can be identified as the "Processing Aid" category and Process solvent used in battery manufacture" subcategory).
    b. Internet research of the types of products made at the facility (*e.g.,* if a facility's website indicates the facility makes adhesives, the COU category of "Processing – Incorporation into formulation, mixture or reaction product" and subcategory of "Adhesives and sealant chemicals" can be assigned and the remaining subcategories [*e.g.,* solvents for cleaning or degreasing, solvents which become part of the product formulation or mixture] are not applicable) 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).

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.

Appendix E 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.

E.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 TSCA 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 are only reported annually for the previous calendar year and is typically released in July (*i.e.,* 2020 TRI data are 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.

E.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 are 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 estimate 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 is always producing 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 chemicals 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.

9. ***All Other OESs:*** Regardless of what the facility operating schedule is, other OES are unlikely to use the chemical of interest every day. Therefore, a value of 250 days/year should be used for these OESs.

E.3 Approach for Estimating Daily Discharges

After the initial steps of selecting and mapping of the water discharge data and estimating the number of facility operating days/year have been completed, the next steps in the analysis are to make estimates of daily wastewater discharges. This guidance presents approaches for making the following estimates:

- Average daily wastewater discharges – this approach averages out the yearly discharges into an average daily discharge rate for the entire year for the facility
- High-end daily wastewater discharges – this approach estimates a high-end daily discharge rate that may take place for a period of time during the year for the facility
- 1-Day maximum discharge rate – this approach estimates a discharge rate that may represent a 1-day maximum rate for the facility.

E.3.1 Average Daily Wastewater Discharges

The following steps should be used to estimate the average daily wastewater discharge for each facility for each year:

1. Obtain total annual loads calculated from the Loading Tool and reported annual surface water discharges in TRI.
2. For facilities with both TRI and DMR data, compare the annual surface water discharges reported to each to see if they agree. If not, select the data representing the highest annual discharge.
3. Divide the annual discharge over the number of estimated operating days for the OES to which the facility has been mapped. The number of operating days will differ for each OES and chemical but typically ranges from 200 to 350 days/year (see Section E.2 for approach to estimating operating days/year).

This approach can be used for both direct discharges to surface water and indirect discharges to POTW or non-POTW WWT. However, special care should be given to facilities reporting transfers to POTW or non-POTW WWT plants in TRI as the subsequent discharge to surface water from these transfers may already be accounted for in the receiving facilities DMRs.

E.3.2 High-End Daily Direct Discharge for Facilities with DMR Data

The following steps should be used to estimate the high-end daily direct discharge for each facility with DMR data for each year:

1. Use the Loading Tool to obtain the reporting periods (*e.g.,* monthly, bimonthly, quarterly, biannually, annually) and required reporting statistics (*e.g.,* average monthly concentration, max daily concentration) for each external outfall at each facility. When there is one outfall reported in the Loading Tool, assume it is an external outfall. If multiple outfalls are reported in the Loading Tool, further investigation to determine the external outfall would be required, such as a review of facility's permits.
2. For each external outfall at each facility, calculate the average daily load for each reporting period by multiplying the period average concentration by the period average wastewater flowrate. If there is one outfall reported in the Loading Tool, assume it is an external outfall. Further investigation is needed if multiple outfalls are reported in the Loading Tool to determine the external outfall, such as a review of the facility's permit.

3. Sum the average daily loads from each external outfall for each period.
4. Select the period with the highest average daily load across all external outfalls as an estimate of the high-end daily discharge assessed over the number of days in the period. The number of days in the reporting period does not necessarily equate to the number of operating days in the reporting period. For example, for a plant that operates 200 days/year, use 200 rather than 365 days/year for average daily discharge. Therefore, discharges will not occur every day of the reporting period, but only for a fraction (200/365 = 68%). The number of days of the reporting period should be multiplied by this factor to maintain consistency between operating days/year and operating days/reporting period.

E.3.3 High-End Daily Direct Consecutive Discharge for Facilities Without DMRs

Some facilities may report surface water discharges to TRI but are not required to monitor or report those discharges under the NPDES. In such cases, EPA will only have the annual discharge value and not discharge values from multiple periods throughout the year. To estimate the high-end daily direct discharges for these facilities the following steps should be taken:

1. Identify facilities that report under the NPDES program for the same chemical, same year, and same OES as the TRI facility and report DMRs monthly. Note: if no monthly reporters exist, reporters with less frequent reporting can be substituted provided the number of release days per year are adjusted in subsequent steps.
2. For each facility identified in #1, calculate the percentage of the total annual discharge that occurred in the highest one-month period.
3. Calculate a generic factor for the OES as the average of the percentages calculated in #2.
4. Estimate the high-end daily discharge for each facility without DMRs by multiplying the annual discharge by the generic factor from #3. For example, a facility reports 500 lb released per year and has a generic factor of 15% for the OES from #3. The estimated high-end chronic daily discharge for the facility would be (500 lb × 15% = 75 lb/month).
5. Use the value calculated in #4 as an estimate of the high-end daily discharge assessed over 30 days per year. For example, the high-end daily discharge assessed over 30 days per year for the facility with the estimated high-end chronic daily discharge of 75 lb/month (from #4 above) is (75 lb/month / 30 days = 2.5 lb/day for 30 days).

This approach can also be applied to facilities that have less frequent reporting periods under the NPDES program (*e.g.,* facilities that report quarterly or biannually), using the facility specific permit data for less frequent reporting periods. Refer to Section E.1 for additional details.

E.3.4 High-End Daily Indirect Discharges

In general, EPA is unlikely to have detailed information to estimate high-end daily indirect discharges to POTWs or non-POTW WWT plants and will only be able to calculate average daily discharges. However, in some cases, EPA may have site-specific information that allows for the estimation of a range for the release days per year (*e.g.,* such information can be found in ECHO). In such instances, EPA can calculate the high-end daily discharge as the annual discharge divided by the minimum number of release days per year.

E.3.5 1-Day Discharges

Facilities required to report under the NPDES may sometimes be required to report a daily maximum discharge concentration for the period. These values can be used to estimate 1-day discharges by

multiplying the maximum daily concentration by the corresponding month's maximum daily wastewater flow rate.

E.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.

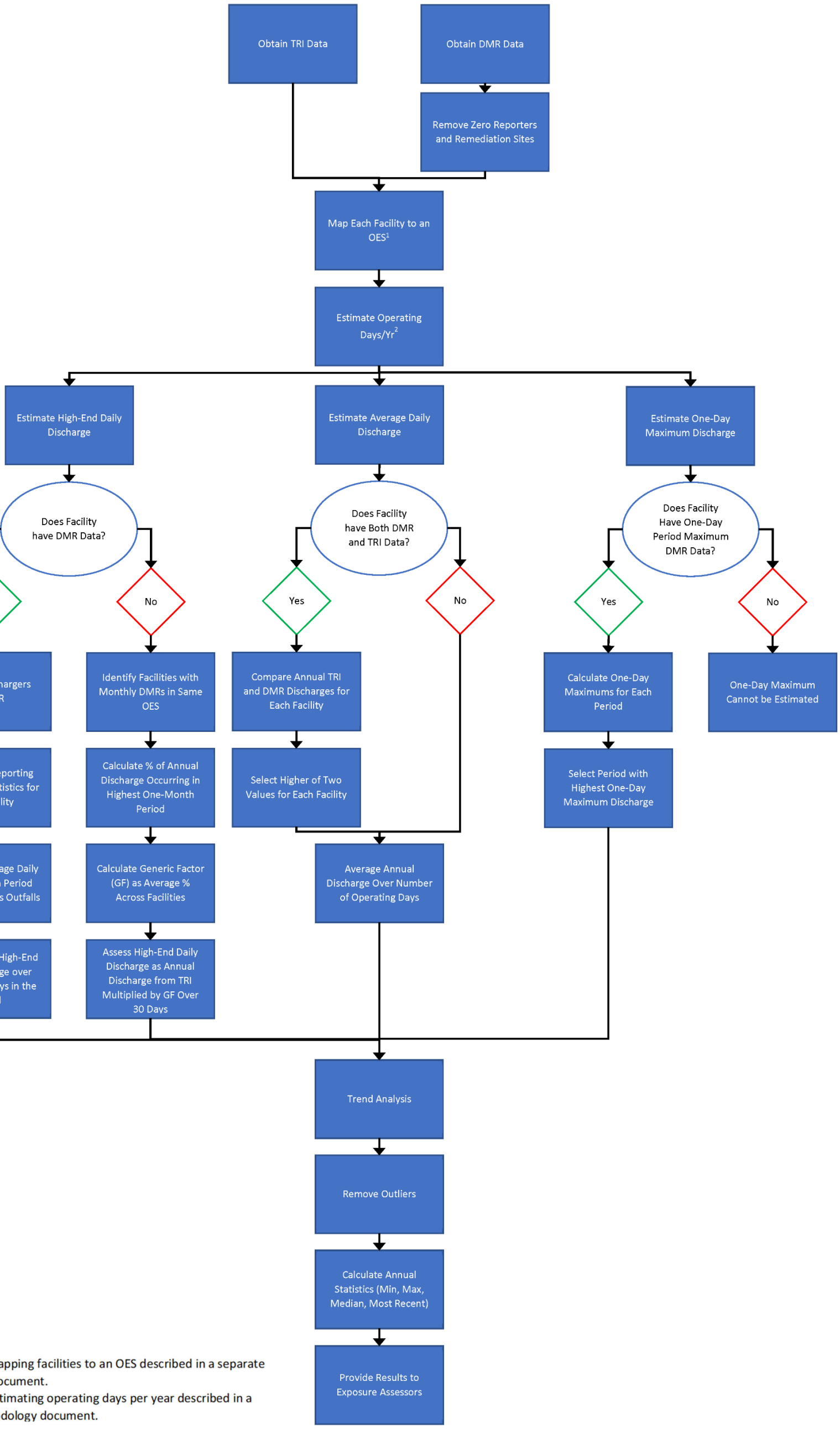
The interquartile rule for outliers states that if the distance between a data point and the first or third quartile is greater than 1.5 times the interquartile range (IQR), the data point is an outlier. The IQR is the difference between the third quartile (*i.e.,* 75th percentile) and first quartile (*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.

E.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 E-1 below, helps visualize the process for estimating daily discharges.



[1] Method for mapping facilities to an OES described in a separate methodology document.
[2] Method for estimating operating days per year described in a separate methodology document.

Figure_Apx E-1. Decision Tree for Wastewater Discharge Estimates Using TRI and DMR Data

Appendix F GUIDANCE FOR USING THE NATIONAL EMISSIONS INVENTORY AND TOXIC RELEASE INVENTORY FOR ESTIMATING AIR RELEASES

This appendix provides guidance for using EPA's NEI and 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.

F.1 Background

EPA's NEI and TRI programs require individual facilities, as well as SLT Air Agencies, to report information on airborne chemical releases to the EPA. While the chemicals reported under each program differ, both inventories include data for some of the chemicals undergoing TSCA risk evaluation. When available, the NEI and TRI data include information on the sources, magnitude, and nature (*e.g.,* stack vs. fugitive, stack height, stack gas velocity/temperature) of airborne releases from industrial/ commercial facilities and other smaller emissions sources. Thus, these databases may provide useful information for estimating air releases of TRI- and/or NEI-covered chemicals, for certain OESs.

As the NEI and TRI programs operate under separate regulatory frameworks, the data reported under these programs do not always overlap. For example, in 2017, approximately 745,000 lb of perchloroethylene (PERC) air emissions were reported to TRI, whereas approximately 16.6 million lb of PERC air emissions were reported to NEI. This document provides an approach for using NEI data, in combination with TRI data, to estimate air emissions.

F.2 Obtaining Air Emissions Data

F.2.1 Obtaining NEI Data

NEI emissions data are categorized into (1) point source data, (2) area or nonpoint source data, (3) onroad mobile source data, and (4) nonroad mobile source data. EPA included only point source data categories in the assessment of environmental releases in this risk evaluation. Point sources are stationary sources of air emissions from facilities with operating permits under Title V of the CAA, also called "major sources." Major sources are defined as having actual or potential emissions at or above the major source thresholds. Although thresholds can vary for certain chemicals in NAAQS non-attainment areas, the default threshold is 100 tons/year for non-HAPs, 10 tons per year for a single HAP, or 25 tons per year for any combination of HAPs. Point source facilities include large energy and industrial sites and are reported at the emission unit- and release point-level.

Area or nonpoint sources are stationary sources that do not qualify as major sources. The nonpoint data are aggregated and reported at the county-level and include emissions from smaller facilities as well as agricultural emissions, construction dust, and open burning. Industrial and commercial/institutional fuel combustion, gasoline distribution, oil and gas production and extraction, publicly owned treatment works, and solvent emissions may be reported in the point or nonpoint source categories depending upon source size. EPA targeted its review of environmental releases to point sources, and did not review the road, nonroad, and other automotive exhaust information identified.

Onroad mobile sources include emissions from onroad vehicles that combust liquid fuels during operation, including passenger cars, motorcycles, trucks, and buses. The nonroad mobiles sources data include emissions from other mobile sources that are not typically operated on public roadways, such as locomotives, aircraft, commercial marine vessels, recreational equipment, and landscaping equipment.

Onroad and nonroad mobile data are reported in the same format as nonpoint data; however, it is not available for every chemical. EPA did not include area or nonpoint sources in the assessment of environmental releases in this risk evaluation. Further details on EPA's approach to using NEI data for estimating releases are described in Section F.4 and 4.2.3.3.

The first step in using NEI data to estimate air releases is to obtain the NEI data in a workable format that provides the requisite data for release estimation and modeling. The NEI data are available on EPA's NEI public website (accessed June 17, 2026) as downloadable zip files, divided into onroad, nonroad, nonpoint, and point source data files. The zipped point source data files are extremely large and require specialized database experience to query and manipulate. As an alternative, EPA's EIS Gateway allows registered EPA users, registered SLT users, and approved contractors to query and download NEI data and associated reporting code descriptions. As a result, this methodology uses the EIS Gateway to query point source data. Following download, the point and nonpoint emissions data for the chemical of interest will be imported into an MS Excel spreadsheet (or using an alternative tool, if the data exceeds Excel's size threshold), to be filtered and manipulated. At this point, EPA will use the EIS lookup tables to populate field descriptions for data fields reported as numerical codes (*e.g.,* NAICS code).

F.2.2 Obtaining TRI Data

TRI data may be downloaded from EPA's public TRI Program and TRI Data and Tools website (accessed June 17, 2026). Once the csv file(s) has (have) been downloaded, the data are filtered by the chemical of interest using the CAS number and/or chemical name. Relevant NEI 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.

F.3 Mapping NEI and TRI Data to Occupational Exposure Scenarios

Once TRI and NEI data are obtained, the next step is to map the data to OESs. For procedures for mapping facilities from TRI and NEI to OESs, refer to Section 4.1.

F.4 Estimating Air Releases Using NEI and TRI Data

EPA will use the mapped NEI and 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.

F.4.1 Linking NEI and TRI Data

Although NEI and TRI have different reporting requirements, some major sources are expected to report to both databases. The most reliable way to link the datasets is with a common identifier. NEI reports EIS Facility Identifier and Facility Registry Identifier (FRSID), although the latter is not reliably populated for all NEI records. TRI reports TRI Facility ID and FRSID. EPA will use its database of EIS Alternate Facility Identifiers ("EISAltFacilityIdentifiers_20211221.accdb") to link TRIFID to an EIS Facility Identifier. Linkages may be confirmed and/or refined using facility names and addresses, if necessary.

Following linkage, EPA will review the linked NEI/TRI data to ensure that facilities with records in both databases are assigned to a consistent OES. When discrepancies arise, the Agency will resolve these discrepancies using the dataset with the greatest level of detail. In general, NEI provides more detailed air emissions data than TRI. For example, NEI reports SCC levels 1 to 4, which provide insight

into the specific operations and/or process units associated with NEI-reported air emissions. For example, "Chemical Evaporation Organic Solvent Evaporation Degreasing Entire Unit: Open-top Vapor Degreasing" is a SCC description used in the NEI. This SCC description identifies the emission unit, not only as a degreaser, but as a specific type of degreaser. NEI also includes free text fields where reporters can include additional information about a particular facility and/or emission unit. TRI does not provide this level of detail.

Following a review of OES assignments, the TRI and NEI data will be divided into separate tables by OES code, which may be linked using the EIS Facility Identifier.

F.4.2 Evaluation of Sub-Annual Emissions

As air emissions data in TRI and NEI 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, this information may be estimated from operating data reported to the NEI.[21] 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. *NEI Data:* The NEI dataset includes facility-specific air emissions estimates for major sources and often includes data on the number of hours of operation per day for these facilities. The number of operating hours from NEI can be used to inform release duration for the specific facilities being assessed. Hours of operation for one facility in NEI are typically not used for a different facility; however, engineers may consider conducting an analysis of operating hours for multiple facilities in NEI that are a part of the same OES to develop a broader estimate of release duration at the OES-level. EPA has previously used this approach to inform development of GS/ESDs, but it is dependent on the amount of data and time available and should be discussed on a chemical-specific basis.

2. *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 Vapor Degreasing Near-Field/Far-Field Inhalation Exposure Model, Spot Cleaning Near-Field/Far-Field Inhalation Exposure Model, models from GS/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 NEI or 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.

3. *Literature:* Literature sources from systematic review, including GS/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

[21] Note that the NEI operating hours fields are not populated for all, or in the case of ethylene dibromide, most, NEI entries.

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.

4. *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. *NEI Data:* The NEI dataset includes facility-specific air emissions estimates for major sources and often includes data on the number of days of operation per week and number of weeks of operation per year for these facilities. NEI does not indicate if the number of days per week or weeks per year of operation are consecutive or intermittent throughout the week/year; however, these data are still useful and should be provided by engineers with air emission estimates to help inform release patterns. Data on operational days per week and weeks per year for one facility in NEI is typically not used for a different facility; however, engineers may consider conducting an analysis of these data for multiple facilities in NEI that are a part of the same OES to develop a broader estimate of release pattern at the OES-level. EPA has previously used this approach to inform development of GS/ESDs, but it is dependent on the amount of data and time available and should be discussed on a chemical-specific basis.
2. *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 GS/ESDs) sometimes, but 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.,* NEI, 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).
3. *Literature:* Literature sources from systematic review, including GS/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.
4. *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

For major sources that report operating data to NEI, EPA will use these data to calculate operating hours on a days per year basis. For major sources that do not report operating data in NEI (including facilities that only report to TRI), EPA will estimate operating hours using the other data sources described above. A hierarchical approach for estimating the number of facility operating days per year is described below.

1. *Facility-Specific Data:* Use facility-specific data, if available. NEI reports operating data as hours per year, hours per day, days per week, and weeks per year.
    a. If possible, calculate operating days per year as: Days/yr = hours per year ÷ hours per day.
    b. If hours per year and/or hours per day are not reported, calculate days per year as: Days/yr = Days per week × weeks per year.
2. *Facility-Specific Use Rate:* If information on facility-specific use rates is available, estimate days/yr using one of the following approaches:
    a. If facilities have known or estimated average daily use rates, calculate the days/yr as: Days/yr = Estimated Annual Use Rate for the Site (kg/yr) ÷ average daily use rate from sites with available data (kg/day).
    b. If sites without days/yr data do not have known or estimated average daily use rates, use the average number of days/yr from the sites with such data.
3. *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.
4. *Manufacture of Large-PV Commodity Chemicals:* For the manufacture of the large-PV commodity chemicals, a value of 350 days/yr should be used. This assumes the plant runs 7 day/week and 50 week/yr (with 2 weeks down for turnaround) and assumes that the plant is always producing the chemical.
5. *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/yr should be used. This assumes the plant manufactures the chemical 5 days/week and 50 weeks/yr (with 2 weeks down for turnaround).
6. *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/yr such that the use of a chemical as a reactant to manufacture a commodity chemical will also occur 350 days/yr.
7. *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/yr can be used.
8. *Other Chemical Plant OES (e.g., Processing into formulation and Use of industrial processing aids):* For these OESs, 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/yr 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/yr for the chemical industry. However, in instances where the OES uses a low volume of the chemical of interest, 250 days/yr can be used as a lower estimate for the days/yr.
9. *All Other OESs:* Regardless of facility operating schedule, other OESs are unlikely to use the chemical of interest every day. Therefore, a value of 250 days/yr should be used for these OESs.

Estimating Number of Operating Days for Area Sources

For area sources, EPA will also estimate operating days per year using information such as NEI operating data for major source facilities within the same OES, general information about the OES, and values from literature.

Facility operating days per year will be used to calculate daily emissions from the NEI and TRI annual emissions data, as follows:

$$\text{Daily emissions (kg/day)} = \text{Annual emissions (kg/yr)} \div \text{Operating days per year (days/yr)}$$

Appendix G AIR MONITORING CONCENTRATIONS FOR *p*-DICHLOROBENZENE

G.1 Ambient Monitoring Technology Information Center (AMTIC) Ambient Monitoring Archive (AMA) Data

Table_Apx G-1. Summary of Air Monitoring Concentrations for *p*-Dichlorobenzene from AMTIC

Ambient Monitoring Technology Information Center Hazardous Air Pollutants						
Chemical	**Sample Duration**	**Statistic ($\mu g/m^3$)**	**Year**			
			2019	**2020**	**2021**	**2022**
***p*-Dichlorobenzene**	**24-Hour**	Maximum	2.45E01	1.59E01	1.18E01	1.39E01
		Arithmetic Mean	6.79E−02	8.20E−02	8.19E−02	9.95E−02
		Without NDs and Below MDL	4.89E−01	3.73E−01	3.78E−01	5.16E−01
		Geometric Mean	0.00E0	0.00E0	0.00E0	0.00E0
		Without NDs and Below MDL	1.99E−01	2.17E−01	2.08E−01	2.78E−01
		Median	0.00E0	0.00E0	0.00E0	7.88E−03
		Without NDs and Below MDL	1.59E−01	2.04E−01	2.10E−01	2.96E−01
		Minimum	0.00E0	0.00E0	0.00E0	0.00E0
		Without NDs and Below MDL	1.83E−02	3.57E−02	2.99E−02	4.13E−02
		Total Samples	4097	7888	8372	8056
		Total NDs	2857	4361	4390	3751
		ND %	69.7%	55.3%	52.4%	46.6%
		MDL	0.0174–4.629	0.0228–4.028	0.03–3.85	0.018–4.45
		Total Below MDL	768	2242	2611	3038
		Below MDL %	18.7%	28.4%	31.2%	37.7%
	25-Minute	Maximum	8.42E−01	7.82E−01	1.16E0	4.04E0
		Arithmetic Mean	1.08E−01	4.92E−02	1.31E−01	1.29E−01
		Without NDs and Below MDL	2.50E−01	1.89E−01	2.79E−01	1.94E−01
		Geometric Mean	0.00E0	0.00E0	0.00E0	0.00E0
		Without NDs and Below MDL	2.09E−01	1.64E−01	2.14E−01	1.13E−01
		Median	6.00E−02	0.00E0	6.01E−02	6.00E−02

Ambient Monitoring Technology Information Center Hazardous Air Pollutants						
Chemical	**Sample Duration**	**Statistic ($\mu g/m^3$)**	**Year**			
			2019	**2020**	**2021**	**2022**
***p*-Dichlorobenzene**	**25-Minute**	Without NDs and Below MDL	1.82E−01	1.21E−01	1.80E−01	1.19E−01
		Minimum	0.00E0	0.00E0	0.00E0	0.00E0
		Without NDs and Below MDL	1.19E−01	1.18E−01	1.17E−01	5.85E−02
		Total Samples	109	158	226	239
		Total NDs	50	100	90	81
		ND %	45.9%	63.3%	39.8%	33.9%
		MDL	0.120246001	0.120246001	0.120246	Federal MDL
		Total Below MDL	16	25	38	–
		Below MDL %	14.7%	15.8%	16.8%	–

9234

G.2 Air Quality System (AQS) Monitoring Data

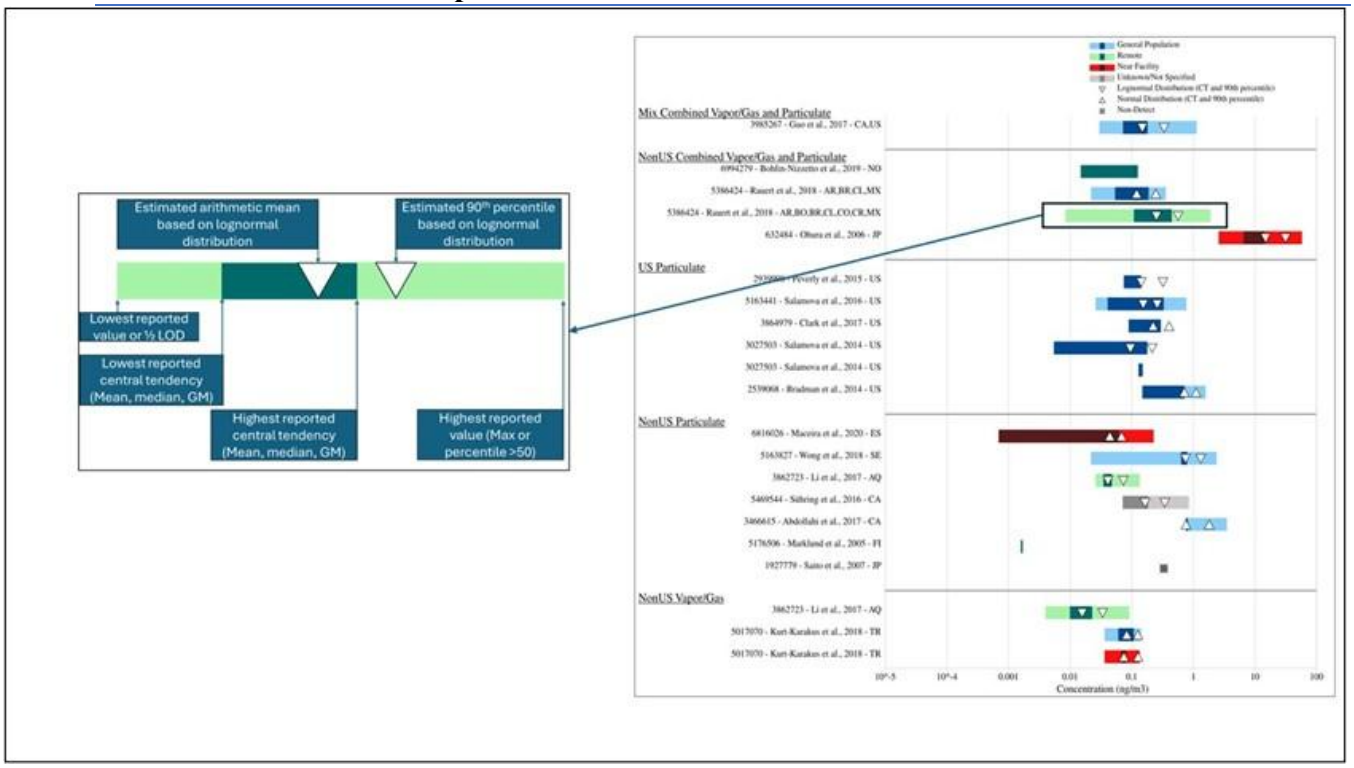
Table_Apx G-2. Summary of Air Monitoring Concentrations for *p*-Dichlorobenzene from Air Quality System (AQS)

Air Quality System							
Chemical	**Sample Duration**	**Statistics (µg/m³)**	**2019**	**2020**	**2021**	**2022**	**2023**
***p*-Dichlorobenzene**	**24-Hour**	Maximum	2.21E01	1.59E01	1.18E01	1.33E01	1.50E01
		Arithmetic Mean	7.63E−02	8.34E−02	8.06E−02	9.30E−02	8.18E−02
		Without Zeros	2.93E−01	2.81E−01	2.84E−01	3.58E−01	2.73E−01
		Geometric Mean	0.00E0	0.00E0	0.00E0	0.00E0	0.00E0
		Without Zeros	1.46E−01	1.58E−01	1.50E−01	1.63E−01	1.58E−01
		Median	0.00E0	0.00E0	0.00E0	0.00E0	0.00E0
		Without Zeros	1.00E−01	1.20E−01	1.00E−01	1.80E−01	1.00E−01
		Minimum	0.00E0	0.00E0	0.00E0	0.00E0	0.00E0
		Without Zeros	1.00E−02	1.00E−02	1.00E−02	1.00E−02	1.00E−02
		Total Samples	7,287	6,903	7,407	7,182	5,850
		Total Zeros	5,393	4,851	5,303	5,317	4,098
		Zeros %	74.0%	70.3%	71.6%	74.0%	70.1%

Appendix H SUPPLEMENTAL INFORMATION OF PEER-REVIEWED LITERATURE AND STUDY RATINGS FOR MEASURED CONCENTRATIONS OF PARA-DICHLOROBENZENE

H.1 Environmental Monitoring Concentrations Reported by Media Type

H.1.1 Tornado Plot Interpretations and Methods



Figure_Apx H-1. Example Tornado Plot

Tornado plots display exposure data from studies identified during systematic review. An example is provided in Figure_Apx H-1. In this document, there is one tornado plot for every media type where chemical concentrations are plotted on a logarithmic scale.

The y-axis of the tornado plot is a list of each study aggregate representing a media sampled in a similar micro-environment and location type and reported on the same unit/weight basis. A study may have more than one aggregate representation dependent on how the data are reported; for example, if a study reports exposure data for two different location types separately, the data would be plotted as two separate aggregates.

Exposure data are classified into a variety of location types:

Ambient Air Classifications

Ambient air samples are classified based on their location to sources of exposures, as described below.

Near Facility
Near Facility exposures are collected near buildings or activities that are industrial in nature (including manufacturing, mining, pulp and paper mill, wastewater treatment plants, fire training facilities, ports), commercial activities known to use chemicals (such as dry cleaners, gas stations, and construction sites), residential areas near a facility (these areas may be referred to as "fence-line communities" or "highly-exposed communities"), or ocean samples from a port or contaminated area. Near facility samples are not strictly contaminated sites and may be site-specific or not site-specific.

General Population
General population exposures are ambient measurements taken in areas near residential populations with no known near-facility sources nearby. The data often represents widely distributed releases to the environment.

Remote
Remote exposures are measurements taken in areas away from residential and industrial activity and have no known sources of contamination beyond long-range transport. Examples of remote exposures include samples collected from polar regions, samples from oceans (not including ports), and sample locations specifically described as remote.

Indoor Air Classifications
Indoor air samples are classified based on sampling location micro-environments such as commercial buildings, residential homes, public buildings (offices, schools), and vehicles. If the reported study data represent a combination of more than one of these micro-environments, then they are classified as mixed use.

Personal Inhalation Classifications
Personal inhalation samples are classified based by indoor, indoor/outdoor, and outdoor, depending on the activity pattern of the monitored subject.

Groundwater, Sediment, Soil and Surface Water Classifications

Near Facility
Near Facility exposures are collected near buildings or activities that are industrial in nature (including manufacturing, mining, pulp and paper mill, wastewater treatment plants, fire training facilities, ports), commercial activities known to use chemicals (such as dry cleaners, gas stations, and construction sites), residential areas near a facility (these areas may be referred to as "fence-line communities" or "highly-exposed communities"), or ocean samples from a port or contaminated area. Near facility samples are not strictly contaminated sites and may be site-specific or not site-specific.

General Population
General population exposures are ambient measurements taken in areas near residential populations with no known near facility sources nearby. The data often represents widely distributed releases to the environment.

Remote
Remote exposures are measurements taken in areas away from residential and industrial activity and have no known sources of contamination beyond long-range transport. Examples of remote exposures include samples collected from polar regions, samples from oceans (not including ports), and sample locations specifically described as remote.

Drinking Water Classifications
Drinking water samples will indicate their sampling location at the drinking water plant or distribution system.

Wastewater Classifications
Wastewater samples will indicate their sampling location at the wastewater processing facility.

Each study on the y-axis is reported with its HERO ID, a short citation, and the country abbreviation of data collection. The studies are grouped by country (US or Canada) and by unit/weight basis, and sorted in descending order by latest sample collection year.

Every study has a colored bar stretching across the x-axis. The color of the bar corresponds to the location type of the exposure data. The lighter bar represents the range of the reported concentrations, and the darker bar represents the range of reported central tendencies. A study with only dark bars indicates that the only data reported was a measure of central tendency.

Using the reported exposure data, we attempted to represent the arithmetic mean and 90th percentile. If sufficient central tendency and variance data were reported, the mean and 90th percentile were calculated directly from the study values where we could assume data were normally or lognormally distributed. When at least a central tendency and percentile value were provided, they were estimated by fitting the data to a lognormal distribution to all available data within the study aggregate. When fitting a lognormal distribution was not possible, a normal distribution was fit. The central tendency and 90th percentile of each distribution are plotted as triangles. Lognormal values are shown as upside-down triangles, while normal values are shown as right-side up. A study with no triangles indicates that there was insufficient data to fit a distribution.

A study may not have reported concentrations because all data are below the limit of detection. In these circumstances, the plot will show a circle with an X through it plotted at half the reported limit of detection. The color of the symbol will correspond to the color of the data's location type.

H.2 Supplemental Information of Peer-Reviewed Literature for Measured Concentrations of *p*-Dichlorobenzene

Table_Apx H-1. Summary of Peer-Reviewed Literature That Measured *p*-Dichlorobenzene (µg/m^3) Levels in the Vapor/Gas Fraction of Ambient Air

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (µg/m^3)	Overall Quality Level
Zhong et al. (2017)	US	General Population	2015–2016	35 (0)	0.03	Medium
U.S. EPA (2015b)	US	General Population	2010–2012	81 (N/R)	N/R	High
Logue et al. (2010)	US	General Population	2006–2008	244 (N/R)	N/R	High
	US	Near Facility	2006–2008	244 (N/R)	N/R	High

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (µg/m^3)	Overall Quality Level
Dodson et al. (2007)	US	General Population	2007	89 (0.46)	0.237	High
Bereznicki et al. (2012)	US	General Population	2004–2007	992 (0.91)	0.134	Medium
Yu et al. (2014)	US	Near Facility	2005–2006	195 (0.75)	0.04	High
Weisel et al. (2005)	US	General Population	1999–2001	555 (0.25)	0.83	High
Delfino et al. (2003)	US	General Population	1999–2000	88 (0.73)	0.6	Medium
Sax et al. (2006)	US	General Population	1999–2000	81 (0.69)	N/R	High
Adgate et al. (2004b)	US	General Population	2000	18 (0.44)	N/R	Medium
Adgate et al. (2004a)	US	General Population	1997	100 (0.42)	0.2	High
N/R = not reported; US = United States						

Table_Apx H-2. Summary of Peer-Reviewed Literature That Measured *p*-Dichlorobenzene (µg/m^3) Levels in the Vapor/Gas Fraction of Indoor Air

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (µg/m^3)	Overall Quality Level
Zhong et al. (2017)	US	Public Space	2015–2016	144 (0.15)	0.03	Medium
Chan et al. (2014)	US	Public Space	2011–2013	21 (0.71)	0.04	Medium
Chin et al. (2014)	US	Residential	2009–2010	325 (0.98)	0.02	High
Dodson et al. (2007)	US	Public Space	2007	178 (0.53)	0.237	High
Dodson et al. (2007)	US	Residential	2007	89 (0.63)	0.237	High
Loh et al. (2006)	US	Public Space	2003–2005	162 (0.99)	0.43	Medium
NYIEQ (2005)	US	Residential	2001–2003	130 (0.15)	N/R	Medium
Weisel et al. (2005)	US	Residential	1999–2001	554 (0.59)	0.83	High
Shendell et al. (2004)	US	Public Space	2000–2001	24 (1)	0.74	High
Sax et al. (2006)	US	Residential	1999–2000	81 (0.91)	N/R	High
Adgate et al. (2004b)	US	Public Space	2000	86 (0.86)	N/R	Medium

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (µg/m^3)	Overall Quality Level
Adgate et al. (2004b)	US	Residential	2000	181 (0.86)	N/R	Medium
Adgate et al. (2004a)	US	Residential	1997	385 (0.86)	0.2	High
Lindstrom et al. (1995)	US	Residential	1992–1993	34 (0)	1.2	Medium
Li et al. (2019)	CA	Residential	2012–2013	3524 (0.95)	0.02	High
Heroux et al. (2008)	CA	Residential	2005	96 (0.61)	0.2	Medium
CA= Canada; N/R = not reported; US = United States						

Table_Apx H-3. Summary of Peer-Reviewed Literature That Measured *p*-Dichlorobenzene (µg/m^3) Levels in the Vapor/Gas Fraction of Personal Inhalation

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (µg/m^3)	Overall Quality Level
Dodson et al. (2007)	US	Indoor/Outdoor	2007	89 (0.80)	0.237	High
Shin et al. (2015)	US	Indoor/Outdoor	2005–2007	239 (N/R)	N/R	Medium
Weisel et al. (2005)	US	Indoor	1999–2001	754 (0.67)	0.83	High
Sax et al. (2006)	US	Indoor/Outdoor	1999–2000	81 (0.96)	N/R	High
Jia et al. (2008)	US	Indoor/Outdoor	1999–2000	641 (0.63)	0.43	Medium
Adgate et al. (2004b)	US	Indoor/Outdoor	2000	181 (0.93)	N/R	Medium
Adgate et al. (2004a)	US	Indoor/Outdoor	1997	73 (0.96)	0.2	High
Heavner et al. (1996)	US	Indoor	1992	173 (N/R)	N/R	Medium
Heavner et al. (1995)	US	Indoor	1991	49 (N/R)	N/R	Medium
N/R = not reported; US = United States						

Table_Apx H-4. Summary of Peer-Reviewed Literature That Measured *p*-Dichlorobenzene (µg/L) Levels in Surface Water

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (µg/L)	Overall Quality Level
Elliott et al. (2017)	US	General Population	2013–2014	291 (0.19)	0.08	High
Coiner et al. (2010)	US	Near Facility	2007–2008	8 (0)	11.8	High
Hart et al. (2005)	US	General Population	2001–2002	45 (0)	0.5	Medium

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (µg/L)	Overall Quality Level
Kolpin et al. (2002)	US	Near Facility	1999–2000	85 (0.26)	0.03	High
Prytula and Pavlostathis (1996)	US	Near Facility	1993–1994	3 (N/R)	0.2	Medium
Chen and Zoltek (1995)	US	Near Facility	1989–1993	12 (0.50)	N/R	Medium
N/R = not reported; US = United States						

Table_Apx H-5. Summary of Peer-Reviewed Literature That Measured *p*-Dichlorobenzene (ng/g) Levels in Sediment

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (ng/g)	Overall Quality Level
Dry						
Coiner et al. (2010)	US	Near Facility	2007–2008	19 (0)	1460	High
Yun and Kannan (2011)	US	General Population	2002–2004	57 (N/R)	0.02	Medium
Yun and Kannan (2011)	US	Near Facility	2002	18 (1)	0.02	Medium
Not specified						
Elliott et al. (2017)	US	General Population	2013–2014	76 (0.30)	33	High
Nilsen and Alvarez (2011)	US	General Population	2009	1 (0)	27.6	Medium
Nilsen and Alvarez (2011)	US	General Population	2009	1 (0)	27.6	Medium
Prytula and Pavlostathis (1996)	US	Near Facility	1993–1994	3 (N/R)	200	Medium
N/R = not reported; US = United States						

Table_Apx H-6. Summary of Peer-Reviewed Literature That Measured *p*-Dichlorobenzene (µg/L) Levels in Drinking Water

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (µg/L)	Overall Quality Level
Bugher et al. (2024)	US	Consumer tap water	2018–2020	307 (0.01)	0.004	High
Hopple et al. (2009)	US	Drinking water treatment plant or distribution system	2004–2005	71 (0.11)	0.034	High
Kingsbury et al. (2008)	US	Drinking water treatment plant or distribution system	2002–2004	336 (0.31)	0.024	High
Focazio et al. (2008)	PR, US	Drinking water treatment plant or distribution system	2001	73 (0.03)	0.1	Medium

PR = Puerto Rico; US = United States

Table_Apx H-7. Summary of Peer-Reviewed Literature That Measured *p*-Dichlorobenzene (µg/L) Levels in Wastewater

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (µg/L)	Overall Quality Level
Conn et al. (2006)	US	Treated Effluent	2003–2004	270 (0.20)	0.5	Medium
Keefe et al. (2004)	US	Treated Effluent	2000	1 (1)	0.05	Medium
Sauer and Tyler (1996)	US	Treated Effluent	1991–1992	58 (0.19)	N/R	Medium

N/R = not reported; US = United States

Table_Apx H-8. Summary of Peer-Reviewed Literature That Measured *p*-Dichlorobenzene (ng/g) Levels in Soil

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (ng/g)	Overall Quality Level
Dry						
Yun and Kannan (2011)	US	General Population	2002–2004	32 (N/R)	0.02	Medium

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (ng/g)	Overall Quality Level
Yun and Kannan (2011)	US	Near Facility	2002	6 (1)	0.02	Medium
Not specified						
Jang and Townsend (2001)	US	Near Facility	2001	43 (0)	5	Medium
N/R = not reported; US = United States						

Table_Apx H-9. Summary of Peer-Reviewed Literature That Measured *p*-Dichlorobenzene (µg/L) Levels in Groundwater

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (µg/L)	Overall Quality Level
Hopple et al. (2009)	US	General Population	2002–2005	292 (0.03)	0.034	High
Buszka et al. (2009)	US	Near Facility	2000–2002	6 (0)	0.5	Medium
Barnes et al. (2008)	US	Near Facility	2000	47 (0.06)	0.5	Medium
Westinghouse Savannah River Company (1997)	US	Near Facility	1995–1996	224 (0.13)	0.05	Medium
Chen and Zoltek (1995)	US	Near Facility	1989–1993	8 (0.75)	N/R	Medium
Heck et al. (1992)	US	Near Facility	1990	13 (0.31)	0.2	Medium
N/R = not reported; US = United States						

Appendix I INTEGRATED INDOOR/OUTDOOR AIR CALCULATOR MODELING

I.1 IIOAC Screening Assessment Results

A total of 21 TRI form R reporting facilities reported releases of *p*-dichlorobenzene to the ambient air. The following three OESs had the highest modeled 95th percentile concentrations relative to the other calculated exposure concentrations evaluated:

- Processing as a Reactant (47.1 µg/m^3);
- Incorporation into air care products (0.53 µg/m^3) and;
- Incorporation into formulation (0.32 µg/m^3).

IIOAC-modeled exposure concentrations results were used to calculate non-cancer risk estimates in the following section as a screening tool to determine whether refined analyses and higher-tier modeling were warranted.

I.1.1 Risk Calculations

I.1.1.1 Inhalation Margin of Exposure

EPA used a margin of exposure (MOE) approach using high-end exposure estimates to determine if the pathway analyzed is a pathway of concern. The MOE is the ratio of the non-cancer hazard value (or point of departure [POD]) divided by a human exposure concentration. The chronic MOEs for non-cancer inhalation risks were calculated using Equation_Apx I-1 below.

Equation_Apx I-1. Margin of Exposure Calculation

$$MOE = \frac{Non-cancer\ Hazard\ Value\ (POD)}{Human\ Exposure}$$

Where:

MOE	=	Margin of exposure for acute, short-term, or chronic risk comparison (unitless)
Non-cancer Hazard Value (POD)	=	Human equivalent concentration (HEC, µg/m^3)
Human Exposure	=	Exposure estimate (µg/m^3)

MOE risk estimates may be interpreted in relation to benchmark MOEs. Benchmark MOEs are typically the total uncertainty factor for each non-cancer POD. The MOE estimate is interpreted as a human health risk of concern if the MOE estimate is less than the benchmark MOE (*i.e.,* the total uncertainty factor). On the other hand, for this screening-level analysis, if the MOE estimate is equal to or exceeds the benchmark MOE, the exposure pathway is not analyzed further. Typically, the larger the MOE, the more unlikely it is that a non-cancer adverse effect occurs relative to the benchmark. When determining whether a chemical substance presents unreasonable risk to human health or the environment, calculated risk estimates are not "bright-line" indicators of unreasonable risk, and EPA has the discretion to consider other risk-related factors in addition to risks identified in the risk characterization.
Briefly, after considering hazard identification and evidence integration, dose-response evaluation, and the weight of scientific evidence of POD candidates, EPA chose a non-cancer endpoint for general population acute exposure with a human equivalent concentration (HEC) value of 49.8 ppm (299,431 µg/m^3) and a chronic exposure HEC value of 0.546 ppm (3,283 µg/m^3). A benchmark of 30 was used for both acute and chronic screening-level risk estimates. For more details on the non-cancer hazard

values used to screen for risk, see the *Draft Human Health and Environmental Hazard Assessment for p-Dichlorobenzene* (U.S. EPA, 2024b). All calculated acute and chronic MOEs were above the benchmark at the 100, 100 to 1,000, and 1,000 m distances.

Appendix J 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 *p*-dichlorobenzene in each of its COU under TSCA. The method consists of the following steps:

1. Identify the North American Industry Classification System (NAICS) codes for the industry sectors associated with each COU.
    a. Refine the identification of applicable NAICS codes by reviewing Chemical Data Reporting (CDR) data for the chemical.
    b. Refine the identification of applicable NAICS codes by referencing EPA/OPPT Generic Scenarios (GSs) and Organisation for Economic Co-operation and Development (OECD) Emission Scenario Documents (ESDs).
2. Estimate total employment by industry/occupation combination using the latest Bureau of Labor Statistics' (BLS) occupational employment statistics data (U.S. BLS, 2023a).
3. Refine the occupational employment statistics estimates where they are not sufficiently granular by using the latest U.S. Census' Statistics of U.S. Businesses (SUSB) data on total employment by 6-digit NAICS.
4. Estimate the percentage of employees likely to be using the chemical of interest instead of other chemicals (*i.e.,* the market penetration of the chemical of interest in the COU).
    a. Conduct market penetration research through a top-down approach.
    b. Conduct market penetration research through a bottom-up approach.
5. Estimate the number of sites and number of potentially exposed employees per site.
6. 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 COU.

EPA generally supplements this query by reviewing other relevant sources of information such as the most recently published CDR data and applicable GSs and ESDs. For each COU, EPA will provide a list of the relevant NAICS codes and a description of how EPA determined them in either the risk evaluation reports or their related technical support documents.

Refine NAICS Codes Using CDR Data: EPA reviewed the most recently reported CDR Data for the chemical of interest. EPA/OPPT generally identifies NAICS industry codes through CDR data by reviewing the most recently published CDR data for the chemical of interest and identifying the industrial sector codes reported for downstream industrial uses, and matching those industrial sector codes using Table D-2 provided in the CDR reporting instructions (U.S. EPA, 2016).

CDR data may provide information on the range of number of workers potentially exposed to the chemical of interest for each respective reporter. If an assessment is tied directly to an entity reporting to CDR, the number of workers reported are assumed to be for that individual reporting site and not for further downstream use. The number of workers reported in CDR for downstream use (*i.e.* Processing and Use data) is often secondhand reporting and does not come directly from the facilities handling the

chemical of interest. The hierarchy of the approach for estimating the number of workers using CDR data is as follows:

1. If the assessment is tied directly to a CDR reporter, the upper bound for the number of workers cited by the reporting entity within CDR if it is not claimed as CBI should be used in the assessment.
2. If the assessment is tied directly to a CDR reporter but they claim the number of workers as CBI, follow the approach outlined in this section.
3. If the assessment is tied to a downstream use of the chemical of interest, follow the approach outlined in this section.
4. If the assessment is tied to a downstream use of the chemical of interest and there is no relevant BLS and SUSB data, the upper bound for the number of workers cited in the relevant downstream use within CDR should be used in the assessment

Refine NAICS Codes Using Generic Scenario and Emission Scenario Documents: EPA/OPPT generally identifies NAICS industry codes through GSs and ESDs by reviewing the existing GSs and ESDs that are relevant to the COU for the chemical of interest and identifying NAICS codes cited by the GS or ESD. NAICS industry codes are updated every five years, so some GSs and ESDs may contain outdated NAICS codes. EPA conducts a query search on the U.S. Census Bureau's NAICS Search tool to confirm the stated NAICS code in the GS or ESD is still accurate. If the NAICS code is inaccurate or has changed, EPA reviews the relevant Industry Code Crosswalk to identify the most up-to-date NAICS industry code.

EPA/OPPT GSs and OECD ESDs may give their own estimate of the number of workers for their respective scenario however the underlying approach may either align with this approach or deviate from it. EPA considers the following when using an EPA/OPPT GS or OECD ESD for estimating the number of workers:

- If the GS or ESD uses the same data (from the same source and date) and approach described in this guidance document, EPA determines if further NAICS granularity or market penetration adjustments are needed. If no adjustment to the data is needed, then the data on number of workers can be used directly in the assessment.
- If the GS or ESD uses the same data and approach described in this guidance document, but the data are outdated (*i.e.* uses outdated publications of BLS and SUSB data), EPA uses the approach described in the guidance document.
- If the GS or ESD uses an alternative source of data on the number of workers such as surveys of relevant workplaces, industry reports, trade organization reports, or other relevant literature, then EPA assesses the quality of that data. The assessment of this data is scored through systematic review, and should the underlying data receive a score of medium or higher, EPA uses the approach described in the GS or ESD. Should the underlying data receive a score of low, EPA uses the approach described in this guidance document.

Step 2: Estimating Total Employment by Industry (NAICS) and Occupation (SOC)

BLS's Occupational Employment Statistics data provide employment data for workers in specific industries and occupations (U.S. BLS, 2023a). The industries are classified by NAICS codes that were previously identified and occupations are classified by Standard Occupational Classification (SOC) codes (U.S. 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 *p*-

dichlorobenzene. Table_Apx J-1 shows the SOC codes by NAICS codes EPA/OPPT classified as occupations potentially exposed to *p*-dichlorobenzene for an example associated with 4-digit NAICS code 336400 Aerospace Product and Parts Manufacturing. 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 Model for p-Dichlorobenzene* (U.S. EPA, 2026u) on sheet "Affected SOCs" 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 100 employees associated with 4-digit NAICS 336400 (Aerospace Product and Parts Manufacturing) and SOC 33-1090 (Miscellaneous First-Line Supervisors, Protective Service 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 results in an overestimate, because not all workers employed in that industry sector will be exposed. However, in some cases, BLS only provides 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 *p*-dichlorobenzene exposure are included. EPA/OPPT generally further refines the employment estimates as follows:

- Review the most recent U.S. Census Bureau's SUSB data for the relevant 6-digit NAICS code level employment data applicable to the chemical of interest and COU that falls under the BLS occupational employment statistics 4- or 5-digit NAICS code level being evaluated.
- Determine the total employment percentage that the relevant 6-digit NAICS code comprises of under the BLS occupational employment statistics 4- or 5-digit NAICS code level (*i.e.* divide the SUSB 6-digit NAICS code level employment by the BLS occupational employment statistics 4- or 5-digit NAICS code level employment and format as a percentage).
- Multiply the total employment percentage by the 4- or 5-digit NAICS code level employment from the BLS occupational employment statistics occupation-specific data to estimate employment by SOC at the 6-digit NAICS code level.

As an example, Occupational Employment Statistics data are available for the 4-digit NAICS 336400 Aerospace Product and Parts Manufacturing, which includes several 6-digit NAICS:

- NAICS 336411 Aircraft Manufacturing
- NAICS 336412 Aircraft Engine and Engine Parts Manufacturing
- NAICS 336413 Other Aircraft Parts and Auxiliary Equipment Manufacturing
- NAICS 336414 Guided Missile and Space Vehicle Manufacturing
- NAICS 336415 Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing

- NAICS 336419 Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing

In this example, two of the listed NAICS are of interest: 336411 Aircraft Manufacturing and 336412 Aircraft Engine and Engine Parts Manufacturing. In the case that not all NAICS are relevant, 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 336411 comprises 42.5% of total employment under the 4-digit NAICS 3364. 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 J-1 illustrates this granularity adjustment for NAICS 336411.

Table_Apx J-1. Estimated Number of Potentially Exposed Workers and ONUs Under NAICS 336411

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
336411	11-3050	Industrial Production Managers	O	7,090	42.5	3,012
336411	11-9040	Architectural and Engineering Managers	O	10,200	42.5	4,333
336411	17-2010	Aerospace Engineers	O	26,400	42.5	11,216
336411	17-2040	Chemical Engineers	O	120	42.5	51
336411	17-2110	Industrial Engineers, Including Health and Safety	O	23,040	42.5	9,788
336411	17-2130	Materials Engineers	O	2,670	42.5	1,134
336411	17-2140	Mechanical Engineers	O	11,160	42.5	4,741
336411	17-3010	Drafters	O	1,360	42.5	578
336411	17-3020	Engineering Technologists and Technicians, Except Drafters	O	14,190	42.5	6,029
336411	19-2031	Chemists	O	100	42.5	42
336411	19-4000	Life, Physical, and Social Science Technicians	O	350	42.5	149
336411	49-1000	Supervisors of Installation, Maintenance, and Repair Workers	O	1,710	42.5	726
336411	49-2000	Electrical and Electronic Equipment Mechanics, Installers, and Repairers	W	9,150	42.5	3,887
336411	49-3000	Vehicle and Mobile Equipment Mechanics, Installers, and Repairers	W	23,850	42.5	10,133

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
336411	49-9000	Other Installation, Maintenance, and Repair Occupations	W	9,590	42.5	4,074
336411	51-1000	Supervisors of Production Workers	O	9,500	42.5	4,036
336411	51-2010	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	W	25,460	42.5	10,817
336411	51-2020	Electrical, Electronics, and Electromechanical Assemblers	W	5,630	42.5	2,392
336411	51-2040	Structural Metal Fabricators and Fitters	W	530	42.5	225
336411	51-2090	Miscellaneous Assemblers and Fabricators	W	19,150	42.5	8,136
336411	51-2090	Miscellaneous Assemblers and Fabricators	W	19,150	42.5	8,136
336411	51-4000	Metal Workers and Plastic Workers	W	39,290	42.5	16,692
336411	51-8000	Plant and System Operators	O	400	42.5	170
336411	51-9020	Crushing, Grinding, Polishing, Mixing, and Blending Workers	W	1,030	42.5	438
336411	51-9030	Cutting Workers	W	60	42.5	25
336411	51-9040	Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders	W	230	42.5	98
336411	51-9050	Furnace, Kiln, Oven, Drier, and Kettle Operators and Tenders	W	230	42.5	98
336411	51-9060	Inspectors, Testers, Sorters, Samplers, and Weighers	W	20,710	42.5	8,799
336411	51-9110	Packaging and Filling Machine Operators and Tenders	W	100	42.5	42
336411	51-9120	Painting Workers	W	4,920	42.5	2,090
336411	51-9191	Adhesive Bonding Machine Operators and Tenders	W	1,520	42.5	646
336411	51-9192	Cleaning, Washing, and Metal Pickling	W	110	42.5	47

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
		Equipment Operators and Tenders				
336411	51-9194	Etchers and Engravers	W	110	42.5	47
Total Potentially Exposed Employees				**289,110**		**122,827**
Total Workers						**76,821**
Total ONUs						**46,006**

SOC = Standard Occupational Classification; 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, 2023a).

Step 4: Estimating the Percentage of Workers Using p-Dichlorobenzene Instead of Other Chemicals

The next step in EPA/OPPT's methodology is to account for the market share of the chemical of interest in a particular industry by applying a factor to the number of workers determined in Step 3. This accounts for the fact that the chemical of interest may be only one of multiple chemicals used for the COUs. EPA/OPPT generally uses a top-down or bottom-up approach to estimate the percentage of workers.

The top-down approach is the preferable method for estimating the percentage of workers for a chemical of interest, however, market penetration data may be scarce or unavailable to EPA. In this case, the bottom-up approach should be utilized and is often the most common method that EPA utilizes to estimate market penetration of a chemical of interest.

In the absence of market penetration data for a given COU, EPA/OPPT assumed *p*-dichlorobenzene may be used at up to all sites and by up to all workers calculated in this method as a bounding estimate. This assumes 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):

Number of Workers or ONUs in NAICS/SOC (Step 2) Granularity Adjustment Percentage (Step 3) = 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 317 establishments associated with 6-digit NAICS code 336411 Aircraft Manufacturing.

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 *p*-dichlorobenzene and the number of sites that use *p*-dichlorobenzene 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 *p*-dichlorobenzene 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 *p*-dichlorobenzene 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 K EQUATIONS FOR CALCULATING ACUTE, INTERMEDIATE, AND CHRONIC (NON-CANCER) INHALATION AND DERMAL EXPOSURES

This report assesses *p*-dichlorobenzene inhalation exposures to workers in occupational settings, presented as 8-, 10-, and 12-hour (*i.e.,* full-shift) time weighted averages (TWAs). The full-shift TWA exposures are then used to calculate acute exposure concentrations (AC), intermediate average daily concentrations (IADC), and average daily concentrations (ADC) for chronic, non-cancer risks. .

This report also assesses *p*-dichlorobenzene dermal exposures to workers in occupational settings, presented as a dermal acute potential dose rate (APDR). The APDRs are then used to calculate acute absorbed doses (AD), intermediate average daily doses ($ADD_{intermediate}$), and average daily doses (ADD) for chronic non-cancer risks.

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

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

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

Equation_Apx K-1.

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

Where:

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

IADC is used to estimate workplace exposures for intermediate risks and is estimated as follows:

Equation_Apx K-2.

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

Equation_Apx K-3.

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

Where:

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

ADC is used to estimate workplace exposures for chronic non-cancer risks. These exposures are estimated as follows:

Equation_Apx K-4.

$$ADC = \frac{C \times ED \times EF \times WY \times BR}{AT_c}$$

Equation_Apx K-5.

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

Where:

ADC	=	Average daily concentration used for chronic non-cancer risk calculations
ED	=	Exposure duration (h/day)
EF	=	Exposure frequency (day/yr)
WY	=	Working years/lifetime (yr)
AT	=	Averaging time (h) for chronic, non-cancer risk
AT_C	=	Averaging time (h) for cancer risk

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

AD is used to estimate workplace dermal exposures for acute risks and are calculated using Equation_Apx K-6.

Equation_Apx K-6.

$$AD = \frac{APDR}{BW}$$

Where:

AD	=	Acute absorbed dose (mg/kg-day)
$APDR$	=	Acute potential dose rate (mg/day)
BW	=	Body weight (kg)

$ADD_{intermediate}$ is used to estimate workplace dermal exposures for intermediate risks and is estimated using Equation_Apx K-7.

Equation_Apx K-7.

$$ADD_{intermediate} = \frac{APDR \times EF_{intermediate}}{BW \times D_{intermediate}}$$

Where:

$ADD_{intermediate}$	=	Intermediate average daily dose (mg/kg-day)

ADD is used to estimate workplace dermal exposures for chronic non-cancer risks and are calculated using Equation_Apx K-8.

Equation_Apx K-8.

$$ADD\ or\ LADD = \frac{APDR \times EF \times WY}{BW \times 365\frac{days}{yr} \times WY}$$

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

The input parameter values in Table_Apx K-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 COUs. The EF and $EF_{intermediate}$ used for each OES can differ and the values used are described in the appropriate sections of this report. The maximum values used in the equations as well as a general summary for these differences are described below in this section.

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

Parameter Name	Symbol	Value	Unit
Exposure Duration	ED	8	h/day
Breathing Rate Ratio	BR	2.04	unitless
Exposure Frequency	EF	6–250 [a]	days/yr
Exposure Frequency, intermediate	$EF_{intermediate}$	22	days
Days for intermediate duration	$D_{intermediate}$	30	days
Working years	WY	31 (50th percentile) 40 (95th percentile)	years
Averaging Time, intermediate	$AT_{intermediate}$	720	hr
Averaging Time, chronic non-cancer	AT	271,560 (central tendency) [b] 350,400 (high-end) [c]	hr
Body Weight	BW	80 (average adult worker) 72.4 (female of reproductive age)	kg

[a] Depending on OES
[b] Calculated using the 50th percentile value for working years (WY)
[c] Calculated using the 95th percentile value for working years (WY)

K.3.1 Exposure Duration (ED)

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

K.3.2 Breathing Rate Ratio

EPA uses a breathing rate ratio, which is the ratio between the worker breathing rate and resting breathing rate, to account for the amount of air a worker breathes during exposure. The typical worker breathes about 10 m^3 of air in 8 hours, or 1.25 m^3/h (CEB, 1991) while the resting breathing rate is 0.6125 m^3/h (CEB, 1991). The ratio of these two values is equivalent to 2.04.

K.3.3 Exposure Frequency (EF)

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

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

Equation_Apx K-9.

$$EF = f \times AWD$$

Where:

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

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

EPA has identified approximately 140 NAICS codes applicable to the multiple COUs for the ten chemicals undergoing risk evaluation. For each NAICS code of interest, the Agency looked up the average hours worked per employee/year at the most granular NAICS level available (*i.e.,* 4-digit, 5-digit, or 6-digit). EPA converted the working hours/employee to working days/year per employee assuming employees work an average of 8 hours/day. The average number of days/year worked, or AWD, ranges from 169 to 282 days/year, with a 50th percentile value of 250 days/year. EPA repeated this analysis for all NAICS codes at the 4-digit level. The average AWD for all 4-digit NAICS codes ranges from 111 to 282 days/year, with a 50th percentile value of 228 days/ year. 250 days/year is approximately the 75th percentile. In the absence of industry- and *p*-dichlorobenzene specific data, EPA assumes the parameter *f* is equal to one for all COUs.

K.3.4 Intermediate Exposure Frequency ($EF_{intermediate}$)

For *p*-dichlorobenzene, the $D_{intermediate}$ was set at 30 days. EPA estimated the maximum number of working days within the $D_{intermediate}$, using the following equation and assuming 5 working days/wk:

Equation_Apx K-10.

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

K.3.5 Intermediate Duration ($D_{intermediate}$)

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

K.3.6 Working Years (WY)

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

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

This triangular distribution has a 50th percentile value of 31 years and a 95th percentile value of 40 years. EPA uses these values for central tendency and high-end ADC calculations, respectively.

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 age 16 and over; CPS data are released every two years. The data are available by demographics and by generic industry sectors but are not available by NAICS codes.

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

SIPP data include fields for the industry in which each surveyed, employed individual works (TJBIND1), worker age (TAGE), and years of work experience *with all employers* over the surveyed individual's lifetime.[22] Census household surveys use different industry codes than the NAICS codes used in its firm surveys, so these were converted to NAICS using a published crosswalk. EPA calculated the average tenure for the following age groups: (1) workers aged 50 and older, (2) workers aged 60 and older, and (3) workers of all ages employed at time of survey. The Agency used tenure data for age group "50 and older" to determine the high-end lifetime working years, because the sample size in this age group is often substantially higher than the sample size for age group "60 and older." For some industries, the number of workers surveyed, or the *sample size*, was too small to provide a reliable representation of the worker tenure in that industry. Therefore, EPA excluded data where the sample size is less than five from the Agency's analysis.

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

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

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

Industry Sectors	Working Years			
	Average	50th Percentile	95th Percentile	Maximum
All industry sectors relevant to the first 10 chemicals that have undergone a risk evaluation	35.9	36	39	44
Manufacturing sectors (NAICS 31–33)	35.7	36	39	40
Non-manufacturing sectors (NAICS 42–81)	36.1	36	39	44
Source: (U.S. Census Bureau, 2019a). Note: Industries where sample size is <5 are excluded from this analysis.				

BLS CPS data provides the median years of tenure that wage and salary workers had been with their current employer. Table_Apx K-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 ages 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 K-3. Median Years of Tenure with Current Employer by Age Group

Age (years)	January 2008	January 2010	January 2012	January 2014
16+	4.1	4.4	4.6	4.6
16–17	0.7	0.7	0.7	0.7
18–19 years	0.8	1.0	0.8	0.8
20–24 years	1.3	1.5	1.3	1.3
25+	5.1	5.2	5.4	5.5
25–34 years	2.7	3.1	3.2	3.0
35–44 years	4.9	5.1	5.3	5.2
45–54 years	7.6	7.8	7.8	7.9
55 to 64 years	9.9	10.0	10.3	10.4
65+	10.2	9.9	10.3	10.3
Source: (U.S. Census Bureau, 2015)				

K.3.7 Body Weight (BW)

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

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

Sample calculations for high-end and central tendency acute and chronic (non-cancer) exposure concentrations for the SEG – Worker (Laboratory Technicians) in the Manufacturing OES, are demonstrated below. The explanation of the equations and parameters used is provided in Appendix K.

L.1 Example High-End AC, IADC, and ADC Calculations

Calculate AC_{HE}:

$$AC_{HE} = \frac{C_{HE} \times ED \times BR}{AT_{acute}}$$

$$AC_{HE} = \frac{0.033\ ppm \times 8\ hr/day \times 2.04}{24\ hr/day} = 0.022\ ppm$$

Calculate $IADC_{,HE}$:

$$ADC_{intermediate,HE} = \frac{C_{HE} \times ED \times EF_{SC} \times BR}{AT_{sc}}$$

$$ADC_{intermediate,HE} = \frac{0.033\ ppm \times 8\frac{hr}{day} \times 22\frac{days}{year} \times 2.04}{24\frac{hr}{day} \times 30\frac{days}{year}} = 0.016\ ppm$$

Calculate ADC_{HE}:

$$ADC_{HE} = \frac{C_{HE} \times ED \times EF \times WY \times BR}{AT}$$

$$ADC_{HE} = \frac{0.033\ ppm \times 8\frac{hr}{day} \times 350\frac{days}{year} \times 40\ years \times 2.04}{40\ years \times 365\frac{days}{yr} \times 24\frac{hr}{day}} = 0.015\ ppm$$

L.2 Example Central Tendency AC, IADC, and ADC Calculations

Calculate AC_{CT}:

$$AC_{CT} = \frac{C_{CT} \times ED \times BR}{AT_{acute}}$$

$$AC_{CT} = \frac{0.017\ ppm \times 8\ hr/day \times 2.04}{24\ hr/day} = 0.011\ ppm$$

Calculate $IADC_{,CT}$:

$$ADC_{intermediate,CT} = \frac{C_{CT} \times ED \times EF_{SC} \times BR}{AT_{sc}}$$

$$ADC_{intermediate,CT} = \frac{0.017\ ppm \times 8\frac{hr}{day} \times 22\frac{days}{year} \times 2.04}{24\frac{hr}{day} \times 30\frac{days}{year}} = 0.0082\ ppm$$

Calculate ADC_{CT}:

$$ADC_{CT} = \frac{C_{CT} \times ED \times EF \times WY \times BR}{AT}$$

$$ADC_{CT} = \frac{0.017\ ppm \times 8\frac{hr}{day} \times 350\frac{days}{year} \times 31\ years \times 2.04}{31\ years \times 365\frac{days}{yr} \times 24\frac{hr}{day}} = 0.0077\ ppm$$

Appendix M DERMAL EXPOSURE ASSESSMENT 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.

M.1 Dermal Dose Equation

EPA used the following equation to estimate the acute potential dose rate (APDR) from occupational dermal exposures:

Equation_Apx M-1.

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

Where:

S	=	surface area of skin in contact with the chemical formulation (cm^2)
Q_u	=	dermal load (*i.e.,* the quantity of the chemical formulation on the skin after the dermal contact event, mg/cm^2-event)
f_{abs}	=	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}	=	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 M.2.

M.2 Model Input Parameters

Table_Apx M-1 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.

9878 **Table_Apx M-1. Summary of 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 M.2.1
Dermal Load (liquid)	Q_u	mg/cm^2-event	2.1	0.7	2.1	–	Uniform	See Appendix M.2.2
Dermal Load (solid, direct)	$Q_{event,direct}$	mg/event	900	100	4200	900	Triangular	See Appendix M.2.2
Dermal Load (solid, article)	$Q_{event,article}$	mg/event	450	100	1,100	450	Triangular	See Appendix M.2.2
Fractional Absorption (>50% weight)	$f_{abs,highwf}$	unitless	0.04	–	–	–	Static	See Appendix M.2.3
Fractional Absorption (<50% weight)	$f_{abs,lowwf}$	unitless	0.02	–	–	–	Static	See Appendix M.2.3
Weight Fraction – Manufacturing OES (liquid)	$Y_{derm,1}$	unitless	0.02	–	–	–	Static	See Appendix M.2.4
Weight Fraction – Repackaging OES (liquid)	$Y_{derm,2l}$	unitless	1	–	–	–	Static	See Appendix M.2.4
Weight Fraction – Repackaging OES (solid, direct)	$Y_{derm,2s}$	unitless	1	0.9	1	–	Uniform	See Appendix M.2.4
Weight Fraction – Processing as a Reactant OES (liquid)	$Y_{derm,3}$	unitless	1	–	–	–	Static	See Appendix M.2.4
Weight Fraction – Incorporation into Air Care Products OES (solid, direct)	$Y_{derm,4}$	unitless	1	0.9	1	–	Uniform	See Appendix M.2.4

Input Parameter	Symbol	Unit	Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale
			Value	Lower Bound	Upper Bound	Mode	Distribution Type	
Weight Fraction – Incorporation into Formulation, Mixture, or Reaction Product OES (liquid)	$Y_{derm,5}$	unitless	1	0.9	1	–	Uniform	See Appendix M.2.4
Weight Fraction – Plastics Compounding OES (liquid)	$Y_{derm,6}$	unitless	1	0.0001	1	–	Uniform	See Appendix M.2.4
Weight Fraction – Use of Lubricants and Greases OES (liquid)	$Y_{derm,7}$	unitless	0.02	0.0003	0.2	0.02	Triangular	See Appendix M.2.4
Weight Fraction – Incorporation into Abrasive Grinding Wheels OES (solid, direct)	$Y_{derm,8}$	unitless	1	–	–	–	Static	See Appendix M.2.4
Weight Fraction – Plastics Converting OES (solid, article)	$Y_{derm,9}$	unitless	0.0001	–	–	–	Static	See Appendix M.2.4
Weight Fraction – Functional Fluids (closed systems) OES (liquid)	$Y_{derm,10}$	unitless	0.25	–	–	–	Static	See Appendix M.2.4
Weight Fraction – Use in Solid Air Care Products (solid, article)	$Y_{derm,11}$	unitless	0.945	0.15	0.999	0.945	Triangular	See Appendix M.2.4
Weight Fraction – Use of Laboratory Chemicals OES (liquid)	$Y_{derm,12l}$	unitless	0.002	0.00002	0.01	0.002	Triangular	See Appendix M.2.4

Input Parameter	Symbol	Unit	Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale
			Value	Lower Bound	Upper Bound	Mode	Distribution Type	
Weight Fraction – Use of Laboratory Chemicals OES (solid, direct)	$Y_{derm,12s}$	unitless	1	–	–	–	Static	See Appendix M.2.4
Weight Fraction – Use of Adhesive and Sealants OES (liquid)	$Y_{derm,13}$	unitless	0.1	0.05	0.1	–	Uniform	See Appendix M.2.4
Weight Fraction – Disposal OES (liquid)	$Y_{derm,14}$	unitless	0.08	0.056	0.08	–	Uniform	See Appendix M.2.4
Frequency of Events	FT	events/day	1	–	–	–	–	See Appendix M.2.5
OES = occupational exposure scenario								

9879

M.2.1 Surface Area

EPA used an exposed skin surface area (S) for workers of 1,070 cm^2 for the upper bound based on the mean two-hand surface area for adult males ages 21 or older from Chapter 7 of EPA's *Exposure Factors Handbook* (U.S. EPA, 2011a). For the lower bound, EPA assumed the exposure surface area was equal to zero, such that any range of potential surface area, from less than one palm to two full hands, may be accounted for. Regarding surface area of dermal exposure to ONUs experiencing incidental contact to mist or dust deposited on surfaces, EPA assumed a representative exposure surface area equivalent to the mean value for one palm (*i.e.,* 268 cm^2) of adult males (U.S. EPA, 2011a).

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 EPA assume that the entirety of the hands is exposed for all activities. Rather, EPA estimated that dermal exposures occur to some portion of the hands plus some portion of other body parts (*e.g.,* arms) such that the total exposed surface area is approximately equal to the surface area between zero and two hands.

M.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/cm^2-event for routine or incidental contact with liquids and 1.3 to 10.3 mg/cm^2-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 technical report *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/cm^2-event for routine/incidental contact with liquids and 3.8 mg/cm^2-event for routine immersion in liquids.

For *p*-dichlorobenzene as a liquid, EPA applied a uniform distribution of 0.7 to 2.1 mg/cm^2-event, respectively, for each OES (U.S. EPA, 2013).

For *p*-dichlorobenzene as a solid powder, EPA applied a triangular distribution of 100 to 4,200 mg/event with a mode of 900 mg/event (Marquart et al., 2006; Lansink et al., 1996). To obtain this distribution, EPA compiled data points from both studies. The lower bound, upper bound, and mode are based on the

minimum, 90th percentile, and geometric mean of all of the identified data, respectively. One literature source reports data from manual dumping of calcium carbonate, so the distribution is representative of all manual dumping scenarios of *p*-dichlorobenzene.

For *p*-dichlorobenzene as a solid article, EPA applied a triangular distribution of 100 to 1,100 mg/event with a mode of 450 mg/event (Marquart et al., 2006; Lansink et al., 1996). To obtain this distribution, EPA compiled data points from both studies. The lower bound, upper bound, and mode are based on the minimum, 90th percentile, and geometric mean of all of the identified data, respectively. One literature source reports data collecting raw calcium carbonate, so the distribution is representative of loading scenarios where *p*-dichlorobenzene is not in powder form, but incorporated into an article.

For ONU dermal exposures to solids, the dermal loading distribution remained triangular, but the maximum was replaced by the mode for both the powder and article case. ONUs include employees who do not directly handle the chemical but may come into contact with dust that settles on surfaces. There are no dermal exposures expected for ONUs for *p*-dichlorobenzene as a liquid because ONUs likely will not come into contact with liquid during their work activities.

M.2.3 Fractional Absorption

EPA assumed a fractional absorption (f_{abs}) of 0.02 to 0.04 dependent on the OES. Test Order data from Charles River Laboratories for neat *p*-dichlorobenzene indicated 4% absorption and up to 2% absorption in organic solvents containing 50% or less of *p*-dichlorobenzene (Charles River Laboratories, 2025). Therefore, for OES with a concentration of *p*-dichlorobenzene exceeding 50% in formulation, 4% absorption was assumed with 2% absorption assumed otherwise.

M.2.4 Weight Fraction of Chemical

The weight fraction of *p*-dichlorobenzene, Y_{derm}, refers to the concentration of *p*-dichlorobenzene in the formulation the worker's skin is exposed to. EPA generally assumes that this concentration will be equal to the weight fraction of *p*-dichlorobenzene in the chemical products being handled within the OES. EPA assessed concentrations of *p*-dichlorobenzene in the chemical products being handled using available Test Order data, CDR data, Generic Scenarios, Emission Scenario Documents, product safety data sheets, and the *p*-dichlorobenzene Use Report (U.S. EPA, 2020e). Table_Apx M-2 summarizes the basis for the concentration values used in assessing worker exposure to *p*-dichlorobenzene.

Table_Apx M-2. Summary of Weight Fraction of *p*-Dichlorobenzene Sources by OES

OES	Distribution Type	Source(s)
Manufacturing	Static Value	(Exponent, 2024)
Repackaging	Uniform	(Charles River Laboratories, 2025; U.S. EPA, 2020b)
Processing as a Reactant	Static Value	(ACC, 2023)
Incorporation into Formulation, Mixture, or Reaction Product	Uniform	Based on upstream concentrations.
Plastics Compounding	Uniform	(ACC, 2023)
Incorporation into Abrasive Grinding Wheels	Static Value	Conservative assumption[a]
Plastics Converting	Static Value	(ACC, 2023)

OES	Distribution Type	Source(s)
Functional Fluids (closed systems)	Static Value	Per company correspondence.
Use in Solid Air Care Products	Triangular	Per SDSs identified in *p*-dichlorobenzene Use Report (U.S. EPA, 2020e)
Use of Laboratory Chemicals	Triangular	Per SDSs identified in *p*-dichlorobenzene Use Report (U.S. EPA, 2020e)
Use of Adhesive and Sealants	Uniform	(Convenience Products, 2016)
Disposal	Uniform	(Midwest Research Institute, 1984)
[a] Due to a lack of chemical specific information, EPA assumed workers may be receiving the chemical in its pure solid form, and thus be exposed via dermal contact to *p*-dichlorobenzene up to 100%.		

M.2.5 Frequency of Events

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 M-1 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 OESs.

Appendix N MODEL APPROACHES AND PARAMETERS

This appendix presents the modeling approach and model equations used in estimating occupational exposures for each of the applicable OESs. Note that though this assessment focuses only on occupational exposure, the models often include environmental release estimates as well, and these are also presented here so the entirety of the models used can be portrayed. 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. EPA 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 7.0.0. 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.

N.1 Inhalation Exposure to Respirable Particulates Model Approach and Parameters

The Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR Model) (U.S. EPA, 2021b) estimates worker inhalation exposure to respirable solid particulates using personal breathing zone Particulate, Not Otherwise Regulated (PNOR) monitoring data from OSHA's Chemical Exposure Health Data (CEHD) data set. The CEHD data provides PNOR exposures as full-shift TWAs by assuming exposures outside the sampling time are zero, and the data also include facility NAICS code information for each data point. To estimate particulate exposures for relevant OESs, EPA used the 50th and 95th percentiles of respirable PNOR values for applicable NAICS codes as the central tendency and high-end exposure estimates, respectively.

Due to lack of data on the concentration of *p*-dichlorobenzene in the particulates, EPA assumed *p*-dichlorobenzene is present in particulates at the same mass fraction as in the bulk solid material, whether that is a plastic product or another solid article. Therefore, EPA calculates the full shift (8-, 10-, or 12-hour) TWA exposure to *p*-dichlorobenzene present in dust and particulates using the following equation:

Equation_Apx N-1.

$$C_{p-DCB} = C_{PNOR} \times F_{p-DCB}$$

Where:

C_{p-DCB} = Full shift TWA exposure to *p*-dichlorobenzene (ppm)
C_{PNOR} = Full shift TWA exposure to PNOR (ppm)
$F_{\mathrm{p-DCB}}$ = Mass fraction of *p*-dichlorobenzene in PNOR (mg/mg)

Table_Apx N-1 provides a summary of the OESs assessed using the PNOR Model (U.S. EPA, 2021b) along with the associated NAICS code, PNOR full shift TWA exposures, *p*-dichlorobenzene mass

fraction, and *p*-dichlorobenzene full shift TWA exposures assessed for each OES.

Table_Apx N-1. Summary of *p*-Dichlorobenzene Exposure Estimates for OESs Using the Generic Model for Exposure to PNOR

Occupational Exposure Scenario	NAICS Code Assessed	Respirable PNOR 8-Hour TWA from Model (mg/m^3)		*p*-Dichlorobenzene Mass Fraction Assessed	*p*-Dichlorobenzene 8-Hour TWA	
		Central Tendency	High-End		Central Tendency	High-End
Use of laboratory chemicals (solid)	54 – Professional, Scientific, and Technical Services	0.19	2.7	1	0.19 mg/m^3 0.032 ppm	2.7 mg/m^3 0.45 ppm

Appendix O OSHA CHEMICAL EXPOSURE HEALTH DATA

OSHA CEHD (Chemical Exposure Health Data) is collected through industrial hygiene samples taken by OSHA compliance officers during monitoring of worker exposures to chemical hazards. OSHA CEHD data are obtained typically from facilities when there is suspicion about high workplace exposure levels or potential violations. OSHA CEHD represents a reasonably available source of information to obtain monitoring data and has received a rating of high from EPA's systematic review process. Air sampling data records from inspections are entered into the OSHA CEHD that can be accessed online. The database includes PBZ monitoring data, area monitoring data, bulk samples, wipe samples, and serum samples. The collected samples are used for comparing to OSHA's PELs. OSHA's CEHD website indicates that they do not: perform routine inspections at every business that uses toxic/hazardous chemicals, completely characterize all exposures for all employees every day, or always obtain a sample for an entire shift. Rather, OSHA performs targeted inspections of certain industries based on National and regional emphasis programs, often attempts to evaluate worst case chemical exposure scenarios, and develop "snapshots" of chemical exposures and assess their significance (*e.g.,* comparing measured concentrations to PELs).

EPA took the following approach to analyzing OSHA CEHD:

1. **Downloaded all data for *p*-dichlorobenzene from all available years in the CEHD** (generally 1984–present).
2. **Organized data by site** (group data collected at the same site together).
3. **Removed data in which all measurements taken at the site were recorded as "0" or below the limit of detection (LOD)** as EPA could not be certain the chemical of interest was at the site at the time of the inspection (Note, sites where bulk samples were collected that indicate *p*-dichlorobenzene was present were not removed from the dataset).
4. **Removed serum samples, bulk samples, wipe samples, and blanks.** These data were not used in EPA's assessment.
5. **Assigned each data point to an OES.** Reviewed NAICS codes, SIC codes, and as needed, company information available online, to map each sample to an OES. In some instances, EPA was not able to determine the OES from the information in the CEHD; in such cases, EPA did not use the data in the assessment. EPA also removed data determined to be for non-TSCA uses or otherwise out of scope.
6. **Combined samples from the same worker.** In some instances, OSHA inspectors will collect multiple samples from the same worker on the same day (these are indicated by sample ID numbers). In these cases, EPA treated these exposures as numerous portions of a single full shift, and combined results from each sample to construct an exposure concentration based on the totality of exposures from each sample. This involved calculating an average of the reported exposures, weighed for the length of time each exposure was measured over.
7. **Addressed less than LOD samples.** Occasionally, one or all the samples associated with a single sample number measured below the limit of detection. Because the samples were often on different time scales (*e.g.,* 1 hour vs. 4 hours), EPA did not include these data in the statistical analysis to estimate values below the LOD as described previously in this section. Sample results from different time scales may vary greatly as short activities may cause a large, short-term exposure that when averaged over a full-shift are comparable to other full-shift data. Therefore, including data of different time scales in the analysis may give the appearance of highly skewed data when in fact the full-shift data are not skewed. Therefore, EPA performed the statistical

analysis (as needed) using all the non-OSHA CEHD data for each OES and applied the approach determined by the analysis to the non-detects in the OSHA CEHD data. Where all the exposure data for an OES came from CEHD, EPA used only the 8-hour TWAs that did not include samples that measured below the LOD to perform the statistical analysis.

8. **Calculated 8-hour TWA results from combined samples.** Where the total sample time was less than 8 hours, EPA calculated an 8-hour TWA by assuming exposures were zero for the remainder of the shift.

It should be noted that the OSHA CEHD does not provide job titles or worker activities associated with the samples; therefore, EPA assumed all data were collected on workers and not ONUs.