Economic Analysis of the Regulation of Trichloroethylene Under TSCA Section 6(a)

November 2024

Office of Pollution Prevention and Toxics U.S. Environmental Protection Agency

Acknowledgement

EPA acknowledges the analytical and draft preparation support of Abt of Rockville, Maryland, provided under Contract No. 68HERH22A0018/68HERH23F0085 in the preparation of this report.

Notice

This document was prepared to provide economic information for the rulemaking process, and to meet various administrative and legislative requirements. Due to the nature of the information available to EPA, the document contains various assumptions that may not reflect how all regulated entities would comply with the rule's requirements. Persons seeking information on regulatory requirements as they apply to specific facilities should consult 40 CFR part 751, the preamble for the regulatory action, and EPA guidance documents.

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List of Acronyms and Abbreviations

EPA	U.S. Environmental Protection Agency
TSCA	Toxic Substances Control Act
TCE	Trichloroethylene
COU	Conditions of Use
HCL	Hydrochloric Acid
EDC	Ethylene Dichloride
WCPP	Workplace Chemical Protection Program
ONU	Occupational Non-Users
CNS	Central Nervous System
CDC	Centers for Disease Control and Prevention
NHL	non-Hodgkin's lymphoma
QWI	Quarterly Workforce Indicators
CHDs	Congenital Heart Defects
TRI	Toxics Release Inventory
NATA	National Air Toxics Assessment
HFC	Hydrofluorocarbons
EJ	Environmental Justice
CDR	Chemical Data Reporting
NEI	National Emissions Inventory
ACS	American Community Survey
SBA	U.S. Small Business Administration
AIM	Innovation and Manufacturing Act
PPE	Personal Protective Equipment
TWA	Time Weighted Average
NESHAP	National Emission Standards for Hazardous Air Pollutants
RCRA	Resource Conservation and Recovery Act
CPSC	U.S. Consumer Product Safety Commission
FDA	Food and Drug Administration
OSHA	Occupational Safety and Health Administration
NIOSH	National Institute for Occupational Safety and Health
PEL	Permissible Exposure Limit
STEL	Short Term Exposure Limit
VOC	Volatile Organic Compound

REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
OEL	Occupational Exposure Limit
ECEL	Existing Chemical Exposure Limit
HOC	Hierarchy of Controls
NAICS	North American Industry Classification System
CPID	Consumer Product Information Database
SDS	Safety Data Sheet
SCAQMD	South Coast Air Quality Management District
OTC	Ozone Transport Commission
TURI	Toxics Use Reduction Institute
HSP	Hansen Solubility Parameters
CARB	California Air Resources Board
SBAR	Small Business Advocacy Review
BLS	U.S. Bureau of Labor Statistics
ECEC	Employer Costs for Employee Compensation
PVC	Polyvinyl chloride
PVA	Polyvinyl alcohol
AL	Action Level
ODC	Other Direct Costs
CIH	Certified Industrial Hygienist
APF	Assigned Protection Factors
LADC	Lifetime Average Daily Concentration
VSL	Value of a Statistical Life
RFA	Regulatory Flexibility Act
SBREFA	Small Business Regulatory Enforcement Fairness Act
GDP	Gross Domestic Product
EJSCREEN	Environmental Justice Screening and Mapping Tool
OTVD	Open Top Vapor Degreasers
CVD	Conveyorized Vapor Degreasers
EVD	Enclosed Vapor Degreasers
WVD	Web Vapor Degreasers
NCA	National Cleaners Association
DLI	Dry Cleaning and Laundry Institute
CBP	County Business Patterns
DMR	Discharge Monitoring Report
RTI	Research Triangle Institute

IRIS	Integrated Risk Information System
UMRA	Unfunded Mandates Reform Act

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Executive Summary

Introduction

The U.S. Environmental Protection Agency (EPA) is finalizing a rule under section 6(a) of the Toxic Substances Control Act (TSCA) for trichloroethylene (TCE) to address the unreasonable risk of injury to human health under its conditions of use (COUs). This report estimates and evaluates the costs, benefits, and impacts expected to result from the rule to regulate manufacture (including import), processing, distribution in commerce, industrial and commercial use, and disposal of TCE to address unreasonable risks so that they are no longer unreasonable. EPA is finalizing the regulation under the authority of TSCA section 6(a) after completing a risk evaluation under TSCA section 6(b) and determining that the chemical substance presents an unreasonable risk of injury to human health. The rule, "Regulation of Trichloroethylene Under TSCA Section 6(a)," addresses the unreasonable risk EPA determined is presented by TCE under the COUs. These COUs are presented below in Table ES-1. Table ES-1 also lists the use categories (or categories of TCE use that are considered in the economic analysis) and defines how the economic analysis use categories map to the COUs.

Table ES-1: Use Categories Considered in the Economic Analysis Mapped to the Conditions of Use (COUs) Defined in the Risk Evaluation

Use Category	Condition of Use (COU)
Laboratory Use	Industrial and commercial use in hoof polish; gun scrubber; pepper spray; other miscellaneous industrial and commercial uses[1]
Manufacturing	Manufacturing: domestic manufacture
Import/Repackage	Manufacturing: import
	Processing: repackaging
Battery and Synthetic Paper Processing Aid	Industrial and commercial use as processing aids in process solvent used in battery manufacture; process solvent used in polymer fiber spinning, fluoroelastomer manufacture and Alcantara manufacture; extraction solvent used in caprolactam manufacture; precipitant used in beta-cyclodextrin manufacture[2]
HFC Manufacturing	Processing: processing as a reactant/intermediate[3]
Intermediate in HCl Production[4]	Processing: processing as a reactant/intermediate[3]
Fluoroelastomer Manufacture	Industrial and commercial use as processing aids in process solvent used in battery manufacture; process solvent used in polymer fiber spinning, fluoroelastomer manufacture and Alcantara manufacture; extraction solvent used in caprolactam manufacture; precipitant used in beta-cyclodextrin manufacture[2]
Open-Top Vapor Degreasing	Industrial and commercial use as a solvent for open-top batch vapor degreasing
Enclosed Vapor Degreasing	Industrial and commercial use as a solvent for closed-loop batch vapor degreasing
Conveyorized Vapor Degreasing	Industrial and commercial use as a solvent for in-line conveyorized vapor degreasing
Web Vapor Degreasing	Industrial and commercial use as a solvent for in-line web cleaner vapor degreasing
Batch Cold Cleaning	Industrial and commercial use as a solvent for cold cleaning
Disposal to Wastewater[5]	Processing: recycling
	Disposal
Energized Electrical Cleaners	Industrial and commercial use as a solvent for aerosol spray degreaser/cleaner and mold release[6]
Incorporation Into Formulation, Mixture, or Reaction Product	Processing: incorporation into a formulation, mixture or reaction product

Table ES-1: Use Categories Considered in the Economic Analysis Mapped to the Conditions of Use (COUs) Defined in the Risk Evaluation

Use Category	Condition of Use (COU)
Mold Release	Industrial and commercial use as a solvent for aerosol spray degreaser/cleaner and mold release[6]
	Consumer use as a solvent in mold release
Liquid Cleaners and Degreasers	Industrial and commercial use in hoof polish; gun scrubber; pepper spray; other miscellaneous industrial and commercial uses[1]
	Consumer use as a solvent in liquid electronic degreaser/cleaner
	Consumer use as a solvent in liquid degreaser/cleaner
	Consumer use as a solvent in liquid gun scrubber
Aerosol Spray Cleaning/Degreasing[7]	Industrial and commercial use as a solvent for aerosol spray degreaser/cleaner and mold release[6]
	Industrial and commercial use in hoof polish; gun scrubber; pepper spray; other miscellaneous industrial and commercial uses[1]
	Industrial and commercial use in automotive care products in brake and parts cleaner
	Consumer use as a solvent in brake and parts cleaner
	Consumer use as a solvent in aerosol electronic degreaser/cleaner
	Consumer use as a solvent in aerosol spray degreaser/cleaner
	Consumer use as a solvent in aerosol gun scrubber
Lubricants and Greases	Industrial and commercial use as a lubricant and grease in tap and die fluid
	Industrial and commercial use as a lubricant and grease in penetrating lubricant
	Consumer use as a lubricant and grease in tap and die fluid
	Consumer use as a lubricant and grease in penetrating lubricant
Adhesives, Sealants, Paints and Coatings	Industrial and commercial use as an adhesive and sealant in solvent-based adhesives and sealants; tire repair cement/sealer; mirror edge sealant
	Consumer use as an adhesive and sealant in solvent-based adhesives and sealants
	Consumer use as an adhesive and sealant in tire repair cement/sealer
	Industrial and commercial use in paints and coatings as a diluent in solvent-based paints and coatings
	Industrial and commercial use in corrosion inhibitors and anti-scaling agents
Spot Removers	Industrial and commercial use in cleaning and furniture care products in carpet cleaner and wipe cleaning
	Industrial and commercial use in laundry and dishwashing products in spot remover
	Consumer use as a cleaning and furniture care product in carpet cleaner
	Consumer use as a cleaning and furniture care product in aerosol spot remover
	Consumer use as a cleaning and furniture care product in liquid spot remover

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Use Category	Condition of Use (COU)
Pepper Spray	Industrial and commercial use in hoof polish; gun scrubber; pepper spray; other miscellaneous industrial and commercial uses[1]
	Consumer use in pepper spray
Distribution in Commerce	Distribution in commerce
Uses where no active users were identified (costs and benefits are not estimated)	Processing: incorporation into articles
	Industrial and commercial use as processing aids in process solvent used in battery manufacture; process solvent used in polymer fiber spinning, fluoroelastomer manufacture and Alcantara manufacture; extraction solvent used in caprolactam manufacture; precipitant used in beta-cyclodextrin manufacture[2] (Only battery manufacture and fluoroelastomer manufacture are believed to be active uses)
	Industrial and commercial use in arts, crafts, and hobby materials in fixatives and finishing spray coatings
	Industrial and commercial use in hoof polish; gun scrubber; pepper spray; other miscellaneous industrial and commercial uses[1] (no active users of TCE for industrial and commercial use of hoof polish were identified)
	Industrial and commercial use in apparel and footwear care products in shoe polish
	Industrial and commercial use as a functional fluid in heat exchange fluid
	Industrial and commercial use as ink, toner and colorant products in toner aid
	Consumer use as a solvent in liquid tire cleaner
	Consumer use as a solvent in aerosol tire cleaner
	Consumer use as an adhesive and sealant in mirror edge sealant
	Consumer use in fabric spray
	Consumer use in arts, crafts, and hobby materials in fixative and finishing spray coatings
	Consumer use in apparel and footwear products in shoe polish
	Consumer use in toner aid
	Consumer use in film cleaner
	Consumer use in hoof polish

[1]Multiple use categories map to this COU: (1) Laboratory Use, (2) Pepper Spray, (3) Liquid Cleaners and Degreasers, (4) Aerosol Spray Cleaning/Degreasing, and (5) inactive uses

[2]Multiple use categories map to this COU: (1) Battery and Synthetic Paper Processing Aid, and (2) Fluoroelastomer Manufacture, (3) inactive uses.

[3]Multiple use categories map to this COU: (1) Hydrofluorocarbon (HFC) Manufacturing, and (2) Hydrochloric Acid Production in Ethylene Dichloride (EDC) Manufacturing and Refineries

[4]TCE is a byproduct of the EDC production process, where it is either sold as TCE or converted to hydrochloric acid (HCl). Some refineries also use TCE as a chloriding agent providing a source of Chloride Ion (Cl-) which acts as a catalyst promoter.

[5]The disposal of TCE to industrial pre-treatment, industrial treatment, or publicly owned treatment works are the uses prohibited under the regulatory options.

[6]Multiple use categories map to this COU: (1) Aerosol Spray Cleaning/Degreasing, and (2) Mold Release

[7]The Aerosol Spray Cleaning/Degreasing Use Category is broken out into Energized Electrical Cleaners and Aerosol Spray Cleaning/Degreasing (except EEC) in some tables and combined in a single row in other tables.

Background

TCE is a volatile organic compound (VOC) used in industry as well as in commercial and consumer products. The primary use of TCE is as an intermediate during the manufacture of refrigerants, specifically HFC-134a, which accounts for about 83.6% of TCE's annual production volume (EPA 2020e). TCE is also used as a solvent, frequently in cleaning and degreasing (including spot cleaning, vapor degreasing, cold cleaning, and aerosol degreasing), which accounts for another 14.7% of TCE production volume, leaving approximately 1.7% for other uses.

TCE is also a widely used solvent in a variety of commercial and consumer applications including lubricants, adhesives and sealants, paints and coatings, and other miscellaneous products. The total aggregate annual production volume ranged from 100 to 250 million pounds between 2016 and 2019 according to CDR (EPA 2016-2019).

Under TSCA section 6(a), if the Administrator determines, through a TSCA section 6(b) risk evaluation that the manufacture (including import), processing, distribution in commerce, use, or disposal of a chemical substance or mixture, or any combination of such activities, presents an unreasonable risk of injury to health or the environment, EPA must by rule apply one or more of the following requirements to the extent necessary so that the chemical substance or mixture no longer presents such risk.

- Prohibit or otherwise restrict the manufacturing, processing, or distribution in commerce of the substance or mixture, or limit the amount of such substance or mixture which may be manufactured, processed, or distributed in commerce (section 6(a)(1)).
- Prohibit or otherwise restrict the manufacturing, processing, or distribution in commerce of the substance or mixture for a particular use or above a specific concentration for a particular use (section 6(a)(2)).
- Limit the amount of the substance or mixture which may be manufactured, processed, or distributed in commerce for a particular use or above a specific concentration for a particular use specified (section 6(a)(2)).
- Require clear and adequate minimum warning and instructions with respect to the substance or mixture or any article containing the substance or mixture's use, distribution in commerce, or disposal, or any combination of those activities, to be marked on or accompanying the substance or mixture (section 6(a)(3)).
- Require manufacturers and processors of the substance or mixture to make and retain certain records or conduct certain monitoring or testing (section 6(a)(4)).
- Prohibit or otherwise regulate any manner or method of commercial use of the substance or mixture (section 6(a)(5)).
- Prohibit or otherwise regulate any manner or method of disposal of the substance or mixture, or any article containing such substance or mixture, by its manufacturer or processor or by any person who uses or disposes of it for commercial purposes (section 6(a)(6)).
- Direct manufacturers or processors of the substance or mixture to give notice of the unreasonable risk determination to distributors, certain other persons, and the public, and to replace or repurchase the substance or mixture (section 6(a)(7)).

EPA analyzed how the TSCA section 6(a) requirements could be applied to address the unreasonable risk found to be present in the 2020 Risk Evaluation for TCE and the final revised unreasonable risk determination, so that TCE no longer presents such unreasonable risk. This document presents an economic analysis of EPA's regulatory action (Option 1) and an alternative regulatory action (Option 2).

Regulatory Options Analyzed

Table ES-2 summarizes the regulatory options by use category. Pursuant to TSCA section 6(b), EPA determined that TCE presents an unreasonable risk of injury to health, without consideration of costs or other nonrisk factors, including an unreasonable risk to a potentially exposed or susceptible subpopulation (PESS) identified as relevant to the 2020 Risk Evaluation for TCE by EPA, under the conditions of use (EPA 2020e, EPA 2022c). Accordingly, to address the unreasonable risk, EPA is finalizing a regulation under TSCA section 6(a), to:

(i) prohibit the manufacture (including import) and processing of TCE for all uses (including all consumer uses), with longer compliance timeframes for manufacture, processing, and distribution in commerce related to certain industrial and commercial uses;

(ii) prohibit the industrial and commercial use of TCE with longer compliance timeframes for certain uses;

(iii) Prohibit the manufacture (including import) and processing of TCE as an intermediate for the manufacturing of hydrofluorocarbon134a (HFC-134a), following an 8.5-year phaseout;

(iv) Prohibit the industrial and commercial use of TCE as a solvent for closed-loop batch vapor degreasing for rayon fabric scouring for end use in rocket booster nozzle production by Federal agencies and their contractors, following a 10-year phaseout;

(v) Prohibit the manufacture (including import), processing, distribution in commerce, and use of TCE as a laboratory chemical for asphalt testing and recovery, following a 10-year phaseout;

(vi) Prohibit the manufacture (including import), processing, distribution in commerce, and industrial and commercial use of TCE as a solvent in batch vapor degreasing for essential aerospace parts and components and narrow tubing used in medical devices, following a 7-year TSCA section 6(g) exemption;

(vii) Prohibit the manufacture (including import), processing, distribution in commerce, and industrial and commercial use of TCE as a solvent in closed loop vapor degreasing necessary for rocket engine cleaning by Federal agencies and their contractors, following a 7-year TSCA section 6(g) exemption;

(viii) For vessels of the Armed Forces and their systems, and in the maintenance, fabrication, and sustainment for and of such vessels and systems, prohibit the industrial and commercial use of TCE as: potting compounds for naval electronic systems and equipment; sealing compounds for high and ultra-high vacuum systems; bonding compounds for materials testing and maintenance of underwater systems and bonding of nonmetallic materials; and cleaning agents to satisfy cleaning requirements (which includes degreasing using wipes, sprays, solvents and vapor degreasing) for: materials and components required for military ordinance testing; temporary resin repairs in vessel spaces where welding is not authorized; ensuring polyurethane adhesion for electronic systems and equipment repair and installation of elastomeric materials; various naval combat systems, radars, sensors, equipment; fabrication and prototyping processes to remove coolant and other residue from machine parts; machined part fabrications for naval systems; installation of topside rubber tile material aboard vessels; and vapor degreasing required for substrate surface preparation prior to electroplating processes, following a 10-year TSCA section 6(g) exemption;

(ix) Prohibit the emergency industrial and commercial use of TCE in furtherance of the NASA mission for specific conditions which are critical or essential and for which no technically and economically feasible safer alternative is available, following a 10-year TSCA section 6(g) exemption;

(x) Prohibit the manufacture (including import), processing, distribution in commerce, disposal, and use of TCE as a processing aid for manufacturing battery separators for lead acid batteries, following a 20-year TSCA section 6(g) exemption;

(xi) Prohibit the manufacture (including import), processing, distribution in commerce, disposal, and use of TCE as a processing aid for manufacturing specialty polymeric microporous sheet materials following a 15-year TSCA section 6(g) exemption;

(xii) Prohibit the manufacture (including import), processing, distribution in commerce, and use of TCE as a laboratory chemical for essential laboratory activities and some research and development activities, following a 50-year TSCA section 6(g) exemption;

(xiii) Require strict workplace controls to limit exposure to TCE, including compliance with a TCE workplace chemical protection program (WCPP), which would include requirements for an interim existing chemical exposure limit (ECEL) revised from the proposed rule, as well as dermal protection, for conditions of use with long term phaseouts or time-limited exemptions under TSCA section 6(g) or prescriptive workplace controls;

(xiv) Prohibit the disposal of TCE to industrial pre-treatment, industrial treatment, or publicly owned treatment works through a phaseout allowing for longer timeframes for disposal necessary for certain industrial and commercial uses along with a 50-year TSCA section 6(g) exemption for cleanup projects before prohibition and interim requirements for wastewater worker protection for such activities; and

(xv) Establish recordkeeping and downstream notification requirements.

The primary alternative regulatory option, Option 2, follows EPA's proposed regulatory option and includes the following requirements that differ from than the Option 1 requirements:

- A lower ECEL of 0.0011 ppm.
- Laboratory use for asphalt testing is prohibited sooner.
- The exemption for battery separator manufacture is 10 years instead of 15 for lead acid batteries and 5 years for lithium batteries; the processing aid use for synthetic paper is not included in the exemption.
- The use as an intermediate in HCl manufacture is subject to prohibition and interim WCPP requirements.
- Disposal to wastewater is prohibited.
- Energized Electrical Cleaners (EEC) are prohibited six months after the effective date of the rule,

Table ES-2: Summary of Regulatory Options by Use Category

Use Category	Option 1 (ECEL of 0.2 ppm)	Option 2 (ECEL of 0.0011ppm)
Laboratory Use	**WCPP followed by prohibition[1]** [1]Asphalt Testing: WCPP for 10 years followed by prohibition (10-year 6g exemption). Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.	**Prohibition/WCPP followed by prohibition[2]** [2]Asphalt Testing: Prohibited. Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.
Manufacturing Import/Repackage	**WCPP for limited uses until prohibited[3]** [3]Interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.	
Battery and Synthetic Paper Processing Aid	**WCPP followed by prohibition[4]** [4]15-year exemption with WCPP 6 months after rule finalization for lead acid battery separators. 5-year exemption with WCPP 6 months after rule finalization for lithium battery separators.15-year exemption with WCPP 6 months after rule finalization for synthetic paper.	**WCPP followed by prohibition[5]** [5]10-year exemption with WCPP 6 months after rule finalization for battery separator manufacture. Synthetic paper use prohibited.
HFC Manufacturing	**Long-Term Phase Out with WCPP followed by Prohibition[6]** [6]Long-term phase out to prohibition over 8.5 years, interim requirements of WCPP.	
Intermediate in HCl Production	**Not Subject to Rule**	**WCPP followed by prohibition[7]** [7]WCPP 6 months to 2 years after rule finalization followed by prohibition.
Fluoroelastomer Manufacture	**WCPP followed by Prohibition[8]** [8]WCPP 6 months to 2 years after rule finalization followed by prohibition.	
Open-Top Vapor Degreasing Enclosed Vapor Degreasing Conveyorized/Web Vapor Degreasing Batch Cold Cleaning	**Prohibition with Interim WCPP for Exemptions[9]** [9]A 6(g) exemption for 7 years applies to OTVD for narrow tubes for aerospace or medical device use. A 6(g) exemption for 10 years applies to naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes for OTVDs. A 6(g) exemption for 7 years applies to human-rated rocket engine cleaning in EVDs by Federal agencies and their contractors. A 6(g) exemption for 10 years applies to rayon fabric scouring in EVDs for rocket booster nozzle production for Federal agencies and their contractors.	
Disposal to Wastewater	**Prohibition 1 year after rule finalization with WCPP requirements for POTWs exceeding a water screening level and worker protection requirements for cleanup sites and industrial treatment/pre-treatment. [10]** [10]For POTWs above the water screening level, WCPP would be required (with the interim occupational exposure limit (ECEL)). For cleanup site workers and industrial treatment/pre-treatment, use TSCA regulatory limit (new interim occupational exposure limit (ECEL)) within the framework of existing OSHA HAZWOPER requirements.	**Prohibition[11]** [11]One year after rule finalization.

Table ES-2: Summary of Regulatory Options by Use Category

<table>
<tr><th>Use Category</th><th>Option 1 (ECEL of 0.2 ppm)</th><th>Option 2 (ECEL of 0.0011ppm)</th></tr>
<tr><td>Energized Electrical Cleaners</td><td>Prohibition with Interim APF50 Respirator Requirement[12]

[12]Prohibit 3 years after rule finalization with interim prescriptive respiratory protection requirements of APF 50 respirator use.</td><td>Prohibition[13]

[13]Six months after rule finalization.</td></tr>
<tr><td>Incorporation into Formulation, Mixture, or Reaction Product</td><td colspan="2" rowspan="14">Prohibition[14,15]

[14]Prohibition six months after rule finalization.

[15]Adhesives and Sealants for Aerospace uses have a 5-year exemption with interim WCPP. Since the numbers of workers affected by the exemption is unknown, the exemption is not accounted for in the analysis and the costs and benefits from prohibition are assumed for all affected users of adhesives, sealants, paints, and coatings.</td></tr>
<tr><td>Commercial Use Pepper Spray</td></tr>
<tr><td>Incorporation into Articles</td></tr>
<tr><td>Mold Release</td></tr>
<tr><td>Liquid Cleaners and Degreasers</td></tr>
<tr><td>Aerosol Spray Cleaning/Degreasing (except EEC)</td></tr>
<tr><td>Lubricants and Greases</td></tr>
<tr><td>Adhesives, Sealants, Paints and Coatings</td></tr>
<tr><td>Functional Fluids</td></tr>
<tr><td>Spot Removers</td></tr>
<tr><td>Film Cleaner</td></tr>
<tr><td>Toner Aid</td></tr>
<tr><td>Polish</td></tr>
</table>

Estimated Number of Affected Entities and Individuals

Table ES-3 presents a summary of the number of firms using TCE and the number of occupational and consumer users[1] exposed to TCE for each use category. Occupational users include workers working directly with TCE and occupational non-users (ONUs). Sections 6.2 and 6.3 describes the approach used to estimate the number of affected entities and individuals.

[1] Note that EPA was unable to estimate the number of bystanders that might be exposed during consumer uses.

Table ES-3: Summary of Occupational and Consumer Users

Use Category	Number of Sites Using TCE	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE	Number of Consumers
Laboratory Use	251	251	2259	-
Manufacturing	2	140	68	-
Import/Repackage	9	18	9	-
Processing Aid (Battery and Synthetic Paper)	3	51	24	-
HFC Manufacturing	2	38	18	-
Intermediate in HCl Production	28	532	252	-
Fluoroelastomer Manufacture	2	34	16	-
Open-Top Vapor Degreasing	350	2,100	1,400	-
Enclosed Vapor Degreasing	7	42	28	-
Conveyorized Vapor Degreasing	8	48	32	-
Web Vapor Degreasing	1	6	4	-
Batch Cold Cleaning	52	312	208	-
Disposal to Wastewater	739	9,607	3,695	-
Incorporation Into Formulation, Mixture, or Reaction Product	28	448	140	
Mold Release	17	371	44	67
Liquid Cleaners and Degreasers	11,815	16,053	1,667	190
Aerosol Spray Cleaning/Degreasing	4,366	5,852	696	12,089
Lubricants and Greases	345	1,751	76	3,159
Adhesives, Sealants, Paints and Coatings	65	616	288	2,184
Spot Removers	4,980	14,940	3,735	2,911
Film Cleaner	-	-	-	-
Toner Aid	-	-	-	-
Polish	-	-	-	-
Pepper Spray	-	-	-	-
Total	**23,070**	**53,210**	**14,659**	**20,600**

Estimated Incremental Costs

Table ES-4 Table ES-5 and Table ES-6 present the total 20-year annualized costs for 3 and 7 percent discount rates, respectively. Note that EPA was unable to estimate costs of prohibition for four use categories that have a prohibition requirement under one of the options (Battery and Synthetic Paper Processing Aid, HFC Manufacturing, Intermediate in HCl Manufacture, and Fluoroelastomer Manufacture). Since the costs of prohibition are unknown, the costs of compliance with a WCPP are used a lower bound estimate for prohibition in these instances.

Costs are presented in 2022 dollars.

Table ES-4: Total 2% 20-Year Annualized Costs Under the Regulatory Options by Use Category (2022$)

Use Category	Option 1 (ECEL 0.20 ppm)		Option 2 (ECEL 0.0011 ppm)	
	Total Annualized Cost	Notes	Total Annualized Cost	Notes
Laboratory Use	$1,020,962	20-Years of WCPP Costs	$1,020,962	20-Years of WCPP Costs
Manufacturing	$257,925		$496,593	
Battery and Synthetic Paper Processing Aid	$271,592	20-Years of WCPP Costs[1]	$311,972	20-Years of WCPP Costs[2]
HFC Manufacturing	$36,605	9-Years of WCPP Costs[3]	$71,153	9-Years of WCPP Costs[3]
Intermediate in HCl Production	-	Not subject to rule under Option 1	$1,916,912	20-Years of WCPP Costs[4]
Fluoroelastomer Manufacture	$181,062	20-Years of WCPP Costs[4]	$207,982	20-Years of WCPP Costs[4]
Open-Top Vapor Degreasing	$45,445,026	Alternatives cost from Table 7-41 with WCPP costs incurred during transition to prohibition under exemptions[5]	$45,493,389	Alternatives cost from Table 7-41 with WCPP costs incurred during transition to prohibition under exemptions[5]
Enclosed Vapor Degreasing	$917,124		$921,179	
Conveyorized Vapor Degreasing	$1,037,791	Alternatives cost from Table 7-41	$1,037,791	Alternatives cost from Table 7-41
Web Vapor Degreasing	$129,724		$129,724	
Batch Cold Cleaning	$6,745,641		$6,745,641	
Disposal to Wastewater	$7,077,581	20-Years of WCPP Costs[6]	$18,630,260	20-Years of WCPP Costs[6]
Energized Electrical Cleaners[7]	$575,451	1 year of Prescriptive Control costs followed by prohibition	$575,451	Estimated as Option 1 Costs
Mold Release[7]	$52,573	Costs of rule familiarization and reformulation.	$52,573	Costs of rule familiarization and reformulation.
Liquid Cleaners and Degreasers[7]	$75,756		$75,756	
Aerosol Spray Cleaning/Degreasing (except EEC)[7]	$99,119		$99,119	
Lubricants and Greases[7]	$28,124		$28,124	
Adhesives, Sealants, Paints and Coatings[7]	$60,332		$60,332	
Spot Removers[7]	$38,715		$38,715	
Pepper Spray[7]	$3,754		$3,754	
Total	**$64,054,859**	-	**$77,917,383**	-

[1]TCE use is prohibited after 15 years, but since the costs of TCE alternatives are unknown, the WCPP costs are used as a lower bound estimate.

[2]TCE use is prohibited after 10 years for battery separator manufacture and in six months for synthetic paper, but since the costs of TCE alternatives are unknown, the WCPP costs are used as a lower bound estimate.

[3]TCE use is prohibited after 8.5 years. It is unknown what the cost implications of a 8.5 year phase out would be, so the costs reflect 9 years of WCPP costs under both options.

[4]Since the regulatory costs of prohibition under this use are unknown, the analysis uses the WCPP costs as a proxy for the prohibition costs to calculate total costs. Thus, the total costs are estimated as the 20-year annualized costs of WCPP compliance. Interim WCPP requirements apply for 2 years under both options for these use categories.

[5]There is longer term compliance timeframe applicable to five Open-Top Vapor Degreasers using TCE for narrow tubes and medical device (7 years), one Open-Top Vapor Degreaser using TCE in naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes (10 years), one enclosed vapor degreasing application using TCE to scour rayon fabric for use in rocket booster engine nozzles (10 years). WCPP compliance is required for 7 years, followed by prohibition for industrial and commercial use of TCE in closed loop vapor degreasing necessary for human-rated rocket engine cleaning by Federal agencies and their contractors. The analysis accounts for one enclosed vapor degreaser and one Open-Top Vapor Degreaser with 9

years of WCPP costs and prohibition costs in years 10-20, One enclosed vapor degreaser and five Open-Top Vapor Degreaser with 6 years of WCPP costs and prohibition costs in years 7-20. Other vapor degreasers have prohibition costs starting at "time zero".

[6]Since the regulatory costs of prohibition under this use are unknown, the analysis uses the WCPP costs as a proxy for the prohibition costs to calculate total costs. Thus, the total costs are estimated as the 20-year annualized costs of WCPP compliance.

[7]The costs for the Import/Repackage and Incorporation into Formulation, Mixture, or Reaction Product use categories are accounted under the respective end-use categories for their products.

Table ES-5: Total 3% 20-Year Annualized Costs Under the Regulatory Options by Use Category (2022$)

Use Category	Option 1 (ECEL 0.20 ppm)		Option 2 (ECEL 0.0011 ppm)	
	Total Annualized Cost	Notes	Total Annualized Cost	Notes
Laboratory Use	$1,019,851	20-Years of WCPP Costs	$1,019,851	20-Years of WCPP Costs
Manufacturing	$257,227		$495,780	
Battery and Synthetic Paper Processing Aid	$270,832	20-Years of WCPP Costs[1]	$313,678	20-Years of WCPP Costs[2]
HFC Manufacturing	$38,271	9-Years of WCPP Costs[3]	$74,458	9-Years of WCPP Costs[3]
Intermediate in HCl Production	-	Not subject to rule under Option 1	$1,913,754	20-Years of WCPP Costs[4]
Fluoroelastomer Manufacture	$180,554	20-Years of WCPP Costs[4]	$209,118	20-Years of WCPP Costs[4]
Open-Top Vapor Degreasing	$51,402,026	Alternatives cost from Table 7-41 with WCPP costs incurred during transition to prohibition under exemptions[5]	$51,454,277	Alternatives cost from Table 7-41 with WCPP costs incurred during transition to prohibition under exemptions[5]
Enclosed Vapor Degreasing	$1,011,662		$1,016,091	
Conveyorized Vapor Degreasing	$1,175,495	Alternatives cost from Table 7-41	$1,175,495	Alternatives cost from Table 7-41
Web Vapor Degreasing	$146,937		$146,937	
Batch Cold Cleaning	$7,640,714		$7,640,714	
Disposal to Wastewater	$7,076,676	20-Years of WCPP Costs[6]	$18,606,842	20-Years of WCPP Costs[6]
Energized Electrical Cleaners[7]	$622,687	1 year of Prescriptive Control costs followed by prohibition	$622,687	Estimated as Option 1 Costs
Mold Release[7]	$57,453	Costs of rule familiarization and reformulation.	$57,453	Costs of rule familiarization and reformulation.
Liquid Cleaners and Degreasers[7]	$82,789		$82,789	
Aerosol Spray Cleaning/Degreasing (except EEC) [7]	$108,321		$108,321	
Lubricants and Greases[7]	$30,735		$30,735	
Adhesives, Sealants, Paints and Coatings[7]	$65,933		$65,933	
Spot Removers[7]	$42,309		$42,309	
Pepper Spray[7]	$4,103		$4,103	
Total	**$71,234,573**	-	**$85,081,323**	-

[1]TCE use is prohibited after 15 years, but since the costs of TCE alternatives are unknown, the WCPP costs are used as a lower bound estimate.

[2]TCE use is prohibited after 10 years for battery separator manufacture and in six months for synthetic paper, but since the costs of TCE alternatives are unknown, the WCPP costs are used as a lower bound estimate.

[3]TCE use is prohibited after 8.5 years. It is unknown what the cost implications of a 8.5 year phase out would be, so the costs reflect 9 years of WCPP costs under both options.

[4]Since the regulatory costs of prohibition under this use are unknown, the analysis uses the WCPP costs as a proxy for the prohibition costs to calculate total costs. Thus, the total costs are estimated as the 20-year annualized costs of WCPP compliance. Interim WCPP requirements apply for 2 years under both options for these use categories.

[5]There is longer term compliance timeframe applicable to five Open-Top Vapor Degreasers using TCE for narrow tubes and medical device (7 years), one Open-Top Vapor Degreaser using TCE in naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes (10 years), one enclosed vapor degreasing application using TCE to scour rayon fabric for use in rocket booster engine nozzles (10 years). WCPP compliance is required for 7 years, followed by prohibition for industrial and commercial use of TCE in closed loop vapor degreasing necessary for human-rated rocket engine cleaning by Federal agencies and their contractors. The analysis accounts for one enclosed vapor degreaser and one Open-Top Vapor Degreaser with 9 years of WCPP costs and prohibition costs in years 10-20, One enclosed vapor degreaser and five Open-Top Vapor Degreaser with 6 years of WCPP costs and prohibition costs in years 7-20. Other vapor degreasers have prohibition costs starting at "time zero".

[6]Since the regulatory costs of prohibition under this use are unknown, the analysis uses the WCPP costs as a proxy for the prohibition costs to calculate total costs. Thus, the total costs are estimated as the 20-year annualized costs of WCPP compliance.

[7]The costs for the Import/Repackage and Incorporation into Formulation, Mixture, or Reaction Product use categories are accounted under the respective end-use categories for their products.

Table ES-6: Total 7% 20-Year Annualized Costs Under the Regulatory Options by Use Category (2022$)

Use Category	Option 1 (ECEL 0.20 ppm)		Option 2 (ECEL 0.0011 ppm)	
	Total Annualized Cost	Notes	Total Annualized Cost	Notes
Laboratory Use	$1,015,018	20-Years of WCPP Costs	$1,015,018	20-Years of WCPP Costs
Manufacturing	$254,189		$492,243	
Battery and Synthetic Paper Processing Aid	$267,524	20-Years of WCPP Costs[1]	$321,094	20-Years of WCPP Costs[2]
HFC Manufacturing	$44,392	9-Years of WCPP Costs[3]	$86,691	9-Years of WCPP Costs[3]
Intermediate in HCl Production	-	Not subject to rule under Option 1	$1,900,018	20-Years of WCPP Costs[4]
Fluoroelastomer Manufacture	$178,349	20-Years of WCPP Costs[4]	$214,063	20-Years of WCPP Costs[4]
Open-Top Vapor Degreasing	$77,266,553	Alternatives cost from Table 7-41 with WCPP costs incurred during transition to prohibition under exemptions[5]	$77,335,094	Alternatives cost from Table 7-41 with WCPP costs incurred during transition to prohibition under exemptions[5]
Enclosed Vapor Degreasing	$1,409,320		$1,415,334	
Conveyorized Vapor Degreasing	$1,774,397	Alternatives cost from Table 7-41	$1,774,397	Alternatives cost from Table 7-41
Web Vapor Degreasing	$221,800		$221,800	
Batch Cold Cleaning	$11,533,580		$11,533,580	
Disposal to Wastewater	$7,072,738	20-Years of WCPP Costs[6]	$18,504,991	20-Years of WCPP Costs[6]
Energized Electrical Cleaners[7]	$820,958	1 year of Prescriptive Control costs followed by prohibition	$820,958	Estimated as Option 1 Costs
Mold Release[7]	$78,680	Costs of rule familiarization and reformulation.	$78,680	Costs of rule familiarization and reformulation.
Liquid Cleaners and Degreasers[7]	$113,376		$113,376	
Aerosol Spray Cleaning/Degreasing (except EEC)[7]	$148,340		$148,340	
Lubricants and Greases[7]	$42,090		$42,090	
Adhesives, Sealants, Paints and Coatings[7]	$90,292		$90,292	
Spot Removers[7]	$57,941		$57,941	
Pepper Spray[7]	$5,618		$5,618	
Total	**$102,395,154**	-	**$116,171,618**	-

[1]TCE use is prohibited after 15 years, but since the costs of TCE alternatives are unknown, the WCPP costs are used as a lower bound estimate.

[2]TCE use is prohibited after 10 years for battery separator manufacture and in six months for synthetic paper, but since the costs of TCE alternatives are unknown, the WCPP costs are used as a lower bound estimate.

[3]TCE use is prohibited after 8.5 years. It is unknown what the cost implications of a 8.5 year phase out would be, so the costs reflect 9 years of WCPP costs under both options.

[4]Since the regulatory costs of prohibition under this use are unknown, the analysis uses the WCPP costs as a proxy for the prohibition costs to calculate total costs. Thus, the total costs are estimated as the 20-year annualized costs of WCPP compliance. Interim WCPP requirements apply for 2 years under both options for these use categories.

[5]There is longer term compliance timeframe applicable to five Open-Top Vapor Degreasers using TCE for narrow tubes and medical device (7 years), one Open-Top Vapor Degreaser using TCE in naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes (10 years), one enclosed vapor degreasing application using TCE to scour rayon fabric for use in rocket booster engine nozzles (10 years). WCPP compliance is required for 7 years, followed by prohibition for industrial and commercial use of TCE in closed loop vapor degreasing necessary for human-rated rocket engine cleaning by Federal agencies and their contractors. The analysis accounts for one enclosed vapor degreaser and one Open-Top Vapor Degreaser with 9 years of WCPP costs and prohibition costs in years 10-20, One enclosed vapor degreaser and five Open-Top Vapor Degreaser

with 6 years of WCPP costs and prohibition costs in years 7-20. Other vapor degreasers have prohibition costs starting at "time zero".

[6]Since the regulatory costs of prohibition under this use are unknown, the analysis uses the WCPP costs as a proxy for the prohibition costs to calculate total costs. Thus, the total costs are estimated as the 20-year annualized costs of WCPP compliance.

[7]The costs for the Import/Repackage and Incorporation into Formulation, Mixture, or Reaction Product use categories are accounted under the respective end-use categories for their products.

Unquantified Costs

This economic analysis does not include quantified cost estimates for all costs under the regulatory options. Although certain costs cannot be quantified, this does not mean that they are less important than the quantified costs. Additional unquantified costs are discussed in more detail in section 7.11, but the unquantified costs include the following:

- Applications where TCE is more effective, reducing labor time and wait time that this analysis was unable to quantify.
- Potential facility closures resulting from challenges to switching to TCE alternatives
- Costs associated with developing and testing alternatives to TCE for rocket booster nozzles
- Under the Option 1, the disposal of TCE to industrial pre-treatment, industrial treatment, or publicly owned treatment work is prohibited after the 6(g) exemption ends, 50 years after the rule is finalized. Cleanup sites would need to identify and implement alternative disposal or treatment methods. The information to estimate how often these costs might be incurred or what the specific costs would be per site when they are incurred is not available.
- Unquantified costs associated with implementing a respirator program, since respirators have been found to interfere with many physiological and psychological aspects of task performance (Johnson 2016).
- The costs of switching to alternatives to TCE are unknown for battery separator manufacture, synthetic paper manufacture, HFC manufacturing, use as an intermediate in HCl production (affected under Option 2), and fluoroelastomer manufacture (see section 7.12.7).

Estimated Incremental Benefits

The health benefits monetized in this analysis include the cancer endpoints considered in EPA's (EPA 2020e) risk evaluation: (1) liver cancer, (2) kidney cancer, and (3) non-Hodgkin's lymphoma (NHL). The benefits for reducing other health risks associated with TCE exposure were not estimated. The risk evaluation identified other potential health effects of TCE exposure, including effects on the central nervous system (CNS), liver, and immune system.

Table ES-7, Table ES-8, and Table ES-9 present the low and high estimates for the total monetized cancer benefits by regulatory option and use category, using 2, 3 and 7 percent discount rates respectively. Benefits are presented in 2022 dollars.

Table ES-7: Total 20-Year Annualized Benefits by Use Category and Regulatory Option (2 Percent Discount Rate)

Use Category	Low Estimate		High Estimate		Notes[1]	
	Option 1	Option 2	Option 1	Option 2	Option 1	Option 2
Manufacturing	$9,955	$11,144	$10,091	$11,296	WCPP	WCPP
Import/Repackage	$1,329	$1,329	$1,347	$1,347	Prohibit	Prohibit
Battery and Synthetic Paper Processing Aid	$55,169	$56,344	$55,921	$57,112	WCPP/Prohibit[2]	WCPP/Prohibit[2]
HFC Manufacturing	$1,349	$1,510	$1,367	$1,531	WCPP[3]	WCPP[3]
Intermediate in HCL Production	-	$42,384	-	$42,962	-	WCPP/Prohibit [4]
Fluoroelastomer Manufacture	$37,513	$37,564	$38,024	$38,076	WCPP/Prohibit[4]	WCPP/Prohibit [4]
Open-Top Vapor Degreasing	$6,580,750	$6,594,356	$6,670,446	$6,684,237	WCPP/Prohibit [5]	WCPP/Prohibit [5]
Enclosed Vapor Degreasing	$2,875	$3,012	$2,914	$3,053	WCPP/Prohibit [6]	WCPP/Prohibit [6]
Conveyorized Vapor Degreasing	$195,973	$195,973	$198,644	$198,644	Prohibit	Prohibit
Web Vapor Degreasing	$6,236	$6,236	$6,321	$6,321	Prohibit	Prohibit
Batch Cold Cleaning	$610,659	$610,659	$618,982	$618,982	Prohibit	Prohibit
Disposal to Wastewater	$860,405	$859,919	$872,142	$871,650	WCPP	WCPP
Energized Electrical Cleaners	$77,160	$77,351	$78,232	$78,426	APF50/Prohibit [7]	Prohibit
Incorporation Into Formulation, Mixture, or Reaction Product	$33,066	$33,075	$33,517	$33,526	Prohibit	Prohibit
Mold Release	$389,330	$389,330	$394,637	$394,637	Prohibit	Prohibit
Liquid Cleaners and Degreasers	$2,225,301	$2,225,301	$2,255,632	$2,255,632	Prohibit	Prohibit
Aerosol Spray Cleaning/Degreasing (except EEC)	$6,239,196	$6,239,196	$6,325,863	$6,325,863	Prohibit	Prohibit
Lubricants and Greases	$1,833,653	$1,833,653	$1,858,645	$1,858,645	Prohibit	Prohibit
Adhesives, Sealants, Paints and Coatings	$849,532	$849,532	$861,111	$861,111	Prohibit	Prohibit
Dry Cleaning and Spot Removers	$2,846,209	$2,846,209	$2,885,745	$2,885,745	Prohibit	Prohibit
Total	**$22,855,659**	**$22,914,077**	**$23,169,579**	**$23,228,794**	Prohibit	Prohibit

[1]Notes indicate how benefits were estimated and do not necessarily directly correspond to the option requirements. See Table 7-2 for more detail about differences between requirements under the options and the analysis assumptions.
[2]WCPP for 16 years and then prohibition for 4.
[3]WCPP for 9 years and then no benefits (elimination in the baseline is assumed starting in year 10).
[4]WCPP for 1 year and then prohibition for 19.
[5]Five OTVDs are assumed to have 6 years of WCPP and 14 years of prohibition. One OTVD is assumed to have 9 years of WCPP and 11 years of prohibition. Other OTVDs are assumed to have 20 years of prohibition.
[6]One enclosed vapor degreaser is assumed to have 6 years of WCPP and 14 years of prohibition and one enclosed vapor degreaser is assumed to have 9 years of WCPP and 11 years of prohibition. Other vapor degreasers are assumed to have 20 years of prohibition.
[7]The benefits are split into Energized Electrical Cleaner (EEC) users and other aerosol degreaser users. EEC users are estimated to be 20.53% of all aerosol degreaser users (see Table 6-20). Using the estimates presented in Table 8-5, the benefits from using APF50 respirators for 2 years are estimated as 97.92% of the benefits of eliminating all

exposure (97.92% = 1-(95%/50+3%/50+0%/50+1%/50+1%/1000+0%/10000)/(95%/1+3%/10+0%/25+1%/50+1%/1000+0%/10000)). In addition, EEC users are assumed to be exposed once monthly instead of 250 days per year; thus, the aerosol user benefits are adjusted by 4.8% (4.8%=12/250).

Table ES-8: Total 20-Year Annualized Benefits by Use Category and Regulatory Option (3 Percent Discount Rate)

Use Category	Low Estimate		High Estimate		Notes[1]	
	Option 1	Option 2	Option 1	Option 2	Option 1	Option 2
Manufacturing	$7,952	$8,902	$8,065	$9,029	WCPP	WCPP
Import/Repackage	$1,061	$1,061	$1,077	$1,077	Prohibit	Prohibit
Battery and Synthetic Paper Processing Aid	$47,589	$45,005	$48,270	$45,649	WCPP/Prohibit[2]	WCPP/Prohibit[2]
HFC Manufacturing	$1,130	$1,264	$1,146	$1,283	WCPP[3]	WCPP[3]
Intermediate in HCL Production	-	$33,854	-	$34,339	-	Prohibit/ WCPP [4]
Fluoroelastomer Manufacture	$29,960	$30,005	$30,389	$30,434	WCPP/Prohibit[4]	Prohibit/WCPP[4]
Open-Top Vapor Degreasing	$5,255,545	$5,267,311	$5,330,782	$5,342,718	WCPP/Prohibit [5]	WCPP/Prohibit [5]
Enclosed Vapor Degreasing	$2,288	$2,406	$2,321	$2,440	WCPP/Prohibit [6]	WCPP/Prohibit [6]
Conveyorized Vapor Degreasing	$156,535	$156,535	$158,776	$158,776	Prohibit	Prohibit
Web Vapor Degreasing	$4,981	$4,981	$5,053	$5,053	Prohibit	Prohibit
Batch Cold Cleaning	$487,770	$487,770	$494,753	$494,753	Prohibit	Prohibit
Disposal to Wastewater	$687,113	$686,726	$696,596	$696,203	WCPP	WCPP
Energized Electrical Cleaners	$61,398	$61,563	$62,264	$62,431	APF50/Prohibit[7]	Prohibit
Incorporation Into Formulation, Mixture, or Reaction Product	$26,411	$26,419	$26,789	$26,797	Prohibit	Prohibit
Mold Release	$310,982	$310,982	$315,434	$315,434	Prohibit	Prohibit
Liquid Cleaners and Degreasers	$1,777,483	$1,777,483	$1,802,929	$1,802,929	Prohibit	Prohibit
Aerosol Spray Cleaning/Degreasing (except EEC)	$4,965,691	$4,965,691	$5,035,708	$5,035,708	Prohibit	Prohibit
Lubricants and Greases	$1,464,649	$1,464,649	$1,485,617	$1,485,617	Prohibit	Prohibit
Adhesives, Sealants, Paints and Coatings	$678,573	$678,573	$688,287	$688,287	Prohibit	Prohibit
Dry Cleaning and Spot Removers	$2,265,259	$2,265,259	$2,297,199	$2,297,199	Prohibit	Prohibit
Total	**$18,232,371**	**$18,276,440**	**$18,491,456**	**$18,536,156**	Prohibit	Prohibit

[1]Notes indicate how benefits were estimated and do not necessarily directly correspond to the option requirements. See Table 7-2 for more detail about differences between requirements under the options and the analysis assumptions.
[2]WCPP for 16 years and then prohibition for 4.
[3]WCPP for 9 years and then no benefits (elimination in the baseline is assumed starting in year 10).
[4]WCPP for 1 year and then prohibition for 19.
[5]Five OTVDs are assumed to have 6 years of WCPP and 14 years of prohibition. One OTVD is assumed to have 9 years of WCPP and 11 years of prohibition. Other OTVDs are assumed to have 20 years of prohibition.
[6]One enclosed vapor degreaser is assumed to have 6 years of WCPP and 14 years of prohibition and one enclosed vapor degreaser is assumed to have 9 years of WCPP and 11 years of prohibition. Other vapor degreasers are assumed to have 20 years of prohibition.
[7]The benefits are split into Energized Electrical Cleaner (EEC) users and other aerosol degreaser users. EEC users are estimated to be 20.53% of all aerosol degreaser users (see Table 6-20). Using the estimates presented in Table 8-5, the benefits from using APF50 respirators for 2 years are estimated as 97.92% of the benefits of eliminating all

exposure (97.92% = 1-(95%/50+3%/50+0%/50+1%/50+1%/1000+0%/10000)/(95%/1+3%/10+0%/25+1%/50+1%/1000+0%/10000)). In addition, EEC users are assumed to be exposed once monthly instead of 250 days per year; thus, the aerosol user benefits are adjusted by 4.8% (4.8%=12/250).

Table ES-9: Total 20-Year Annualized Benefits by Use Category and Regulatory Option (7 Percent Discount Rate)

Use Category	Low Estimate		High Estimate		Notes[1]	
	Option 1	Option 2	Option 1	Option 2	Option 1	Option 2
Manufacturing	$3,805	$4,260	$3,867	$4,329	WCPP	WCPP
Import/Repackage	$508	$508	$516	$516	Prohibit	Prohibit
Battery and Synthetic Paper Processing Aid	$22,296	$21,535	$22,658	$21,884	WCPP/Prohibit[2]	WCPP/Prohibit[2]
HFC Manufacturing	$635	$711	$645	$723	WCPP[3]	WCPP[3]
Intermediate in HCL Production	-	$16,199	-	$16,462	-	WCPP/Prohibit[4]
Fluoroelastomer Manufacture	$14,329	$14,357	$14,561	$14,590	WCPP/Prohibit[4]	WCPP/Prohibit[4]
Open-Top Vapor Degreasing	$2,512,991	$2,520,450	$2,553,722	$2,561,302	WCPP/Prohibit [5]	WCPP/Prohibit [5]
Enclosed Vapor Degreasing	$1,079	$1,151	$1,096	$1,170	WCPP/Prohibit[6]	WCPP/Prohibit[6]
Conveyorized Vapor Degreasing	$74,903	$74,903	$76,117	$76,117	Prohibit	Prohibit
Web Vapor Degreasing	$2,384	$2,384	$2,422	$2,422	Prohibit	Prohibit
Batch Cold Cleaning	$233,402	$233,402	$237,185	$237,185	Prohibit	Prohibit
Disposal to Wastewater	$329,139	$328,953	$334,474	$334,285	WCPP	WCPP
Energized Electrical Cleaners	$29,406	$29,511	$29,860	$29,967	APF50/Prohibit[7]	Prohibit
Incorporation Into Formulation, Mixture, or Reaction Product	$12,637	$12,642	$12,842	$12,847	Prohibit	Prohibit
Mold Release	$148,807	$148,807	$151,219	$151,219	Prohibit	Prohibit
Liquid Cleaners and Degreasers	$850,540	$850,540	$864,325	$864,325	Prohibit	Prohibit
Aerosol Spray Cleaning/Degreasing (except EEC)	$2,380,373	$2,380,373	$2,417,138	$2,417,138	Prohibit	Prohibit
Lubricants and Greases	$700,847	$700,847	$712,206	$712,206	Prohibit	Prohibit
Adhesives, Sealants, Paints and Coatings	$324,703	$324,703	$329,965	$329,965	Prohibit	Prohibit
Dry Cleaning and Spot Removers	$1,085,883	$1,085,883	$1,102,655	$1,102,655	Prohibit	Prohibit
Total	**$8,728,666**	**$8,752,119**	**$8,867,475**	**$8,891,308**	Prohibit	Prohibit

[1]Notes indicate how benefits were estimated and do not necessarily directly correspond to the option requirements. See Table 7-2 for more detail about differences between requirements under the options and the analysis assumptions.
[2]WCPP for 16 years and then prohibition for 4.
[3]WCPP for 9 years and then no benefits (elimination in the baseline is assumed starting in year 10).
[4]WCPP for 1 year and then prohibition for 19.
[5]Five OTVDs are assumed to have 6 years of WCPP and 14 years of prohibition. One OTVD is assumed to have 9 years of WCPP and 11 years of prohibition. Other OTVDs are assumed to have 20 years of prohibition.
[6]One enclosed vapor degreaser is assumed to have 6 years of WCPP and 14 years of prohibition and one enclosed vapor degreaser is assumed to have 9 years of WCPP and 11 years of prohibition. Other vapor degreasers are assumed to have 20 years of prohibition.
[7]The benefits are split into Energized Electrical Cleaner (EEC) users and other aerosol degreaser users. EEC users are estimated to be 20.53% of all aerosol degreaser users (see Table 6-20). Using the estimates presented in Table 8-5, the benefits from using APF50 respirators for 2 years are estimated as 97.92% of the benefits of eliminating all

exposure (97.92% = 1-(95%/50+3%/50+0%/50+1%/50+1%/1000+0%/10000)/(95%/1+3%/10+0%/25+1%/50+1%/1000+0%/10000)). In addition, EEC users are assumed to be exposed once monthly instead of 250 days per year; thus, the aerosol user benefits are adjusted by 4.8% (4.8%=12/250).

Unquantified Benefits

Both animal and human studies demonstrate that TCE exposure can result in either autoimmune/immune enhancement responses or immunosuppression. There is also evidence of both systemic and localized hypersensitivity resulting in skin sensitization and autoimmune hepatitis. Overall, immunotoxicity in the form of both autoimmunity and immune suppression following TCE exposure are supported by the weight of evidence (EPA 2020e).

As discussed in EPA's risk evaluation (EPA 2020e), there is positive overall evidence that TCE may produce congenital heart defects (CHDs) in humans (based on positive evidence from epidemiology studies, ambiguous evidence from animal toxicity studies, and stronger positive evidence from mechanistic studies). This analysis is unable to quantify the magnitude of avoided risk of autoimmune/immune enhancement responses or immunosuppression or CHDs due to reductions in TCE exposure under the rule, and thus is unable to develop monetized estimates of the benefits of non-cancer risk reductions. However, section 8.9 presents a qualitative discussion of non-cancer endpoints, potential social costs, and the potential number of pregnant individuals exposed to TCE.

Estimated Incremental Net Benefits

Quantified net benefits are estimated by subtracting the total annualized quantified cost of the regulatory options (see Chapter 7) from the total annualized quantified benefits (see Chapter 8). Total quantified costs reflect costs of compliance with the regulatory options, including requirements for prohibition and WCPP requirements, for those uses where costs could be estimated. Total quantified benefits reflect the benefits of reduced risk for kidney, liver and NHL cancer. Costs, benefits, and net benefits are presented in 2022 dollars in this document unless otherwise noted.

Table ES-10 and Table ES-11 present the net benefits by use category estimated using a 2 percent discount rate using the low and high benefits estimates, respectively. Table ES-12 and Table ES-13 present the net benefits by use category estimated using a 3 percent discount rate using the low and high benefits estimates, respectively. Table ES-14 and Table ES-15 present the net benefits by use category estimated using a 7 percent discount rate using the low and high benefits estimates, respectively Table ES-16 summarizes the four net benefits estimates that were estimated.

Note that as discussed in Chapter 7, section 7.11, there are additional unquantified costs that affect all options. Similarly, Chapter 8 notes that there are also unquantified benefits. Therefore, it is not clear whether the monetized net benefits presented in the tables below under- or over-estimate the true social net benefits of the regulatory options.

Table ES-10: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (Low Benefits Estimate, 2 Percent Discount Rate)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Laboratory Use	$1,020,962	$1,020,962	-	-	($1,020,962)	($1,020,962)
Manufacturing	$257,925	$496,593	$9,955	$11,144	($247,970)	($485,449)
Battery and Synthetic Paper Processing Aid	$271,592	$311,972	$55,169	$56,344	($216,423)	($255,629)
HFC Manufacturing	$36,605	$71,153	$1,349	$1,510	($35,256)	($69,644)
Intermediate in HCl Production	-	$1,916,912	-	$42,384	-	($1,874,528)
Fluoroelastomer Manufacture	$181,062	$207,982	$37,513	$37,564	($143,549)	($170,418)
Open-Top Vapor Degreasing	$45,445,026	$45,493,389	$6,580,750	$6,594,356	($38,864,276)	($38,899,033)
Enclosed Vapor Degreasing	$917,124	$921,179	$2,875	$3,012	($914,249)	($918,167)
Conveyorized Vapor Degreasing	$1,037,791	$1,037,791	$195,973	$195,973	($841,818)	($841,818)
Web Vapor Degreasing	$129,724	$129,724	$6,236	$6,236	($123,488)	($123,488)
Batch Cold Cleaning	$6,745,641	$6,745,641	$610,659	$610,659	($6,134,983)	($6,134,983)
Disposal to Wastewater	$7,077,581	$18,630,260	$860,405	$859,919	($6,217,177)	($17,770,341)
Energized Electrical Cleaners (EEC)	$575,451	$575,451	$79,514	$79,714	($495,937)	($495,737)
Mold Release[1]	$52,573	$52,573	$392,326	$396,232	$339,753	$343,659
Liquid Cleaners and Degreasers[1]	$75,756	$75,756	$2,227,169	$2,226,780	$2,151,412	$2,151,023
Aerosol Spray Cleaning/Degreasing[1]	$99,119	$99,119	$6,249,562	$6,249,548	$6,150,443	$6,150,429
Lubricants and Greases[1]	$28,124	$28,124	$1,839,215	$1,837,103	$1,811,092	$1,808,979
Adhesives, Sealants, Paints and Coatings[1]	$60,332	$60,332	$857,989	$857,419	$797,657	$797,087
Spot Removers[1]	$38,715	$38,715	$2,848,077	$2,847,688	$2,809,362	$2,808,972
Pepper Spray[1]	$3,754	$3,754	$924	$493	($2,830)	($3,261)
Total	**$64,054,859**	**$77,917,383**	**$22,855,659**	**$22,914,077**	**($41,199,199)**	**($55,003,306)**

[1]Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products. These costs and benefits are aggregated under the use categories for the formulated products here so that benefits and costs are comparable. This is why the costs and benefits presented in this table are larger for the use categories for the formulated products compared to values in the cost and benefits summary tables.

Table ES-11: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (High Benefits Estimate, 2 Percent Discount Rate)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2

Table ES-11: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (High Benefits Estimate, 2 Percent Discount Rate)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Laboratory Use	$1,020,962	$1,020,962	-	-	($1,020,962)	($1,020,962)
Manufacturing	$257,925	$496,593	$10,091	$11,296	($247,835)	($485,297)
Battery and Synthetic Paper Processing Aid	$271,592	$311,972	$55,921	$57,112	($215,671)	($254,861)
HFC Manufacturing	$36,605	$71,153	$1,367	$1,531	($35,238)	($69,623)
Intermediate in HCl Production	-	$1,916,912	-	$42,962	-	($1,873,950)
Fluoroelastomer Manufacture	$181,062	$207,982	$38,024	$38,076	($143,038)	($169,906)
Open-Top Vapor Degreasing	$45,445,026	$45,493,389	$6,670,446	$6,684,237	($38,774,581)	($38,809,152)
Enclosed Vapor Degreasing	$917,124	$921,179	$2,914	$3,053	($914,210)	($918,126)
Conveyorized Vapor Degreasing	$1,037,791	$1,037,791	$198,644	$198,644	($839,147)	($839,147)
Web Vapor Degreasing	$129,724	$129,724	$6,321	$6,321	($123,403)	($123,403)
Batch Cold Cleaning	$6,745,641	$6,745,641	$618,982	$618,982	($6,126,659)	($6,126,659)
Disposal to Wastewater	$7,077,581	$18,630,260	$872,142	$871,650	($6,205,439)	($17,758,610)
Energized Electrical Cleaners (EEC)	$575,451	$575,451	$80,618	$80,820	($494,833)	($494,630)
Mold Release[1]	$52,573	$52,573	$397,674	$401,632	$345,101	$349,059
Liquid Cleaners and Degreasers[1]	$75,756	$75,756	$2,257,525	$2,257,131	$2,181,769	$2,181,374
Aerosol Spray Cleaning/Degreasing[1]	$99,119	$99,119	$6,336,370	$6,336,356	$6,237,251	$6,237,237
Lubricants and Greases[1]	$28,124	$28,124	$1,864,284	$1,862,143	$1,836,160	$1,834,019
Adhesives, Sealants, Paints and Coatings[1]	$60,332	$60,332	$869,683	$869,106	$809,351	$808,773
Spot Removers[1]	$38,715	$38,715	$2,887,638	$2,887,244	$2,848,923	$2,848,528
Pepper Spray[1]	$3,754	$3,754	$936	$500	($2,818)	($3,254)
Total	**$64,054,859**	**$77,917,383**	**$23,169,579**	**$23,228,794**	**($40,885,279)**	**($54,688,590)**

[1]Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products. These costs and benefits are aggregated under the use categories for the formulated products here so that benefits and costs are comparable. This is why the costs and benefits presented in this table are larger for the use categories for the formulated products compared to values in the cost and benefits summary tables.

Table ES-12: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (Low Benefits Estimate, 3 Percent Discount Rate)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2

Table ES-12: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (Low Benefits Estimate, 3 Percent Discount Rate)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Laboratory Use	$1,019,851	$1,019,851	-	-	($1,019,851)	($1,019,851)
Manufacturing	$257,227	$495,780	$7,952	$8,902	($249,275)	($486,878)
Battery and Synthetic Paper Processing Aid	$270,832	$313,678	$47,589	$45,005	($223,243)	($268,673)
HFC Manufacturing	$38,271	$74,458	$1,130	$1,264	($37,141)	($73,193)
Intermediate in HCl Production	-	$1,913,754	-	$33,854	-	($1,879,899)
Fluoroelastomer Manufacture	$180,554	$209,118	$29,960	$30,005	($150,594)	($179,114)
Open-Top Vapor Degreasing	$51,402,026	$51,454,277	$5,255,545	$5,267,311	($46,146,482)	($46,186,966)
Enclosed Vapor Degreasing	$1,011,662	$1,016,091	$2,288	$2,406	($1,009,374)	($1,013,685)
Conveyorized Vapor Degreasing	$1,175,495	$1,175,495	$156,535	$156,535	($1,018,959)	($1,018,959)
Web Vapor Degreasing	$146,937	$146,937	$4,981	$4,981	($141,955)	($141,955)
Batch Cold Cleaning	$7,640,714	$7,640,714	$487,770	$487,770	($7,152,944)	($7,152,944)
Disposal to Wastewater	$7,076,676	$18,606,842	$687,113	$686,726	($6,389,562)	($17,920,116)
Energized Electrical Cleaners (EEC)	$622,687	$622,687	$63,278	$63,450	($559,409)	($559,237)
Mold Release[1]	$57,453	$57,453	$313,375	$316,494	$255,921	$259,041
Liquid Cleaners and Degreasers[1]	$82,789	$82,789	$1,778,975	$1,778,664	$1,696,185	$1,695,875
Aerosol Spray Cleaning/Degreasing[1]	$108,321	$108,321	$4,973,971	$4,973,960	$4,865,650	$4,865,639
Lubricants and Greases[1]	$30,735	$30,735	$1,469,093	$1,467,406	$1,438,358	$1,436,671
Adhesives, Sealants, Paints and Coatings[1]	$65,933	$65,933	$685,328	$684,873	$619,395	$618,940
Spot Removers[1]	$42,309	$42,309	$2,266,751	$2,266,440	$2,224,442	$2,224,131
Pepper Spray[1]	$4,103	$4,103	$738	$394	($3,365)	($3,709)
Total	**$71,234,573**	**$85,081,323**	**$18,232,371**	**$18,276,440**	**($53,002,202)**	**($66,804,883)**

[1]Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products. These costs and benefits are aggregated under the use categories for the formulated products here so that benefits and costs are comparable. This is why the costs and benefits presented in this table are larger for the use categories for the formulated products compared to values in the benefits summary tables.

Table ES-13: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (High Benefits Estimate, 3 Percent Discount Rate)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2

Table ES-13: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (High Benefits Estimate, 3 Percent Discount Rate)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Laboratory Use	$1,019,851	$1,019,851	-	-	($1,019,851)	($1,019,851)
Manufacturing	$257,227	$495,780	$8,065	$9,029	($249,161)	($486,751)
Battery and Synthetic Paper Processing Aid	$270,832	$313,678	$48,270	$45,649	($222,561)	($268,028)
HFC Manufacturing	$38,271	$74,458	$1,146	$1,283	($37,125)	($73,175)
Intermediate in HCl Production	-	$1,913,754	-	$34,339	-	($1,879,415)
Fluoroelastomer Manufacture	$180,554	$209,118	$30,389	$30,434	($150,166)	($178,684)
Open-Top Vapor Degreasing	$51,402,026	$51,454,277	$5,330,782	$5,342,718	($46,071,244)	($46,111,560)
Enclosed Vapor Degreasing	$1,011,662	$1,016,091	$2,321	$2,440	($1,009,341)	($1,013,650)
Conveyorized Vapor Degreasing	$1,175,495	$1,175,495	$158,776	$158,776	($1,016,718)	($1,016,718)
Web Vapor Degreasing	$146,937	$146,937	$5,053	$5,053	($141,884)	($141,884)
Batch Cold Cleaning	$7,640,714	$7,640,714	$494,753	$494,753	($7,145,961)	($7,145,961)
Disposal to Wastewater	$7,076,676	$18,606,842	$696,596	$696,203	($6,380,080)	($17,910,639)
Energized Electrical Cleaners (EEC)	$622,687	$622,687	$64,170	$64,345	($558,516)	($558,342)
Mold Release[1]	$57,453	$57,453	$317,861	$321,025	$260,408	$263,572
Liquid Cleaners and Degreasers[1]	$82,789	$82,789	$1,804,442	$1,804,127	$1,721,653	$1,721,338
Aerosol Spray Cleaning/Degreasing[1]	$108,321	$108,321	$5,044,106	$5,044,095	$4,935,786	$4,935,774
Lubricants and Greases[1]	$30,735	$30,735	$1,490,124	$1,488,413	$1,459,390	$1,457,678
Adhesives, Sealants, Paints and Coatings[1]	$65,933	$65,933	$695,139	$694,677	$629,206	$628,744
Spot Removers[1]	$42,309	$42,309	$2,298,713	$2,298,397	$2,256,403	$2,256,088
Pepper Spray[1]	$4,103	$4,103	$748	$399	($3,354)	($3,703)
Total	**$71,234,573**	**$85,081,323**	**$18,491,456**	**$18,536,156**	**($52,743,118)**	**($66,545,167)**

[1]Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products. These costs and benefits are aggregated under the use categories for the formulated products here so that benefits and costs are comparable. This is why the costs and benefits presented in this table are larger for the use categories for the formulated products compared to values in the cost and benefits summary tables.

Table ES-14: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (Low Benefits Estimate, 7 Percent Discount Rate)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2

Table ES-14: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (Low Benefits Estimate, 7 Percent Discount Rate)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Laboratory Use	$1,015,018	$1,015,018	-	-	($1,015,018)	($1,015,018)
Manufacturing	$254,189	$492,243	$3,805	$4,260	($250,384)	($487,983)
Battery and Synthetic Paper Processing Aid	$267,524	$321,094	$22,296	$21,535	($245,227)	($299,559)
HFC Manufacturing	$44,392	$86,691	$635	$711	($43,757)	($85,980)
Intermediate in HCl Production	-	$1,900,018	-	$16,199	-	($1,883,819)
Fluoroelastomer Manufacture	$178,349	$214,063	$14,329	$14,357	($164,021)	($199,706)
Open-Top Vapor Degreasing	$77,266,553	$77,335,094	$2,512,991	$2,520,450	($74,753,562)	($74,814,643)
Enclosed Vapor Degreasing	$1,409,320	$1,415,334	$1,079	$1,151	($1,408,241)	($1,414,183)
Conveyorized Vapor Degreasing	$1,774,397	$1,774,397	$74,903	$74,903	($1,699,494)	($1,699,494)
Web Vapor Degreasing	$221,800	$221,800	$2,384	$2,384	($219,416)	($219,416)
Batch Cold Cleaning	$11,533,580	$11,533,580	$233,402	$233,402	($11,300,178)	($11,300,178)
Disposal to Wastewater	$7,072,738	$18,504,991	$329,139	$328,953	($6,743,599)	($18,176,037)
Energized Electrical Cleaners (EEC)	$820,958	$820,958	$30,304	$30,414	($790,654)	($790,544)
Mold Release[1]	$78,680	$78,680	$149,952	$151,445	$71,272	$72,765
Liquid Cleaners and Degreasers[1]	$113,376	$113,376	$851,254	$851,105	$737,878	$737,729
Aerosol Spray Cleaning/Degreasing[1]	$148,340	$148,340	$2,384,335	$2,384,330	$2,235,995	$2,235,989
Lubricants and Greases[1]	$42,090	$42,090	$702,973	$702,165	$660,883	$660,076
Adhesives, Sealants, Paints and Coatings[1]	$90,292	$90,292	$327,935	$327,717	$237,643	$237,425
Spot Removers[1]	$57,941	$57,941	$1,086,597	$1,086,449	$1,028,657	$1,028,508
Pepper Spray[1]	$5,618	$5,618	$353	$188	($5,265)	($5,430)
Total	**$102,395,154**	**$116,171,618**	**$8,728,666**	**$8,752,119**	**($93,666,488)**	**($107,419,499)**

[1]Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products. These costs and benefits are aggregated under the use categories for the formulated products here so that benefits and costs are comparable. This is why the costs and benefits presented in this table are larger for the use categories for the formulated products compared to values in the cost and benefits summary tables.

Table ES-15: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (High Benefits Estimate, 7 Percent Discount Rate)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2

Table ES-15: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (High Benefits Estimate, 7 Percent Discount Rate)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Laboratory Use	$1,015,018	$1,015,018	-	-	($1,015,018)	($1,015,018)
Manufacturing	$254,189	$492,243	$3,867	$4,329	($250,322)	($487,914)
Battery and Synthetic Paper Processing Aid	$267,524	$321,094	$22,658	$21,884	($244,866)	($299,210)
HFC Manufacturing	$44,392	$86,691	$645	$723	($43,747)	($85,969)
Intermediate in HCl Production	-	$1,900,018	-	$16,462	-	($1,883,557)
Fluoroelastomer Manufacture	$178,349	$214,063	$14,561	$14,590	($163,788)	($199,473)
Open-Top Vapor Degreasing	$77,266,553	$77,335,094	$2,553,722	$2,561,302	($74,712,831)	($74,773,791)
Enclosed Vapor Degreasing	$1,409,320	$1,415,334	$1,096	$1,170	($1,408,223)	($1,414,164)
Conveyorized Vapor Degreasing	$1,774,397	$1,774,397	$76,117	$76,117	($1,698,279)	($1,698,279)
Web Vapor Degreasing	$221,800	$221,800	$2,422	$2,422	($219,377)	($219,377)
Batch Cold Cleaning	$11,533,580	$11,533,580	$237,185	$237,185	($11,296,395)	($11,296,395)
Disposal to Wastewater	$7,072,738	$18,504,991	$334,474	$334,285	($6,738,264)	($18,170,706)
Energized Electrical Cleaners (EEC)	$820,958	$820,958	$30,773	$30,884	($790,185)	($790,074)
Mold Release[1]	$78,680	$78,680	$152,383	$153,900	$73,703	$75,220
Liquid Cleaners and Degreasers[1]	$113,376	$113,376	$865,051	$864,900	$751,675	$751,524
Aerosol Spray Cleaning/Degreasing[1]	$148,340	$148,340	$2,421,164	$2,421,159	$2,272,824	$2,272,819
Lubricants and Greases[1]	$42,090	$42,090	$714,367	$713,546	$672,277	$671,457
Adhesives, Sealants, Paints and Coatings[1]	$90,292	$90,292	$333,250	$333,029	$242,958	$242,736
Spot Removers[1]	$57,941	$57,941	$1,103,380	$1,103,229	$1,045,440	$1,045,289
Pepper Spray[1]	$5,618	$5,618	$359	$191	($5,259)	($5,427)
Total	**$102,395,154**	**$116,171,618**	**$8,867,475**	**$8,891,308**	**($93,527,680)**	**($107,280,310)**

[1]Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products. These costs and benefits are aggregated under the use categories for the formulated products here so that benefits and costs are comparable. This is why the costs and benefits presented in this table are larger for the use categories for the formulated products compared to values in the cost and benefits summary tables.

Table ES-16: Total 20-Year Annualized Net Benefits by Regulatory Option, (Millions, 2022$)

Estimate	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Low Benefits, 2 Percent Discount Rate	$64	$78	$23	$23	($41)	($55)
High Benefits, 2 Percent Discount Rate	$64	$78	$23	$23	($41)	($55)
Low Benefits, 3 Percent Discount Rate	$71	$85	$18	$18	($53)	($67)
High Benefits, 3 Percent Discount Rate	$71	$85	$18	$19	($53)	($67)
Low Benefits, 7 Percent Discount Rate	$102	$116	$9	$9	($94)	($107)
High Benefits, 7 Percent Discount Rate	$102	$116	$9	$9	($94)	($107)

Environmental Justice Impacts

EPA's "Technical Guidance for Assessing Environmental Justice in Regulatory Analysis" provides recommendations that encourage analysts to conduct the highest quality analysis feasible, recognizing that data limitations, time and resource constraints, and analytic challenges will vary by media and circumstance (EPA 2016b). This analysis presents information about the facilities, workforce, and communities potentially affected by the regulatory options under current conditions. It draws on publicly available data provided by EPA and U.S. Census, including the Toxics Release Inventory (TRI), Chemical Data Reporting (CDR), National Emissions Inventory (NEI), the American Community Survey (ACS), and the Quarterly Workforce Indicators (QWI).

The purpose of this analysis is to characterize the baseline conditions faced by communities and workers affected by the regulation to identify the potential for disproportionate impacts on minority and low-income populations. The EJ analysis first characterizes the average demographic characteristics of communities near all TCE facilities compared to national and rural averages. The baseline characterization across all facilities establishes typical demographics near these facilities and provides a useful point of departure for examining specific subsets of facilities of special interest. The analysis then delves into the characteristics of communities near facilities associated with highlighted COUs.

This data is presented in Table ES-17. The table presents average information on communities surrounding all identified facilities likely to be affected by the regulation compared to both the overall national average and the national average for rural areas. The analysis uses socioeconomic and demographic data from the American Community Survey 1-year data release for 2020 (the most recent year available). The values in the last three columns reflect population-weighted averages across the Census block groups within a 1-, 3-, and 5- mile radius of each facility. The table presents rural in addition to overall national statistics for comparison because 1,412 of the 2,595 facilities are located in rural communities. The table also includes the national air toxics assessment (NATA) national average respiratory hazard score. These indices are developed as part of EPA's Air Toxics Screening Assessment (https://www.epa.gov/AirToxScreen). The respiratory hazard index is the sum of hazard indices of air toxics with reference concentrations based on respiratory endpoints, where each hazard index (HI) is the ratio of exposure concentration in the air to the health-based reference concentration set by EPA. A hazard index of 1 or lower means air toxics are unlikely to cause adverse noncancer health effects over a lifetime of exposure. However, an HI greater than 1 does not necessarily mean adverse effects are likely. The cancer risk is an estimate of the lifetime cancer risk from inhalation of air toxics (meaning the risk of developing cancer due to inhalation exposure to each air toxic compound over a normal lifetime of 70 years), as risk per lifetime per million people[2].

[2] The Air Toxics Screening Assessment results are most meaningful when viewed at the state or national level. These results alone are not sufficient to draw conclusions about local concentrations and risk (EPA 2017h). Results are presented to give an indication of the baseline cancer and respiratory risk due to exposure to a wide variety of air toxics for communities near a TCE facility.

Table ES-17: Demographics of Communities Within 1-, 3-, and 5-mile Radii of Trichloroethylene Facilities, Population Weighted Averages

Demographic	National	Urban	Rural	1 Mile Average	3 Mile Average	5 Mile Average
Median Household Income	$64,994	$71,293	$51,878	$74,374	$77,378	$77,984
White	70.4%	66.5%	87.6%	63.0%	62.5%	62.7%
Black	12.6%	14.2%	5.8%	13.1%	14.1%	15.0%
American Indian	0.8%	0.6%	1.7%	0.6%	0.6%	0.6%
Asian	5.6%	6.6%	1.2%	8.9%	8.9%	8.3%
Pacific Islander	0.2%	0.2%	0.1%	0.2%	0.2%	0.2%
Other	5.1%	6.1%	0.8%	8.3%	7.8%	7.5%
2 or More Races	5.2%	5.7%	2.8%	5.9%	5.8%	5.7%
Hispanic	18.2%	21.7%	2.4%	23.2%	23.1%	22.4%
2x Poverty Line	29.8%	30.6%	26.0%	33.7%	31.6%	31.0%
Below Poverty Line	12.8%	13.6%	9.6%	15.7%	14.3%	13.9%
NATA Cancer Risk	20	-	-	30	30	31
NATA Respiratory Hazard Score	0.3	-	-	0.4	0.4	0.4
Total Population	**-**	**-**	**-**	**8,558,151**	**55,806,017**	**106,394,429**

The analysis then explores the characteristics of communities near facilities associated with several COUs. These COUs were selected for a number of reasons described in the respective analyses for each of the uses. The analysis also presents an assessment of worker demographics for each of these COUs. These uses include:

- manufacturing of TCE (Section 10.6.2),
- use of TCE as an intermediate in the manufacture of HFCs (Section 10.6.3),
- use as a process solvent in the manufacture of battery separators Section 10.6.4), and
- use in vapor degreasing (Section 10.6.5).

In the analysis, EPA also presents information on the number of facilities that may pose potential risk to individuals living in close proximity to facilities releasing toxic chemicals according to TRI data from 2020 for each of the uses covered. This shows whether TCE facilities are in areas with clustering of TRI sites. However, assessing cumulative impacts on communities requires understanding what is being emitted and what risks these facilities pose, which does not exactly correspond to facility counts.

Presented as an example, Table ES-18 examines TRI facilities clustering around facilities associated with the use of TCE as an intermediate in the manufacture of HFCs.

Table ES-18: Total Number of Other TRI Facilities Within 1, 3 and 5 Miles of Facilities Using TCE to Manufacture HFCs

Facility Name	Location	Other TRI Facilities Within 1 Mile	Other TRI Facilities Within 3 Miles	Other TRI Facilities Within 5 Miles
Arkema, Inc.	Marshall, KY	5	11	11
Mexichem Fluor, Inc.	Iberville, LA	4	14	21

Data from EJSCREEN, EPA's environmental justice mapping and screening tool, are also presented. Specifically, two environmental indicators from EJSCREEN are included: the air toxics cancer risk and the air toxics respiratory hazard index, averaged across the geographic areas for facilities of interest.

The benefits chapter (Chapter 8) does not discuss the sociodemographic characteristics of the affected workers and ONUs. While EPA lacks information on the characteristics of the workers and ONUs in the specific regulated facilities, this analysis provides sociodemographic information on workers in the affected industries and locations as a proxy for the likely characteristics of affected workers and ONUs. It also provides information on the sociodemographic characteristics of nearby communities and general population.

Table ES-19 provides a sample of how demographic and EJSCREEN data was presented in the analysis. Specifically, it addresses the Mexichem Fluor, Inc. facility in Louisiana, which uses TCE as an intermediate in the manufacture of HFCs.

Table ES-19: Community Demographics Near Mexichem Fluor, St. Gabriel, LA

Demographic	National	Rural	1 mile	3 miles	5 miles
Median Household Income	$64,994	$51,878	$54,613	$52,868	$67,954
White	70.4%	87.60%	21.5%	29.7%	45%
Black	12.6%	5.80%	77.5%	68.5%	51%
American Indian	0.8%	1.70%	0.0%	0.0%	0%
Asian	5.6%	1.20%	0.1%	0.1%	0%
Pacific Islander	0.2%	0.10%	0.0%	0.0%	0%
2 or more races	5.1%	-	0.0%	0.3%	1%
Other	5.2%	3.60%	0.8%	1.4%	2%
Hispanic	18.2%	2.40%	2.4%	2.0%	4%
2x Below Poverty Level	29.8%	26.00%	45.3%	38.4%	33%
Below Poverty Level	12.8%	9.60%	20.3%	16.9%	15%
NATA Cancer	20	-	200	200	180
NATA Respiratory	0.3	-	0.6	0.61	0.59
Total Population	**-**	**-**	**304**	**4,252**	**8,287**

This analysis characterizes baseline conditions, so it does not provide information about the relative merits of the primary alternative regulatory options. The EPA found unreasonable risk for numerous uses of trichloroethylene. The regulatory options considered both would prohibit the manufacture (including import), processing, distribution in commerce, industrial and commercial use, and disposal of trichloroethylene in the short term for most of these uses. The risk evaluation did not evaluate potential unreasonable risk to the general population from ambient air, water and disposal and pathways for any condition of use for trichloroethylene.

Data limitations prevent EPA from conducting a more comprehensive EJ analysis that would identify the incremental impacts of the regulatory options and assess the extent to which they mitigate or exacerbate any disproportionate impacts in communities with environmental justice concerns. Uncertainties include the sociodemographic characteristics of the specific individuals affected by the use categories and the substitute technologies and practices that would be adopted at regulated entities in response to the rule. While the final regulation is anticipated to eliminate unreasonable risks from exposure to TCE, EPA is not able to quantify the distribution of the change in risk across affected workers, communities, or demographic groups. EPA is also unable to quantify the changes in risks to workers, communities, and demographic groups from non-TCE-using technologies, substitutes, or practices that firms may adopt in response to the regulation to determine whether any such changes could pose environmental justice concerns.

Overall, the baseline characterization established in this analysis suggests that workers (including ONUs) in affected industries and regions, as well as residents of nearby communities, are often more likely people of color than the general population in affected geographic areas. Further, the data suggest that there are differentials in the demographics in communities surrounding most facilities subject to this regulation compared to national averages. These include both race and ethnicity as well as income. Battery separator manufacturing facilities are located near communities with larger percentages of White populations when compared to the national average. Although one facility identified has a higher percent American Indian population nearby, the facility is not within 5 miles of tribal lands. Most facilities are in areas where there is a high density of other TRI facilities, which could mean there is a cumulative risk to populations in the surrounding areas. Also, almost all facilities are in areas where both the NATA Cancer Risk and NATA Respiratory Hazard Scores are greater than the national average, with the highest NATA Cancer score of any facility investigated in this EJ analysis at 10x the national average.

Estimated Small Business Impacts

Table ES-20 presents a summary of the small business impacts overall and for each of the use categories where small business impacts were estimated.

Table ES-20: Summary of Small Business Impacts

Use Category	Number of Small Firms	Average Cost Per Small Firm (2022$, 7% Discount Rate)	Number and Percent of Firms by Cost-Revenue Impact Threshold		
			<1%	1-3%	>3%
Laboratory Use	25	$4,044	25 (100%)	-	-
Import/Repackage	5	$25	5 (100%)	-	-
Battery and Synthetic Paper Processing Aid	1	$89,175	1 (100%)	-	-
Vapor Degreasing and Batch Cold Cleaning Uses	330	$129,916	-	-	330 (100%)
Incorporation Into Formulation, Mixture, or Reaction Product	16	$2,371 - $61,637	16 (100%)	-	-
Energized Electrical Cleaners	651	$107	651 (100%)	-	-
Disposal and Recycling	17	$9,571	17 (100%)	-	-
Mold Release	15	$8	15 (100%)	-	-
Liquid Cleaners and Degreasers	11,574	$8	11,574 (100%)	-	-
Aerosol Spray Cleaning/Degreasing	3,626	$8	3,626 (100%)	-	-
Lubricants and Greases	332	$8	332 (100%)	-	-
Adhesives, Sealants, Paints and Coatings	58	$8	58 (100%)	-	-
Spot Removers	4,949	$8	4,949 (100%)	-	-
Total	**21,599**	**$8 - $129,916**	**21,269 (98.5%)**	**-**	**330 (1.5%)**

1. Introduction

The U.S. Environmental Protection Agency (EPA) is undertaking rulemaking under section 6(a) of the Toxic Substances Control Act (TSCA) for TCE after completing a risk evaluation and determining that the chemical substance presents unreasonable risk under the conditions of use (COU). This report estimates and evaluates the costs, benefits, and impacts expected to result from the final rule to regulate manufacture (including import), processing, distribution in commerce and industrial, commercial, and consumer use of TCE. EPA is finalizing the regulation under the authority granted by Section 6 of TSCA. The final rule, "Regulation of Trichloroethylene Under TSCA Section 6(a)," addresses the unreasonable risk from TCE. These COUs are presented below in Table 1-1. Table 1-1 also lists the use categories (or categories of TCE use that are considered in the economic analysis) and defines how the economic analysis use categories map to the COUs.

Table 1-1: Use Categories Considered in the Economic Analysis Mapped to the Conditions of Use (COUs) Defined in the Risk Evaluation

Use Category	Option 1 (ECEL of 0.2 ppm)	Option 2 (ECEL of 0.0011ppm)
Laboratory Use	**WCPP followed by prohibition[1]** [1]Asphalt Testing: WCPP for 10 years followed by prohibition (10-year 6g exemption). Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.	**Prohibition/WCPP followed by prohibition[2]** [2]Asphalt Testing: Prohibited. Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.
Manufacturing Import/Repackage	**WCPP for limited uses until prohibited[3]** [3]Interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.	
Battery and Synthetic Paper Processing Aid	**WCPP followed by prohibition[4]** [4]15-year exemption with WCPP 6 months after rule finalization for lead acid battery separators. 5-year exemption with WCPP 6 months after rule finalization for lithium battery separators.15-year exemption with WCPP 6 months after rule finalization for synthetic paper.	**WCPP followed by prohibition[5]** [5]10-year exemption with WCPP 6 months after rule finalization for battery separator manufacture. Synthetic paper use prohibited.
HFC Manufacturing	**Long-Term Phase Out with WCPP followed by Prohibition[6]** [6]Long-term phase out to prohibition over 8.5 years, interim requirements of WCPP.	
Intermediate in HCl Production	**Not Subject to Rule**	**WCPP followed by prohibition[7]** [7]WCPP 6 months to 2 years after rule finalization followed by prohibition.
Fluoroelastomer Manufacture	**WCPP followed by Prohibition[8]** [8]WCPP 6 months to 2 years after rule finalization followed by prohibition.	
Open-Top Vapor Degreasing Enclosed Vapor Degreasing Conveyorized/Web Vapor Degreasing Batch Cold Cleaning	**Prohibition with Interim WCPP for Exemptions[9]** [9]A 6(g) exemption for 7 years applies to OTVD for narrow tubes for aerospace or medical device use. A 6(g) exemption for 10 years applies to naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes for OTVDs. A 6(g) exemption for 7 years applies to human-rated rocket engine cleaning in EVDs by Federal agencies and their contractors. A 6(g) exemption for 10 years applies to rayon fabric scouring in EVDs for rocket booster nozzle production for Federal agencies and their contractors.	
Disposal to Wastewater	**Prohibition 1 year after rule finalization with WCPP requirements for POTWs exceeding a water screening level and worker protection requirements for cleanup sites and industrial treatment/pre-treatment. [10]** [10]For POTWs above the water screening level, WCPP would be required (with the interim occupational exposure limit (ECEL)). For cleanup site workers and industrial treatment/pre-treatment, use TSCA regulatory limit (new interim occupational exposure limit (ECEL)) within the framework of existing OSHA HAZWOPER requirements.	**Prohibition[11]** [11]One year after rule finalization.
Energized Electrical Cleaners	**Prohibition with Interim APF50 Respirator Requirement[12]** [12]Prohibit 3 years after rule finalization with interim prescriptive respiratory protection requirements of APF 50 respirator use.	**Prohibition[13]** [13]Six months after rule finalization.
Incorporation into	**Prohibition[14,15]**	

Table 1-1: Use Categories Considered in the Economic Analysis Mapped to the Conditions of Use (COUs) Defined in the Risk Evaluation

Use Category	Option 1 (ECEL of 0.2 ppm)	Option 2 (ECEL of 0.0011ppm)
Formulation, Mixture, or Reaction Product	[14]Prohibition six months after rule finalization. [15]Adhesives and Sealants for Aerospace uses have a 5-year exemption with interim WCPP. Since the numbers of workers affected by the exemption is unknown, the exemption is not accounted for in the analysis and the costs and benefits from prohibition are assumed for all affected users of adhesives, sealants, paints, and coatings.	
Commercial Use Pepper Spray		
Incorporation into Articles		
Mold Release		
Liquid Cleaners and Degreasers		
Aerosol Spray Cleaning/Degreasing (except EEC)		
Lubricants and Greases		
Adhesives, Sealants, Paints and Coatings[3]		
Functional Fluids		
Spot Removers		
Film Cleaner		
Toner Aid		
Polish		

1.1 Background

TCE is a volatile organic compound (VOC) used in industry as well as in commercial and consumer products. The primary use of TCE is as an intermediate during the manufacture of refrigerants, specifically HFC-134a, which accounts for about 83.6% of TCE's annual production volume (EPA 2020e). TCE is also used as a solvent, frequently in cleaning and degreasing (including spot cleaning, vapor degreasing, cold cleaning, and aerosol degreasing), which accounts for another 14.7% of TCE production volume, leaving approximately 1.7% for other uses.

TCE is also a widely used solvent in a variety of commercial and consumer applications including lubricants, adhesives and sealants, paints and coatings, and other miscellaneous products. The total aggregate annual production volume ranged from 100 to 250 million pounds between 2016 and 2019 according to CDR (EPA 2016-2019).

Under TSCA section 6(a), if the Administrator determines, through a TSCA section 6(b) risk evaluation that the manufacture (including import), processing, distribution in commerce, use, or disposal of a chemical substance or mixture, or any combination of such activities, presents an unreasonable risk of injury to health or the environment, EPA must by rule apply one or more of the following requirements to the extent necessary so that the chemical substance or mixture no longer presents such risk.

- Prohibit or otherwise restrict the manufacturing, processing, or distribution in commerce of the substance or mixture, or limit the amount of such substance or mixture which may be manufactured, processed, or distributed in commerce (section 6(a)(1)).

- Prohibit or otherwise restrict the manufacturing, processing, or distribution in commerce of the substance or mixture for a particular use or above a specific concentration for a particular use (section 6(a)(2)).

- Limit the amount of the substance or mixture which may be manufactured, processed, or distributed in commerce for a particular use or above a specific concentration for a particular use specified (section 6(a)(2)).

- Require clear and adequate minimum warning and instructions with respect to the substance or mixture or any article containing the substance or mixture's use, distribution in commerce, or disposal, or any combination of those activities, to be marked on or accompanying the substance or mixture (section 6(a)(3)).

- Require manufacturers and processors of the substance or mixture to make and retain certain records or conduct certain monitoring or testing (section 6(a)(4)).

- Prohibit or otherwise regulate any manner or method of commercial use of the substance or mixture (section 6(a)(5)).

- Prohibit or otherwise regulate any manner or method of disposal of the substance or mixture, or any article containing such substance or mixture, by its manufacturer or processor or by any person who uses or disposes of it for commercial purposes (section 6(a)(6)).

- Direct manufacturers or processors of the substance or mixture to give notice of the unreasonable risk determination to distributors, certain other persons, and the public, and to replace or repurchase the substance or mixture (section 6(a)(7)).

EPA analyzed how the TSCA section 6(a) requirements could be applied to address the unreasonable risk found to be present in the 2020 Risk Evaluation for TCE and the final revised unreasonable risk determination, so that TCE no longer presents such unreasonable risk. This document presents an economic analysis of EPA's final regulatory action (Option 1) and an alternative regulatory action (Option 2).

1.2 Regulatory Options Analyzed

Table 1-2 summarizes the regulatory options by use category. Pursuant to TSCA section 6(b), EPA determined that TCE presents an unreasonable risk of injury to health, without consideration of costs or other nonrisk factors, including an unreasonable risk to a potentially exposed or susceptible subpopulation (PESS) identified as relevant to the 2020 Risk Evaluation for TCE by EPA, under the conditions of use (EPA 2020e, EPA 2022c). Accordingly, to address the unreasonable risk, EPA is finalizing a regulation under TSCA section 6(a), to:

(i) Prohibit the manufacture (including import) and processing of TCE for all uses (including all consumer uses), with longer compliance timeframes for manufacture, processing, and distribution in commerce related to certain industrial and commercial uses;

(ii) Prohibit the industrial and commercial use of TCE with longer compliance timeframes for certain uses;

(iii) Prohibit the manufacture (including import) and processing of TCE as an intermediate for the manufacturing of hydrofluorocarbon134a (HFC-134a), following an 8.5-year phaseout;

(iv) Prohibit the industrial and commercial use of TCE as a solvent for closed-loop batch vapor degreasing for rayon fabric scouring for end use in rocket booster nozzle production by Federal agencies and their contractors, following a 10-year phaseout;

(v) Prohibit the manufacture (including import), processing, distribution in commerce, and use of

TCE as a laboratory chemical for asphalt testing and recovery, following a 10-year phaseout;

(vi) Prohibit the manufacture (including import), processing, distribution in commerce, and industrial and commercial use of TCE as a solvent in batch vapor degreasing for essential aerospace parts and components and narrow tubing used in medical devices, following a 7-year TSCA section 6(g) exemption;

(vi) Prohibit the manufacture (including import), processing, distribution in commerce, and industrial and commercial use of TCE as a solvent in closed loop vapor degreasing necessary for rocket engine cleaning by Federal agencies and their contractors, following a 7-year TSCA section 6(g) exemption;

(viii) For vessels of the Armed Forces and their systems, and in the maintenance, fabrication, and sustainment for and of such vessels and systems, prohibit the industrial and commercial use of TCE as: potting compounds for naval electronic systems and equipment; sealing compounds for high and ultra-high vacuum systems; bonding compounds for materials testing and maintenance of underwater systems and bonding of nonmetallic materials; and cleaning agents to satisfy cleaning requirements (which includes degreasing using wipes, sprays, solvents and vapor degreasing) for: materials and components required for military ordnance testing; temporary resin repairs in vessel spaces where welding is not authorized; ensuring polyurethane adhesion for electronic systems and equipment repair and installation of elastomeric materials; various naval combat systems, radars, sensors, equipment; fabrication and prototyping processes to remove coolant and other residue from machine parts; machined part fabrications for naval systems; installation of topside rubber tile material aboard vessels; and vapor degreasing required for substrate surface preparation prior to electroplating processes, following a 10-year TSCA section 6(g) exemption;

(ix) Prohibit the emergency industrial and commercial use of TCE in furtherance of the NASA mission for specific conditions which are critical or essential and for which no technically and economically feasible safer alternative is available, following a 10-year TSCA section 6(g) exemption;

(x) Prohibit the manufacture (including import), processing, distribution in commerce, disposal, and use of TCE as a processing aid for manufacturing battery separators for lead acid batteries, following a 20-year TSCA section 6(g) exemption;

(xi) Prohibit the manufacture (including import), processing, distribution in commerce, disposal, and use of TCE as a processing aid for manufacturing microporous special~~i~~ty film following a 15-year TSCA section 6(g) exemption;

(xii) Prohibit the manufacture (including import), processing, distribution in commerce, and use of TCE as a laboratory chemical for essential laboratory activities and some research and development activities, following a 50-year TSCA section 6(g) exemption;

(xiii) Require strict workplace controls to limit exposure to TCE, including compliance with a TCE workplace chemical protection program (WCPP), which would include requirements for an interim existing chemical exposure limit (ECEL) revised from the proposed rule, as well as dermal protection, to limit exposure to TCE, for conditions of use with long term phaseouts or time-limited exemptions under TSCA section 6(g) or prescriptive workplace controls.

(xiv) Prohibit the disposal of TCE to industrial pre-treatment, industrial treatment, or publicly owned treatment works through a phaseout allowing for longer timeframes for disposal necessary for certain industrial and commercial uses along with a 50-year TSCA section 6(g) exemption for disposal for cleanup before prohibition, and interim requirements for wastewater worker protection; and

(xv) Establish recordkeeping and downstream notification requirements.

The primary alternative regulatory option, Option 2, follows EPA's proposed regulatory option and includes the following requirements that differ from than the Option 1 requirements:

- A lower ECEL of 0.0011 ppm.
- Laboratory use for asphalt testing is prohibited.
- The exemption for battery separator manufacture is 10 years instead of 15 for lead acid batteries and 5 years for lithium batteries; the processing aid use for synthetic paper is not included in the exemption.
- The use as an intermediate in HCl manufacture is subject to prohibition and interim WCPP requirements
- Disposal to wastewater is prohibited
- Energized Electrical Cleaners (EEC) are prohibited six months after prohibition

Table 1-2: Summary of Regulatory Options by Use Category

Use Category	Option 1 (ECEL of 0.2 ppm)	Option 2 (ECEL of 0.0011ppm)
Laboratory Use	**WCPP followed by prohibition[1]** [1]Asphalt Testing: WCPP for 10 years followed by prohibition (10-year 6g exemption). Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.	**Prohibition/WCPP followed by prohibition[2]** [2]Asphalt Testing: Prohibited. Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.
Manufacturing	**WCPP for limited uses until prohibited[3]** [3]Interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.	
Import/Repackage		
Battery and Synthetic Paper Processing Aid	**WCPP followed by prohibition[4]** [4]20-year exemption with WCPP 6 months after rule finalization for lead acid battery separators. 5-year exemption with WCPP 6 months after rule finalization for lithium battery separators.15-year exemption with WCPP 6 months after rule finalization for synthetic paper.	**WCPP followed by prohibition[5]** [5]10-year exemption with WCPP 6 months after rule finalization for battery separator manufacture. Synthetic paper use prohibited.
HFC Manufacturing	**Long-Term Phase Out with WCPP followed by Prohibition[6]** [6]Long-term phase out to prohibition over 8.5 years, interim requirements of WCPP.	
Intermediate in HCl Production	**Not Subject to Rule**	**WCPP followed by prohibition[7]** [7]WCPP 6 months to 2 years after rule finalization followed by prohibition.
Fluoroelastomer Manufacture	**WCPP followed by Prohibition[8]** [8]WCPP 6 months to 2 years after rule finalization followed by prohibition.	
Open-Top Vapor Degreasing	**Prohibition with Interim WCPP for Exemptions[9]** [9]A 6(g) exemption for 7 years applies to OTVD for narrow tubes for aerospace or medical device use. A 6(g) exemption for 10 years applies to naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes for OTVDs. A 6(g) exemption for 7 years applies to human-rated rocket engine cleaning in EVDs by Federal agencies and their contractors. A 6(g) exemption for 10 years applies to rayon fabric scouring in EVDs for rocket booster nozzle production for Federal agencies and their contractors.	
Enclosed Vapor Degreasing		
Conveyorized/Web Vapor Degreasing		
Batch Cold Cleaning		
Disposal to Wastewater	**Prohibition 1 year after rule finalization with WCPP requirements for POTWs exceeding a water screening level and worker protection requirements for cleanup sites and industrial treatment/pre-treatment. [10]** [10]For POTWs above the water screening level, WCPP would be required (with the interim occupational exposure limit (ECEL)). For cleanup site workers and industrial treatment/pre-treatment, use TSCA regulatory limit (new interim occupational exposure limit (ECEL)) within the framework of existing OSHA HAZWOPER requirements.	**Prohibition[11]** [11]One year after rule finalization.
Energized Electrical Cleaners	**Prohibition with Interim APF50 Respirator Requirement[12]** [12]Prohibit 3 years after rule finalization with interim prescriptive respiratory protection requirements of APF 50 respirator use.	**Prohibition[13]** [13]Six months after rule finalization.
Incorporation into	**Prohibition[14,15]**	

Table 1-2: Summary of Regulatory Options by Use Category

<table>
<tr><th>Use Category</th><th>Option 1 (ECEL of 0.2 ppm)</th><th>Option 2 (ECEL of 0.0011ppm)</th></tr>
<tr><td>Formulation, Mixture, or Reaction Product</td><td colspan="2" rowspan="13">[14]Prohibition six months after rule finalization.

[15]Adhesives and Sealants for Aerospace uses have a 5-year exemption with interim WCPP. Since the numbers of workers affected by the exemption is unknown, the exemption is not accounted for in the analysis and the costs and benefits from prohibition are assumed for all affected users of adhesives, sealants, paints, and coatings.</td></tr>
<tr><td>Commercial Use Pepper Spray</td></tr>
<tr><td>Incorporation into Articles</td></tr>
<tr><td>Mold Release</td></tr>
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<tr><td>Spot Removers</td></tr>
<tr><td>Film Cleaner</td></tr>
<tr><td>Toner Aid</td></tr>
<tr><td>Polish</td></tr>
</table>

1.3 Organization of this Document

Chapter 2 presents a discussion of the problems with TCE uses that are addressed through the final rule. Chapter 3 presents general industry statistics for the sectors expected to be affected under the regulatory options. Chapter 4 presents information on the products formulated with TCE identified by EPA and the producers of those products. Section 5 discusses the availability of alternatives for the different categories of TCE usage and considers the costs and efficacy of the available alternatives. Chapter 6 presents a baseline analysis of the volume of TCE consumption and the numbers of firms, employees, and consumers using TCE. The estimated costs, benefits, and net benefits of the regulatory options are presented in Chapter 7, 8, and 9, respectively. Chapter 10 presents various impact analyses. Finally, the references are listed in Chapter 11.

2. Problem Definition/Market Failure

This report estimates and evaluates the costs and benefits expected to result from the final rule limiting the use of TCE by the U.S. Environmental Protection Agency (EPA) under the authority granted by Section 6 of the Toxic Substances Control Act (TSCA). The final rule, "Trichloroethylene (TCE); Rulemaking Under TSCA Section 6(a)" addresses the unreasonable risk from TCE under the conditions of use (COUs).

2.1 Trichloroethylene Problem

2.1.1 Sources of Exposure

Exposure to TCE occurs through the chemical substance's COU. TSCA Section 3(4) defines a chemical substance's conditions of use 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's 2020 Risk Evaluation for TCE evaluated whether exposure resulting from TCE's conditions of use presents an unreasonable risk to health and/or the environment (EPA 2020e).

2.1.2 Health Effects of TCE Exposure

TCE has a large database of human health toxicity data. The 2020 Risk Evaluation for TCE identified several endpoints, such as kidney toxicity, immunotoxicity, or developmental toxicity, and often a single endpoint was examined by multiple studies. For acute exposures, EPA evaluated non-cancer effects (developmental toxicity and mortality due to immunosuppression). For chronic exposures, EPA evaluated non-cancer effects (liver toxicity, kidney toxicity, neurotoxicity, autoimmunity, reproductive toxicity, and developmental toxicity) as well as cancer (liver, kidney, and non-Hodgkin Lymphoma), most strongly supported by the data on kidney cancer. (EPA 2020e). As discussed in the preamble, the 2020 Risk Evaluation for TCE contains quantitative risk estimates using several points of departure (PODs), including both the immunotoxicity endpoints as well as the more sensitive developmental toxicity endpoints, specifically fetal cardiac defects, and both demonstrate that TCE presents unreasonable risk.

2.1.3 Regulatory Approaches for Primary and Alternative Options

Under TSCA section 6(a), if the EPA pursuant to TSCA section 6(b)(4)(A) determines that 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 Agency's risk evaluation, under the conditions of use, EPA must by rule apply one or more requirements to the extent necessary so that the chemical substance no longer presents such risk.

The TSCA section 6(a) requirements can include one or more, or a combination of, the following actions:

- Prohibit or otherwise restrict, or limit the manufacturing, processing, or distribution in commerce of the substance or mixture (TSCA section 6(a)(1)).

- Prohibit or otherwise restrict, or limit the manufacturing, processing, or distribution in commerce of the substance or mixture for particular uses or above a specific concentration for a particular use (TSCA section 6(a)(2)).

- Require clear and adequate minimum warning and instructions with respect to its use, distribution in commerce, or disposal of the substance or mixture (TSCA section 6(a)(3)).

- Require record keeping, monitoring or testing by manufacturers and processors (TSCA 6(a)(4)).

- Prohibit or regulate any manner or method of commercial use of the substance or mixture (TSCA section 6(a)(5)).

- Prohibit or otherwise regulate any manner or method of disposal of the substance or mixture (TSCA section 6(a)(6)).

- Direct manufacturers or processors to give notice of the determination of risk to distributors and users and replace or repurchase the substance or mixture (TSCA section 6(a)(7)).

EPA considered all of the regulatory mechanisms described above, but EPA believes only a few would be effective in addressing the identified unreasonable risk. The regulatory mechanisms that are being utilized as part of this rulemaking include the following:

- **Prohibitions:** The final rule considers specific prohibitions on TCE for the use categories indicated in Table 2-1.

- **Workplace Chemical Protection Program (WCPP):** The rule requires a workplace chemical protection program as an interim measure until the prohibition that includes setting an interim existing chemical exposure limit (ECEL) of 0.2 ppm for inhalation exposures to TCE (8-hr time-weighted average (TWA)) for the use categories indicated in Table 2-1 (EPA 2021a). Firms would be required to monitor potentially exposed persons[3] to ensure they are not exposed to the chemical at a level that exceeds the exposure limit. The method of reducing exposure to this limit would be left to the firm, but it may include respiratory and dermal personal protective equipment (PPE) or other engineering controls.

The regulatory action that EPA chose for TCE under this rulemaking, as well as an alternative option, are summarized in Table 2-1 (see Table 1-1 for a map between the Use Categories and the COUs). Both EPA's final rule and an alternative option were considered in this Economic Analysis.

Table 2-1: Summary of Regulatory Options by Use Category

[3] EPA uses the term "potentially exposed person" in this economic analysis and in the regulatory text to include workers, ONUs, employees, independent contractors, employers, and all other persons in the work area who may be exposed to TCE under the conditions of use for which a WCPP would apply.

<table>
<tr><th>Use Category</th><th>Option 1 (ECEL of 0.2 ppm)</th><th>Option 2 (ECEL of 0.0011ppm)</th></tr>
<tr><td>Laboratory Use</td><td>WCPP followed by prohibition[1]

[1]Asphalt Testing: WCPP for 10 years followed by prohibition (10-year 6g exemption). Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.</td><td>Prohibition/WCPP followed by prohibition[2]

[2]Asphalt Testing: Prohibited. Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.</td></tr>
<tr><td>Manufacturing</td><td colspan="2" rowspan="2">WCPP for limited uses until prohibited[3]

[3]Interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.</td></tr>
<tr><td>Import/Repackage</td></tr>
<tr><td>Battery and Synthetic Paper Processing Aid</td><td>WCPP followed by prohibition[4]

[4]20-year exemption with WCPP 6 months after rule finalization for lead acid battery separators. 5-year exemption with WCPP 6 months after rule finalization for lithium battery separators.15-year exemption with WCPP 6 months after rule finalization for synthetic paper.</td><td>WCPP followed by prohibition[5]

[5]10-year exemption with WCPP 6 months after rule finalization for battery separator manufacture. Synthetic paper use prohibited.</td></tr>
<tr><td>HFC Manufacturing</td><td colspan="2">Long-Term Phase Out with WCPP followed by Prohibition[6]

[6]Long-term phase out to prohibition over 8.5 years, interim requirements of WCPP.</td></tr>
<tr><td>Intermediate in HCl Production</td><td>Not Subject to Rule</td><td>WCPP followed by prohibition[7]

[7]WCPP 6 months to 2 years after rule finalization followed by prohibition.</td></tr>
<tr><td>Fluoroelastomer Manufacture</td><td colspan="2">WCPP followed by Prohibition[8]

[8]WCPP 6 months to 2 years after rule finalization followed by prohibition.</td></tr>
<tr><td>Open-Top Vapor Degreasing</td><td colspan="2" rowspan="4">Prohibition with Interim WCPP for Exemptions[9]

[9]A 6(g) exemption for 7 years applies to OTVD for narrow tubes for aerospace or medical device use. A 6(g) exemption for 10 years applies to naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes for OTVDs. A 6(g) exemption for 7 years applies to human-rated rocket engine cleaning in EVDs by Federal agencies and their contractors. A 6(g) exemption for 10 years applies to rayon fabric scouring in EVDs for rocket booster nozzle production for Federal agencies and their contractors.</td></tr>
<tr><td>Enclosed Vapor Degreasing</td></tr>
<tr><td>Conveyorized/Web Vapor Degreasing</td></tr>
<tr><td>Batch Cold Cleaning</td></tr>
<tr><td>Disposal to Wastewater</td><td>Prohibition 1 year after rule finalization with WCPP requirements for POTWs exceeding a water screening level and worker protection requirements for cleanup sites and industrial treatment/pre-treatment. [10]

[10]For POTWs above the water screening level, WCPP would be required (with the interim occupational exposure limit (ECEL)). For cleanup site workers and industrial treatment/pre-treatment, use TSCA regulatory limit (new interim occupational exposure limit (ECEL)) within the framework of existing OSHA HAZWOPER requirements.</td><td>Prohibition[11]

[11]One year after rule finalization.</td></tr>
<tr><td>Energized Electrical Cleaners</td><td>Prohibition with Interim APF50 Respirator Requirement[12]

[12]Prohibit 3 years after rule finalization with interim prescriptive respiratory protection requirements of APF 50 respirator use.</td><td>Prohibition[13]

[13]Six months after rule finalization.</td></tr>
<tr><td>Incorporation into</td><td colspan="2">Prohibition[14,15]</td></tr>
</table>

Table 2-1: Summary of Regulatory Options by Use Category

Use Category	Option 1 (ECEL of 0.2 ppm)	Option 2 (ECEL of 0.0011ppm)
Formulation, Mixture, or Reaction Product	[14]Prohibition six months after rule finalization. [15]Adhesives and Sealants for Aerospace uses have a 5-year exemption with interim WCPP. Since the numbers of workers affected by the exemption is unknown, the exemption is not accounted for in the analysis and the costs and benefits from prohibition are assumed for all affected users of adhesives, sealants, paints, and coatings.	
Commercial Use Pepper Spray		
Incorporation into Articles		
Mold Release		
Liquid Cleaners and Degreasers		
Aerosol Spray Cleaning/Degreasing (except EEC)		
Lubricants and Greases		
Adhesives, Sealants, Paints and Coatings[3]		
Functional Fluids		
Spot Removers		
Film Cleaner		
Toner Aid		
Polish		

2.2 Regulatory Background

Because of its potential health effects, TCE is subject to numerous state, federal, and international regulations restricting and regulating its use. For a full description see Appendix A of the Risk Evaluation (EPA 2020e).

2.3 Justification for Risk Management Action for TCE

This section provides legal and economic justification of the final rule to regulate TCE in the United States at the federal level of government. Section 2.3.1 indicates the statutory authority for EPA to take risk management action, Section 2.3.2 identifies market failure in the industries where TCE is used, Section 2.3.3 discusses regulatory remedies to address market failure from negative externalities, and Section 2.3.4 provides justification for regulation at the federal level specifically.

2.3.1 Statutory Authority

The Frank R. Lautenberg Chemical Safety for the 21st Century Act amended the Toxic Substances Control Act (TSCA), the nation's primary chemicals management law, in June 2016.[4] Under the amended statute, EPA is required, under TSCA section 6(b), to conduct risk evaluations to determine whether a chemical substance presents an unreasonable risk of injury to health or the environment, including an unreasonable risk to potentially exposed or susceptible subpopulations identified as relevant to the Risk Evaluation under the conditions of use, without consideration of costs or other non-risk factors. If unreasonable risk is found, the agency must apply one or more of the risk management options listed in TSCA 6(a) to the extent necessary to reduce or eliminate these risks.

[4] See https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/frank-r-lautenberg-chemical-safety-21st-century-act.

2.3.2 Market Failure

The private market is a mechanism that can allocate resources efficiently. However, the market's allocation of resources will not always be desirable from the standpoint of society. The market will fail to achieve a socially efficient outcome when differences exist between private market values and social values.

Welfare economics states that a socially efficient outcome is achieved if no alternative allocation of society's resources can make at least one person better off without making another one worse off. This is referred to as a Pareto optimal outcome. If the private market fails to achieve this efficient outcome, too little or too much is produced, resulting in a loss in economic welfare. This is referred to as a market failure.

However, Pareto optimality is a strict condition and can allow for very unequal allocations. It does not address redistributive actions, in which one group is made worse off and another group is made better off. A less strict criteria for measuring economic improvement is Kaldor-Hicks efficiency. Under this criterion, economic efficiency is improved if those who benefit from an action gain more than those who lose from that action.[5] This is the fundamental efficiency criterion of benefit-cost analysis: society is considered to be better off (in terms of economic efficiency) if the benefits of an action outweigh the cost of undertaking it.

Government regulation of a private market is justified when the market fails to deliver a socially efficient outcome. If a regulation can produce benefits that exceeds its cost, then economic efficiency has been improved. The economic literature has identified the following common causes of market failure and economic inefficiency:

- Existence of externalities (negative and positive);
- Under-provision of common property resources, and public goods;
- Market power (e.g., monopolies);
- Inadequate or asymmetric information

This section discusses how negative externalities are present in the market for the chemical regulated under this rule.[6] By understanding how the market is affected by this market failure, more effective regulations can be designed.

A negative externality occurs when one party's action imposes an uncompensated negative effect on another party. For example, the manufacturer, processor, or consumer of a good may impose costs on another party if the good causes an adverse health impact that is not known or factored into the market transaction. Since these external costs are not internalized by the manufacturer, processor, or

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[5] The Kaldor-Hicks criterion is also referred to as the potential Pareto criterion or the potential compensation principle because it implies that economic efficiency is improved if those who benefit from an action could fully compensate those who lose from that action, and still be better off. In other words, it is theoretically possible to achieve a Pareto improvement – in which some are made better off, and no one is made worse off – if those who benefit from a regulation were to fully compensate those who pay the cost. The word "potential" is used because the compensation does not have to actually occur, it just has to be theoretically possible to do so for this to be a social improvement.

[6] This discussion focuses on negative externalities because this is the market failure addressed by this regulation. Please refer to EPA Guidelines for Preparing Economic Analyses (EPA 2014a) for a discussion on additional sources of market failure identified in the literature.

user, they are not considered in the production (or processing, use) and pricing decisions. As a result, the societal cost of these goods is under-valued and the level of output produced (or processed, used) is higher than the social optimal output level. In other words, a negative externality occurs when a firm makes decisions based on private costs instead of social costs, leading to an excess of product in the market.

EPA believes that the cause of market failure in the market for TCE subject to this rule stems from negative externalities and imperfect information. A negative externality occurs when one party's action imposes an uncompensated negative effect on an affected party. For example, the manufacturer, processor, or consumer of a good may impose uncompensated healthcare costs or damages that are not reflected in the cost of that good. Even when both parties have full information about the magnitude of the health damages—which is not always the case in the context of hazardous chemical exposures—the private market is likely to reach an efficient outcome only when bargaining is possible and transaction costs are low (Coase 1960). While many of the adverse health effects from exposure to TCE are well established (EPA 2020d), some effects are difficult to quantify in humans and to predict at the individual level. (EPA 2011b). Bargaining is not possible because neither party has the information or skill to predict the risk accurately. Even if the EPA provided this information, transaction costs are high because of the effort required for workers and employers to determine the correct risk-adjusted wage for each site. Therefore, the adverse health effects of TCE exposure are imposed on workers who may not be fully compensated for the additional burden from increased health risks and are thus not internalized by those manufacturing, processing, distributing, or using the chemical.

Because these adverse health effects are not internalized by the manufacturer, processor, or user, they are therefore not considered in the production (or processing, use) and pricing decision of the manufacturer, processor or user. As a result, costs are under-valued and the level of output produced (or processed, used) is higher than the socially optimal output level. Therefore, a negative externality occurs when a firm has made decisions based on private costs instead of social costs, leading to an excess of product in the market (EPA 2011).

While it is theoretically possible to force manufactures, processers, distributers, and users to internalize the external costs of TCE (for example, thorough a pollution tax or tradable permit program), EPA believes that this is not the right approach for addressing the negative externality in this market. This approach would be administratively burdensome and impose high transaction costs in a market with a multitude and varied conditions of use. Instead, EPA's approach is to decrease the volume of TCE in the market closer to what would be socially optimal and, thereby, reduce the negative externality of health impacts caused by exposure to the chemical.

Society will experience health benefits from regulatory measures that limit or eliminate the manufacture, processing, distribution, use, and disposal of TCE. However, society will experience *net benefits* from these regulatory measures only up to the point where the benefits of reducing these negative externalities are less than the costs of achieving them. If the costs of these regulatory measures on manufacturers, processors, and users of TCE are greater than the external costs imposed by their use, the regulation is too strict and the new state is also suboptimal. Social welfare would be decreased by any regulatory measure that goes beyond the point where the volume of TCE has been reduced to the same point as if the externalities were internalized. The economically efficient level of control is where the additional (marginal) cost of further control equals society's willingness to pay for the next increment of control. Adverse effects may still occur at this level, but additional regulatory costs to further reduce or eliminate these effects would not be Pareto optimal. Conversely, if post-rule, the cost to society from release and exposure to TCE remains greater than costs to regulated firms, the rule would also not produce a Pareto optimal outcome.

2.3.3 Regulatory Remedies to Reduce Negative Externalities

As discussed in Section 2.1.3, the regulatory options detail various requirements that will reduce the negative human health costs associated with the negative externality. Prohibition of the chemical, Existing Chemical Exposure Limit (ECEL), and Monitoring and Hierarchy of Controls (HOC) requirements all eliminate or reduce (for long-term phaseouts and longer compliance timeframes) exposure of TCE to third parties. EPA contends that these measures are sufficient to reduce negative externalities associated with TCE.

2.3.4 Justification for Regulation at Federal Level

The chemical and products associated with this rulemaking are distributed in commerce across state lines, and thus they fall under the federal jurisdiction of regulation under TSCA. It is more efficient for companies manufacturing, processing, distributing, using and disposing of these products to comply with a single federal standard rather than a patchwork of different state regulations. EPA acknowledges that because of its health effects, TCE is subject to numerous State, Federal, and international regulations restricting and regulating its use.

3. Profile of Affected Industries

Table 3-1 shows the industry statistics for each NAICS code, indicates which use categories are applicable for each NAICS, and presents the estimated numbers of firms and employment for firms defined as small businesses according to the SBA definitions (SBA 2023).

NAICS codes were identified for the use categories as follows:

- Manufacturing; import/repackaging, and HFC manufacturing; NAICS were identified using 2020 CDR data (EPA 2020j). Additional processing as a reactant/intermediate NAICS were identified using 2020 TRI (EPA 2022b) and 2017 NEI data (EPA 2020a).
- Vapor degreasing NAICS were identified in EPA's risk evaluation (EPA 2020e).
- Incorporation into formulation, mixture, or reaction product NAICS were identified through product searches (see Chapter 4).
- Battery manufacturing; mold release; liquid cleaners and degreasers; and adhesives, sealants, paints, and coatings NAICS were identified using 2017 NEI data (EPA 2020a). Additional NAICS for adhesives, sealants, paints, and coatings were also identified from EPA's risk evaluation (EPA 2020e).
- Aerosol spray cleaning/degreasing and spot removers NAICS were assumed to be the same as those identified in EPA's Economic Analysis of Proposed TSCA Section 6 Action on Trichloroethylene in Dry Cleaning Spot Removers and Aerosol Degreasers (EPA 2017a).
- NAICS for remaining use categories were selected based on EPA best judgement.

Table 3-2 presents company information and the small business determinations for any parent companies identified by EPA as potentially affected under the regulatory options. Companies using TCE were identified using 2020 CDR data (EPA 2020j), 2020 TRI data (EPA 2022b), 2017 NEI data (EPA 2020a), and EPA's risk evaluation (EPA 2020e). Companies producing TCE products were identified as described below in Chapter 4. Company information was obtained from the Dun and Bradstreet Hoovers database (Dun & Bradstreet 2022) and the Experian Business Target IQ database (Experian 2023). The small business determinations were made using SBA's small business thresholds (SBA 2023).

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business Threshold	Number of Firms[1]		Number of Establish-ments[1]	Employment		Annual Payroll (thousands, 2022$)	Preliminary Receipts (thousands, 2022$)
			All	SBA-Defined Small		All	SBA-Defined Small		

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
Laboratory Use	211120: Crude Petroleum Extraction	1,250 Employees	4,570	4,524	5,333	85,169	53,015	$11,661,714	$192,535,137
	313310: Textile and Fabric Finishing Mills	1,000 Employees	650	633	678	20,556	13,385	$781,035	$5,827,994
	541715: Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology)	1,000 Employees	8,019	7,641	10,032	465,680	147,517	$78,501,616	$115,647,395
	541720: Research and Development in the Social Sciences and Humanities	$28 Million	1,732	1,661	1,946	44,665	14,027	$3,725,397	$8,493,643
	611210: Junior Colleges	$32.5 Million	443	369	806	61,685	23,407	$2,320,900	$7,016,534
	611310: Colleges, Universities and Professional Schools	$34.5 Million	2,433	1,463	4,450	1,867,444	88,804	$99,365,452	$305,158,514
	928110: Other Similar Organizations (except Business, Professional, Labor, and Political Organizations)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manufacturing	221112: Fossil Fuel Electric Power Generation	950 Employees	231	169	1,700	75,470	16,472	$9,185,713	$90,013,617
	325180: Other Basic Inorganic Chemical Manufacturing	1,000 Employees	363	302	626	39,878	16,307	$4,345,440	$38,167,323
	325199: All Other Basic Organic Chemical Manufacturing	1,250 Employees	591	511	814	67,603	24,105	$7,870,579	$91,550,816
	325411: Medicinal and Botanical Manufacturing	1,000 Employees	451	429	492	27,160	16,464	$2,775,937	$13,188,303
Import/ Repackage	325180: Other Basic Inorganic Chemical Manufacturing	1,000 Employees	363	302	626	39,878	16,307	$4,345,440	$38,167,323
	325510: Paint and Coating Manufacturing	1,000 Employees	998	964	1,197	39,139	22,907	$2,989,102	$32,768,919
	325520: Adhesive Manufacturing	550 Employees	403	346	559	24,231	9,109	$1,966,229	$17,661,519
	423840: Industrial Supplies Merchant Wholesalers	125 Employees	5,811	5,495	9,463	105,490	52,940	$8,601,821	$91,461,027
	424690: Other Chemical and Allied Products Merchant Wholesalers	175 Employees	6,069	5,767	9,418	126,009	50,790	$12,168,548	$234,995,872

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
Battery and Synthetic Paper Processing Aid	325998: All Other Miscellaneous Chemical Product and Preparation Manufacturing	650 Employees	1,064	982	1,230	36,900	17,820	$3,363,541	$26,088,857
	326291: Rubber Product Manufacturing for Mechanical Use	750 Employees	346	315	411	30,895	14,720	$1,733,734	$9,086,527
	335911: Storage Battery Manufacturing	1,250 Employees	123	112	164	22,805	7,104	$1,499,462	$8,866,515
HFC Manufacturing	325180: Other Basic Inorganic Chemical Manufacturing	1,000 Employees	363	302	626	39,878	16,307	$4,345,440	$38,167,323
	325411: Medicinal and Botanical Manufacturing	1,000 Employees	451	429	492	27,160	16,464	$2,775,937	$13,188,303
Intermediate in HCl Production	221118: Other Electric Power Generation	650 Employees	36	33	54	150	125	$45,289	$44,407
	324110: Petroleum Refineries	1,500 Employees	70	44	155	63,594	5,381	$9,364,769	$571,414,981
	325110: Petrochemical Manufacturing	1,300 Employees	28	17	44	9,369	1,691	$1,466,152	$63,239,154
	325180: Other Basic Inorganic Chemical Manufacturing	1,000 Employees	363	302	626	39,878	16,307	$4,345,440	$38,167,323
	325193: Ethyl Alcohol Manufacturing	1,000 Employees	121	107	210	11,276	5,583	$894,727	$38,210,789
	325199: All Other Basic Organic Chemical Manufacturing	1,250 Employees	591	511	814	67,603	24,105	$7,870,579	$91,550,816
	325211: Plastics Material and Resin Manufacturing	1,250 Employees	852	768	1,125	75,998	34,018	$8,264,736	$106,880,973
	562212: Solid Waste Landfill	$47 Million	668	631	1,439	18,711	6,044	$1,454,084	$9,117,835
Fluoroelastomer Manufacture	321911: Wood Window and Door Manufacturing	1,000 Employees	961	932	1,110	54,943	20,728	$2,927,323	$14,686,172
	326220: Rubber and Plastics Hoses and Belting Manufacturing	800 Employees	196	177	273	19,713	8,697	$1,186,280	$6,330,711
Open-Top Vapor Degreasing	333415: Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	1,250 Employees	705	653	841	89,119	28,842	$5,670,644	$38,502,337
	333515: Cutting Tool and Machine	500	1,285	1,253	1,347	26,940	20,611	$1,555,905	$6,244,600

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	Tool Accessory Manufacturing	Employees							
	333612: Speed Changer, Industrial High-Speed Drive and Gear Manufacturing	750 Employees	194	176	230	11,926	7,046	$713,824	$3,991,472
	333912: Air and Gas Compressor Manufacturing	1,000 Employees	261	238	297	18,362	8,437	$1,655,285	$10,999,105
	333914: Measuring, Dispensing, and Other Pumping Equipment Manufacturing	750 Employees	457	410	576	37,181	11,735	$3,055,087	$19,698,490
	333921: Elevator and Moving Stairway Manufacturing	1,000 Employees	166	158	176	8,545	5,015	$644,430	$4,088,596
	333922: Conveyor and Conveying Equipment Manufacturing	500 Employees	718	683	779	37,082	24,636	$2,878,058	$11,783,275
	333923: Overhead Traveling Crane, Hoist and Monorail System Manufacturing	1,250 Employees	268	255	303	19,299	8,356	$1,380,271	$8,109,698
	333924: Industrial Truck, Tractor, Trailer and Stacker Machinery Manufacturing	900 Employees	311	287	333	27,533	11,576	$1,894,944	$12,378,097
	333991: Power-Driven Hand Tool Manufacturing	950 Employees	123	110	130	7,246	2,374	$431,216	$4,062,356
	333992: Welding and Soldering Equipment Manufacturing	1,250 Employees	341	331	363	16,213	6,225	$1,182,351	$6,664,593
	333993: Packaging Machinery Manufacturing	600 Employees	471	440	518	20,826	12,357	$1,826,335	$8,329,437
	333994: Industrial Process Furnace and Oven Manufacturing	500 Employees	317	302	344	10,868	7,984	$750,978	$3,045,889
	333995: Fluid Power Cylinder and Actuator Manufacturing	800 Employees	253	221	317	22,529	8,816	$1,675,845	$8,571,075
	333996: Fluid Power Pump and Motor Manufacturing	1,250 Employees	132	116	157	10,484	4,092	$892,979	$5,175,264
	333997: Scale and Balance Manufacturing	700 Employees	73	68	83	3,707	1,686	$231,853	$1,230,627
	333999: All Other Miscellaneous General Purpose Machinery Manufacturing	700 Employees	1,558	1,467	1,645	55,552	29,610	$4,522,513	$19,556,021

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	334416: Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing	550 Employees	334	311	371	17,270	9,717	$1,090,752	$4,304,247
	334417: Electronic Connector Manufacturing	1,000 Employees	161	144	204	18,962	7,153	$1,575,672	$7,122,743
	334418: Printed Circuit Assembly (Electronic Assembly) Manufacturing	750 Employees	753	713	808	50,868	30,425	$3,500,909	$21,949,716
	334419: Other Electronic Component Manufacturing	750 Employees	1,131	1,059	1,236	51,084	28,209	$3,935,327	$14,584,976
	334512: Automatic Environmental Control Manufacturing for Residential, Commercial and Appliance Use	650 Employees	261	234	274	12,197	5,237	$965,146	$3,562,841
	334513: Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables	750 Employees	750	710	816	33,789	16,453	$2,946,063	$12,926,459
	334515: Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals	750 Employees	710	664	753	30,275	13,750	$3,918,430	$13,738,113
	335110: Electric Lamp Bulb and Part Manufacturing	1,250 Employees	66	61	74	4,518	3,368	$197,019	$1,796,597
	335121: Residential Electric Lighting Fixture Manufacturing	750 Employees	258	253	262	6,300	3,363	$325,620	$2,046,560
	335122: Commercial, Industrial and Institutional Electric Lighting Fixture Manufacturing	600 Employees	423	403	455	20,089	11,413	$1,238,897	$6,894,528
	335129: Other Lighting Equipment Manufacturing	1,250 Employees	268	252	276	12,462	6,565	$812,364	$5,463,104
	335311: Power, Distribution and Specialty Transformer Manufacturing	800 Employees	216	190	242	18,502	6,516	$1,399,079	$6,156,990
	335312: Motor and Generator Manufacturing	1,250 Employees	372	339	424	28,980	9,911	$2,030,495	$11,827,046
	335313: Switchgear and Switchboard Apparatus Manufacturing	1,250 Employees	413	390	484	31,048	13,584	$2,514,090	$14,094,089

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	335314: Relay and Industrial Control Manufacturing	750 Employees	795	735	873	34,975	17,276	$2,563,167	$12,488,311
	335921: Fiber Optic Cable Manufacturing	1,000 Employees	87	77	92	6,974	2,683	$479,625	$3,506,576
	335991: Carbon and Graphite Product Manufacturing	900 Employees	120	109	151	8,718	3,421	$709,415	$4,215,876
	336310: Motor Vehicle Gasoline Engine and Engine Parts Manufacturing	1,050 Employees	706	654	758	58,120	16,149	$4,188,464	$39,164,777
	336320: Motor Vehicle Electrical and Electronic Equipment Manufacturing	1,000 Employees	565	513	624	62,867	20,363	$3,635,019	$32,932,311
	336330: Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing	1,000 Employees	220	192	261	38,255	14,076	$2,087,719	$17,933,893
	336340: Motor Vehicle Brake System Manufacturing	1,250 Employees	139	118	179	23,359	9,684	$1,247,985	$13,488,749
	336350: Motor Vehicle Transmission and Power Train Parts Manufacturing	1,500 Employees	390	346	474	73,386	19,121	$4,999,215	$48,004,088
	336360: Motor Vehicle Seating and Interior Trim Manufacturing	1,500 Employees	307	273	429	72,273	24,943	$3,839,997	$36,931,706
	336370: Motor Vehicle Metal Stamping	1,000 Employees	597	550	757	107,888	53,521	$5,958,475	$43,657,001
	336390: Other Motor Vehicle Parts Manufacturing	1,000 Employees	1,268	1,145	1,483	148,076	56,090	$8,488,570	$75,669,654
	336411: Aircraft Manufacturing	1,500 Employees	262	236	317	166,716	10,736	$19,959,658	$174,304,589
	336412: Aircraft Engine and Engine Parts Manufacturing	1,500 Employees	319	289	410	67,207	16,938	$7,488,721	$44,249,951
	336413: Other Aircraft Part and Auxiliary Equipment Manufacturing	1,250 Employees	750	692	921	103,133	26,327	$8,610,442	$41,415,958
	336415: Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	1,250 Employees	16	7	33	16,635	219	$2,417,490	$9,799,835
	336510: Railroad Rolling Stock Manufacturing	1,500 Employees	153	131	229	29,532	6,983	$2,061,548	$15,265,739
	337127: Institutional Furniture	500	574	554	596	24,464	18,646	$1,226,940	$5,865,029

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	Manufacturing	Employees							
	339113: Surgical Appliance and Supplies Manufacturing	800 Employees	1,651	1,592	1,867	86,837	38,259	$8,060,278	$43,237,782
	339114: Dental Equipment and Supplies Manufacturing	750 Employees	557	544	579	15,040	8,167	$1,107,904	$5,838,867
	339910: Jewelry and Silverware Manufacturing	700 Employees	1,967	1,954	1,986	23,813	16,523	$1,061,332	$8,608,096
	339993: Fastener, Button, Needle and Pin Manufacturing	750 Employees	103	97	110	3,992	1,595	$211,581	$1,067,437
	339999: All Other Miscellaneous Manufacturing	550 Employees	5,738	5,681	5,755	52,935	41,053	$2,377,517	$14,439,605
	488190: Other Support Activities for Air Transportation	$40 Million	3,197	3,052	3,894	85,531	30,184	$6,424,300	$21,511,890
	811212: Computer and Office Machine Repair and Maintenance	$34 Million	5,068	5,014	5,454	33,730	22,877	$1,713,860	$5,383,666
	811310: Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	$12.5 Million	19,986	19,238	21,814	200,268	101,827	$13,758,532	$47,179,941
Enclosed Vapor Degreasing	331210: Iron and Steel Pipe and Tube Manufacturing from Purchased Steel	1,000 Employees	180	144	241	23,495	11,670	$1,787,070	$12,548,156
	331221: Rolled Steel Shape Manufacturing	1,000 Employees	170	147	204	8,126	5,502	$619,227	$6,926,084
	331222: Steel Wire Drawing	1,000 Employees	210	186	252	14,585	9,090	$831,628	$6,322,048
	332721: Precision Turned Product Manufacturing	500 Employees	3,670	3,582	3,791	103,249	81,265	$6,369,088	$22,589,437
	332722: Bolt, Nut, Screw, Rivet and Washer Manufacturing	600 Employees	650	619	774	37,940	20,892	$2,394,029	$12,956,800
	332911: Industrial Valve Manufacturing	750 Employees	385	337	490	34,425	14,175	$2,465,073	$13,889,921
	332912: Fluid Power Valve and Hose Fitting Manufacturing	1,000 Employees	294	261	363	36,324	12,240	$2,795,840	$12,901,153
	332913: Plumbing Fixture Fitting and Trim Manufacturing	1,000 Employees	94	87	106	8,536	3,854	$592,260	$5,767,598

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	332919: Other Metal Valve and Pipe Fitting Manufacturing	750 Employees	217	189	232	13,100	7,569	$880,283	$4,637,735
	332991: Ball and Roller Bearing Manufacturing	1,250 Employees	104	88	162	20,744	3,822	$1,196,188	$7,415,023
	332992: Small Arms Ammunition Manufacturing	1,300 Employees	148	140	154	13,229	1,960	$788,231	$5,165,006
	332993: Ammunition (except Small Arms) Manufacturing	1,500 Employees	43	35	53	11,441	625	$1,333,021	$3,207,404
	332994: Small Arms, Ordnance, and Ordnance Accessories Manufacturing	1,000 Employees	388	377	403	20,333	9,988	$1,509,226	$7,543,375
	332996: Fabricated Pipe and Pipe Fitting Manufacturing	550 Employees	644	606	712	27,077	17,665	$1,619,065	$7,679,763
	332999: All Other Miscellaneous Fabricated Metal Product Manufacturing	750 Employees	3,514	3,458	3,593	66,842	56,916	$3,923,793	$16,669,247
Conveyorized Vapor Degreasing	331210: Iron and Steel Pipe and Tube Manufacturing from Purchased Steel	1,000 Employees	180	144	241	23,495	11,670	$1,787,070	$12,548,156
	331221: Rolled Steel Shape Manufacturing	1,000 Employees	170	147	204	8,126	5,502	$619,227	$6,926,084
	331222: Steel Wire Drawing	1,000 Employees	210	186	252	14,585	9,090	$831,628	$6,322,048
	331410: Nonferrous Metal (except Aluminum) Smelting and Refining	1,000 Employees	129	113	146	7,908	3,738	$628,839	$11,933,969
	331420: Copper Rolling, Drawing, Extruding, and Alloying	1,050 Employees	164	138	247	24,375	10,955	$1,623,662	$26,573,554
	331491: Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing and Extruding	900 Employees	227	202	255	15,488	4,606	$1,189,857	$7,987,055
	331492: Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum)	850 Employees	183	166	220	9,305	6,199	$704,523	$8,660,900
	332111: Iron and Steel Forging	750 Employees	324	295	376	19,681	9,072	$1,347,767	$9,162,151
	332112: Nonferrous Forging	950 Employees	50	39	60	6,753	1,717	$451,852	$3,465,437

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	332114: Custom Roll Forming	600 Employees	344	308	407	18,050	11,441	$1,080,586	$8,143,768
	332117: Powder Metallurgy Part Manufacturing	550 Employees	114	104	134	9,416	5,313	$475,096	$2,788,621
	332119: Metal Crown, Closure, and Other Metal Stamping (except Automotive)	500 Employees	1,288	1,231	1,385	51,465	38,579	$2,828,653	$13,796,615
	332215: Metal Kitchen Cookware, Utensil, Cutlery, and Flatware (except Precious) Manufacturing	1,000 Employees	207	195	213	7,430	3,892	$440,404	$3,878,405
	332216: Saw Blade and Handtool Manufacturing	750 Employees	864	845	930	26,889	18,722	$1,622,697	$7,542,339
	332710: Machine Shops	500 Employees	17,829	17,686	18,100	228,373	209,790	$13,711,558	$43,605,091
	332721: Precision Turned Product Manufacturing	500 Employees	3,670	3,582	3,791	103,249	81,265	$6,369,088	$22,589,437
	332722: Bolt, Nut, Screw, Rivet and Washer Manufacturing	600 Employees	650	619	774	37,940	20,892	$2,394,029	$12,956,800
Web Vapor Degreasing	331110: Iron and Steel Mills and Ferroalloy Manufacturing	1,500 Employees	369	325	522	93,552	17,946	$8,294,778	$109,616,435
Batch Cold Cleaning	324110: Petroleum Refineries	1,500 Employees	70	44	155	63,594	5,381	$9,364,769	$571,414,981
	325612: Polish and Other Sanitation Good Manufacturing	900 Employees	419	396	458	15,779	10,287	$1,366,012	$7,441,941
	325992: Photographic Film, Paper, Plate and Chemical Manufacturing	1,500 Employees	189	175	204	8,712	2,547	$467,524	$7,965,732
	327420: Gypsum Product Manufacturing	1,500 Employees	127	116	202	9,618	949	$839,940	$7,120,689
	331110: Iron and Steel Mills and Ferroalloy Manufacturing	1,500 Employees	369	325	522	93,552	17,946	$8,294,778	$109,616,435
	331210: Iron and Steel Pipe and Tube Manufacturing from Purchased Steel	1,000 Employees	180	144	241	23,495	11,670	$1,787,070	$12,548,156
	332119: Metal Crown, Closure, and Other Metal Stamping (except Automotive)	500 Employees	1,288	1,231	1,385	51,465	38,579	$2,828,653	$13,796,615
	332721: Precision Turned Product	500	3,670	3,582	3,791	103,249	81,265	$6,369,088	$22,589,437

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	Manufacturing	Employees							
	332811: Metal Heat Treating	750 Employees	617	589	774	21,545	16,349	$1,192,719	$5,808,978
	332812: Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	600 Employees	2,338	2,275	2,590	54,860	39,406	$3,097,271	$16,081,694
	332994: Small Arms, Ordnance, and Ordnance Accessories Manufacturing	1,000 Employees	388	377	403	20,333	9,988	$1,509,226	$7,543,375
	332999: All Other Miscellaneous Fabricated Metal Product Manufacturing	750 Employees	3,514	3,458	3,593	66,842	56,916	$3,923,793	$16,669,247
	334511: Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	1,350 Employees	421	379	549	126,636	10,417	$14,333,232	$60,777,797
	336111: Automobile Manufacturing	1,500 Employees	162	144	175	82,780	2,754	$10,640,547	$124,938,819
	336214: Travel Trailer and Camper Manufacturing	1,000 Employees	601	585	729	54,221	17,342	$3,295,403	$21,162,015
	336412: Aircraft Engine and Engine Parts Manufacturing	1,500 Employees	319	289	410	67,207	16,938	$7,488,721	$44,249,951
	336414: Guided Missile and Space Vehicle Manufacturing	1,300 Employees	22	12	42	35,386	679	$6,250,662	$19,339,215
	336415: Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	1,250 Employees	16	7	33	16,635	219	$2,417,490	$9,799,835
	336611: Ship Building and Repairing	1,300 Employees	503	478	588	99,963	22,304	$7,931,248	$29,829,971
	339991: Gasket, Packing, and Sealing Device Manufacturing	600 Employees	490	449	562	28,575	10,851	$2,345,444	$8,525,934
	423510: Metal Service Centers and Other Metal Merchant Wholesalers	200 Employees	6,965	6,647	9,421	147,441	81,185	$11,080,171	$238,413,323
	493190: Other Warehousing and Storage	$36.5 Million	1,424	1,001	2,701	60,681	11,392	$4,509,754	$8,469,484
	811219: Other Electronic and Precision Equipment Repair and	$34 Million	2,787	2,702	3,421	35,369	15,943	$3,221,485	$9,965,767

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	Maintenance								
	812332: Industrial Launderers	$47 Million	380	356	1,544	63,811	12,149	$3,225,682	$10,323,507
Disposal to Wastewater	562211: Hazardous Waste Treatment and Disposal	$47 Million	414	359	873	34,341	3,475	$2,891,985	$10,640,229
	562920: Materials Recovery Facilities	$25 Million	1,004	900	1,389	20,279	11,156	$1,182,011	$7,583,229
Incorporation Into Formulation, Mixture, or Reaction Product	313210: Broadwoven Fabric Mills	1,000 Employees	269	257	295	16,912	10,752	$660,186	$4,707,435
	313220: Narrow Fabric Mills and Schiffli Machine Embroidery	550 Employees	176	173	184	5,624	4,765	$242,031	$1,079,208
	324110: Petroleum Refineries	1,500 Employees	70	44	155	63,594	5,381	$9,364,769	$571,414,981
	325211: Plastics Material and Resin Manufacturing	1,250 Employees	852	768	1,125	75,998	34,018	$8,264,736	$106,880,973
	325412: Pharmaceutical Preparation Manufacturing	1,300 Employees	1,007	942	1,280	147,442	52,343	$18,786,983	$184,572,754
	326299: All Other Rubber Product Manufacturing	650 Employees	565	508	666	29,771	15,816	$1,912,224	$12,089,006
	327110: Pottery, Ceramics, and Plumbing Fixture Manufacturing	1,000 Employees	566	556	585	12,508	8,262	$623,944	$2,662,007
	331110: Iron and Steel Mills and Ferroalloy Manufacturing	1,500 Employees	369	325	522	93,552	17,946	$8,294,778	$109,616,435
	332119: Metal Crown, Closure, and Other Metal Stamping (except Automotive)	500 Employees	1,288	1,231	1,385	51,465	38,579	$2,828,653	$13,796,615
	332216: Saw Blade and Handtool Manufacturing	750 Employees	864	845	930	26,889	18,722	$1,622,697	$7,542,339
	332710: Machine Shops	500 Employees	17,829	17,686	18,100	228,373	209,790	$13,711,558	$43,605,091
	332811: Metal Heat Treating	750 Employees	617	589	774	21,545	16,349	$1,192,719	$5,808,978
	332812: Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	600 Employees	2,338	2,275	2,590	54,860	39,406	$3,097,271	$16,081,694
	332813: Electroplating, Plating, Polishing, Anodizing and Coloring	500 Employees	2,068	2,032	2,169	51,056	42,608	$2,583,952	$8,564,178

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	333515: Cutting Tool and Machine Tool Accessory Manufacturing	500 Employees	1,285	1,253	1,347	26,940	20,611	$1,555,905	$6,244,600
	333519: Rolling Mill and Other Metalworking Machinery Manufacturing	500 Employees	390	363	410	13,635	10,218	$908,332	$4,648,896
	333993: Packaging Machinery Manufacturing	600 Employees	471	440	518	20,826	12,357	$1,826,335	$8,329,437
	334513: Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables	750 Employees	750	710	816	33,789	16,453	$2,946,063	$12,926,459
	424690: Other Chemical and Allied Products Merchant Wholesalers	175 Employees	6,069	5,767	9,418	126,009	50,790	$12,168,548	$234,995,872
	424950: Paint, Varnish, and Supplies Merchant Wholesalers	150 Employees	1,012	957	1,916	20,851	8,754	$1,653,368	$22,235,804
	525990: Other Financial Vehicles	$40 Million	784	761	794	3,144	2,266	$977,221	$1,642,985
	541720: Research and Development in the Social Sciences and Humanities	$28 Million	1,732	1,661	1,946	44,665	14,027	$3,725,397	$8,493,643
	551112: Offices of Other Holding Companies	$45.5 Million	5,973	4,230	6,431	113,687	36,849	$13,777,640	$48,497,110
	921110: Other Similar Organizations (except Business, Professional, Labor, and Political Organizations)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mold Release	326211: Tire Manufacturing (except Retreading)	1,500 Employees	81	63	114	45,509	2,569	$3,320,091	$21,713,321
	326212: Tire Retreading	500 Employees	261	241	373	6,568	3,379	$329,305	$1,756,248
	332919: Other Metal Valve and Pipe Fitting Manufacturing	750 Employees	217	189	232	13,100	7,569	$880,283	$4,637,735
	335220: Major Household Appliance Manufacturing	1,500 Employees	127	108	162	42,464	1,968	$2,636,742	$22,969,050
	336320: Motor Vehicle Electrical and Electronic Equipment Manufacturing	1,000 Employees	565	513	624	62,867	20,363	$3,635,019	$32,932,311
	336390: Other Motor Vehicle Parts	1,000	1,268	1,145	1,483	148,076	56,090	$8,488,570	$75,669,654

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	Manufacturing	Employees							
	812332: Industrial Launderers	$47 Million	380	356	1,544	63,811	12,149	$3,225,682	$10,323,507
Liquid Cleaners and Degreasers	313230: Nonwoven Fabric Mills	850 Employees	195	171	230	17,440	7,680	$1,147,607	$8,703,456
	333514: Special Die and Tool, Die Set, Jig and Fixture Manufacturing	500 Employees	2,293	2,240	2,337	44,454	35,069	$2,955,594	$10,620,091
	334310: Audio and Video Equipment Manufacturing	750 Employees	462	452	474	8,902	7,276	$757,699	$3,367,569
	441110: New Car Dealers	200 Employees	17,423	16,559	21,636	1,177,984	750,891	$76,197,101	$1,082,556,180
	441120: Used Car Dealers	$30.5 Million	23,627	22,991	25,512	154,136	94,791	$8,388,749	$121,263,038
	451110: Sporting Goods Stores	$26.5 Million	16,233	16,102	21,422	240,816	96,677	$6,415,905	$53,651,547
	811111: General Automotive Repair	$9 Million	79,072	78,287	83,216	358,905	307,596	$17,196,451	$60,981,693
	811112: Automotive Exhaust System Repair	$9 Million	1,521	1,521	1,575	4,996	4,996	$192,377	$727,761
	811113: Automotive Transmission Repair	$9 Million	4,206	4,196	4,320	16,300	15,939	$713,511	$2,637,445
	811118: Other Automotive Mechanical and Electrical Repair and Maintenance	$9 Million	3,027	3,000	3,384	14,620	12,218	$626,191	$2,418,837
	811121: Automotive Body, Paint and Interior Repair and Maintenance	$9 Million	32,696	32,098	35,387	243,020	180,877	$13,550,246	$45,723,127
	811122: Automotive Glass Replacement Shops	$17.5 Million	4,764	4,744	6,051	29,811	28,419	$1,453,118	$5,114,646
	811191: Automotive Oil Change and Lubrication Shops	$11 Million	4,467	4,368	8,236	61,501	32,632	$2,060,614	$6,935,359
	811198: All Other Automotive Repair and Maintenance	$10 Million	3,637	3,596	4,007	17,686	10,639	$877,843	$2,854,891
	811211: Consumer Electronics Repair and Maintenance	$34 Million	1,746	1,728	1,845	12,636	7,510	$571,485	$1,752,730
	811212: Computer and Office Machine Repair and Maintenance	$34 Million	5,068	5,014	5,454	33,730	22,877	$1,713,860	$5,383,666
	811213: Communication Equipment Repair and Maintenance	$34 Million	1,738	1,712	2,036	17,740	9,574	$1,488,811	$7,258,425

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	811219: Other Electronic and Precision Equipment Repair and Maintenance	$34 Million	2,787	2,702	3,421	35,369	15,943	$3,221,485	$9,965,767
	811310: Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	$12.5 Million	19,986	19,238	21,814	200,268	101,827	$13,758,532	$47,179,941
	811411: Home and Garden Equipment Repair and Maintenance	$9 Million	1,704	1,698	1,722	4,559	4,317	$143,378	$733,505
	811490: Other Personal and Household Goods Repair and Maintenance	$9 Million	9,938	9,864	10,643	36,437	29,621	$1,401,390	$5,040,083
Aerosol Spray Cleaning/ Degreasing	313230: Nonwoven Fabric Mills	850 Employees	195	171	230	17,440	7,680	$1,147,607	$8,703,456
	333514: Special Die and Tool, Die Set, Jig and Fixture Manufacturing	500 Employees	2,293	2,240	2,337	44,454	35,069	$2,955,594	$10,620,091
	334310: Audio and Video Equipment Manufacturing	750 Employees	462	452	474	8,902	7,276	$757,699	$3,367,569
	441110: New Car Dealers	200 Employees	17,423	16,559	21,636	1,177,984	750,891	$76,197,101	$1,082,556,180
	441120: Used Car Dealers	$30.5 Million	23,627	22,991	25,512	154,136	94,791	$8,388,749	$121,263,038
	451110: Sporting Goods Stores	$26.5 Million	16,233	16,102	21,422	240,816	96,677	$6,415,905	$53,651,547
	811111: General Automotive Repair	$9 Million	79,072	78,287	83,216	358,905	307,596	$17,196,451	$60,981,693
	811112: Automotive Exhaust System Repair	$9 Million	1,521	1,521	1,575	4,996	4,996	$192,377	$727,761
	811113: Automotive Transmission Repair	$9 Million	4,206	4,196	4,320	16,300	15,939	$713,511	$2,637,445
	811118: Other Automotive Mechanical and Electrical Repair and Maintenance	$9 Million	3,027	3,000	3,384	14,620	12,218	$626,191	$2,418,837
	811121: Automotive Body, Paint and Interior Repair and Maintenance	$9 Million	32,696	32,098	35,387	243,020	180,877	$13,550,246	$45,723,127
	811122: Automotive Glass Replacement Shops	$17.5 Million	4,764	4,744	6,051	29,811	28,419	$1,453,118	$5,114,646

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	811191: Automotive Oil Change and Lubrication Shops	$11 Million	4,467	4,368	8,236	61,501	32,632	$2,060,614	$6,935,359
	811198: All Other Automotive Repair and Maintenance	$10 Million	3,637	3,596	4,007	17,686	10,639	$877,843	$2,854,891
	811211: Consumer Electronics Repair and Maintenance	$34 Million	1,746	1,728	1,845	12,636	7,510	$571,485	$1,752,730
	811212: Computer and Office Machine Repair and Maintenance	$34 Million	5,068	5,014	5,454	33,730	22,877	$1,713,860	$5,383,666
Energized Electrical Cleaners	811213: Communication Equipment Repair and Maintenance	$34 Million	1,738	1,712	2,036	17,740	9,574	$1,488,811	$7,258,425
	811219: Other Electronic and Precision Equipment Repair and Maintenance	$34 Million	2,787	2,702	3,421	35,369	15,943	$3,221,485	$9,965,767
	811310: Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	$12.5 Million	19,986	19,238	21,814	200,268	101,827	$13,758,532	$47,179,941
	811411: Home and Garden Equipment Repair and Maintenance	$9 Million	1,704	1,698	1,722	4,559	4,317	$143,378	$733,505
	811490: Other Personal and Household Goods Repair and Maintenance	$9 Million	9,938	9,864	10,643	36,437	29,621	$1,401,390	$5,040,083
Lubricants and Greases	332321: Metal Window and Door Manufacturing	750 Employees	875	831	1,029	52,263	24,857	$3,235,329	$14,858,651
	332322: Sheet Metal Work Manufacturing	500 Employees	3,752	3,670	4,045	106,102	82,263	$6,775,964	$27,320,163
	332323: Ornamental and Architectural Metal Work Manufacturing	500 Employees	2,322	2,294	2,366	36,724	29,346	$2,323,837	$9,404,073
	332410: Power Boiler and Heat Exchanger Manufacturing	750 Employees	268	236	313	22,770	11,080	$1,760,652	$8,281,667
	332420: Metal Tank (Heavy Gauge) Manufacturing	750 Employees	636	601	734	33,637	24,825	$2,276,549	$9,713,135
	332431: Metal Can Manufacturing	1,500 Employees	66	50	185	16,618	2,081	$1,721,524	$17,878,846
	332439: Other Metal Container	600	261	240	295	10,717	5,401	$657,295	$3,962,430

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	Manufacturing	Employees							
	332510: Hardware Manufacturing	750 Employees	568	541	614	28,626	15,980	$1,803,213	$10,124,195
	332613: Spring Manufacturing	600 Employees	312	297	375	17,047	10,851	$964,972	$4,715,302
	332618: Other Fabricated Wire Product Manufacturing	500 Employees	680	647	764	21,457	15,446	$1,142,155	$6,192,053
	332710: Machine Shops	500 Employees	17,829	17,686	18,100	228,373	209,790	$13,711,558	$43,605,091
	332721: Precision Turned Product Manufacturing	500 Employees	3,670	3,582	3,791	103,249	81,265	$6,369,088	$22,589,437
	332722: Bolt, Nut, Screw, Rivet and Washer Manufacturing	600 Employees	650	619	774	37,940	20,892	$2,394,029	$12,956,800
	332911: Industrial Valve Manufacturing	750 Employees	385	337	490	34,425	14,175	$2,465,073	$13,889,921
	332912: Fluid Power Valve and Hose Fitting Manufacturing	1,000 Employees	294	261	363	36,324	12,240	$2,795,840	$12,901,153
	332913: Plumbing Fixture Fitting and Trim Manufacturing	1,000 Employees	94	87	106	8,536	3,854	$592,260	$5,767,598
	332919: Other Metal Valve and Pipe Fitting Manufacturing	750 Employees	217	189	232	13,100	7,569	$880,283	$4,637,735
	332991: Ball and Roller Bearing Manufacturing	1,250 Employees	104	88	162	20,744	3,822	$1,196,188	$7,415,023
	332992: Small Arms Ammunition Manufacturing	1,300 Employees	148	140	154	13,229	1,960	$788,231	$5,165,006
	332993: Ammunition (except Small Arms) Manufacturing	1,500 Employees	43	35	53	11,441	625	$1,333,021	$3,207,404
	332994: Small Arms, Ordnance, and Ordnance Accessories Manufacturing	1,000 Employees	388	377	403	20,333	9,988	$1,509,226	$7,543,375
	332996: Fabricated Pipe and Pipe Fitting Manufacturing	550 Employees	644	606	712	27,077	17,665	$1,619,065	$7,679,763
	332999: All Other Miscellaneous Fabricated Metal Product Manufacturing	750 Employees	3,514	3,458	3,593	66,842	56,916	$3,923,793	$16,669,247
	333111: Farm Machinery and Equipment Manufacturing	1,250 Employees	1,054	1,031	1,141	60,554	30,267	$4,279,212	$29,768,753

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	333112: Lawn and Garden Tractor and Home Lawn and Garden Equipment Manufacturing	1,500 Employees	148	138	166	18,727	5,006	$957,196	$10,458,667
	333120: Construction Machinery Manufacturing	1,250 Employees	651	616	743	59,684	25,323	$4,342,795	$38,121,362
	333131: Mining Machinery and Equipment Manufacturing	900 Employees	224	206	262	11,081	5,290	$1,069,933	$4,398,437
	333132: Oil and Gas Field Machinery and Equipment Manufacturing	1,250 Employees	502	469	611	33,066	17,568	$2,746,983	$14,853,528
	333241: Food Product Machinery Manufacturing	500 Employees	432	411	470	16,175	10,855	$1,395,377	$5,807,266
	333242: Semiconductor Machinery Manufacturing	1,500 Employees	140	126	157	17,407	5,709	$2,921,043	$8,665,874
	333243: Sawmill, Woodworking, and Paper Machinery Manufacturing	550 Employees	337	326	371	12,603	8,155	$1,004,111	$3,956,210
	333244: Printing Machinery and Equipment Manufacturing	750 Employees	263	257	277	7,215	5,922	$428,085	$2,254,072
	333249: Other Industrial Machinery Manufacturing	750 Employees	1,811	1,742	1,866	53,766	42,042	$3,955,833	$17,341,401
	333314: Optical Instrument and Lens Manufacturing	1,000 Employees	390	363	413	14,658	7,178	$1,463,018	$5,355,644
	333316: Photographic and Photocopying Equipment Manufacturing	1,000 Employees	180	170	186	3,777	2,638	$230,350	$1,834,046
	333318: Other Commercial and Service Industry Machinery Manufacturing	1,000 Employees	1,231	1,174	1,316	52,148	31,141	$4,051,583	$21,760,953
	333413: Industrial and Commercial Fan and Blower and Air Purification Equipment Manufacturing	500 Employees	401	374	475	23,406	11,429	$1,533,364	$6,717,282
	333414: Heating Equipment (except Warm Air Furnaces) Manufacturing	500 Employees	362	337	394	15,660	9,503	$987,929	$5,325,971
	333415: Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment	1,250 Employees	705	653	841	89,119	28,842	$5,670,644	$38,502,337

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	Manufacturing								
	333511: Industrial Mold Manufacturing	500 Employees	1,392	1,347	1,442	35,364	27,243	$2,167,065	$7,620,834
	333514: Special Die and Tool, Die Set, Jig and Fixture Manufacturing	500 Employees	2,293	2,240	2,337	44,454	35,069	$2,955,594	$10,620,091
	333515: Cutting Tool and Machine Tool Accessory Manufacturing	500 Employees	1,285	1,253	1,347	26,940	20,611	$1,555,905	$6,244,600
	333517: Machine Tool Manufacturing	500 Employees	787	761	818	27,289	18,430	$2,059,888	$9,115,633
	333519: Rolling Mill and Other Metalworking Machinery Manufacturing	500 Employees	390	363	410	13,635	10,218	$908,332	$4,648,896
	333611: Turbine and Turbine Generator Set Unit Manufacturing	1,500 Employees	115	96	165	35,634	6,615	$2,668,163	$15,317,660
	333612: Speed Changer, Industrial High-Speed Drive and Gear Manufacturing	750 Employees	194	176	230	11,926	7,046	$713,824	$3,991,472
	333613: Mechanical Power Transmission Equipment Manufacturing	750 Employees	200	173	236	15,749	6,236	$1,118,467	$5,258,691
	333618: Other Engine Equipment Manufacturing	1,500 Employees	261	225	319	35,396	7,100	$2,710,197	$29,543,357
	333912: Air and Gas Compressor Manufacturing	1,000 Employees	261	238	297	18,362	8,437	$1,655,285	$10,999,105
	333914: Measuring, Dispensing, and Other Pumping Equipment Manufacturing	750 Employees	457	410	576	37,181	11,735	$3,055,087	$19,698,490
	333921: Elevator and Moving Stairway Manufacturing	1,000 Employees	166	158	176	8,545	5,015	$644,430	$4,088,596
	333922: Conveyor and Conveying Equipment Manufacturing	500 Employees	718	683	779	37,082	24,636	$2,878,058	$11,783,275
	333923: Overhead Traveling Crane, Hoist and Monorail System Manufacturing	1,250 Employees	268	255	303	19,299	8,356	$1,380,271	$8,109,698
	333924: Industrial Truck, Tractor, Trailer and Stacker Machinery	900 Employees	311	287	333	27,533	11,576	$1,894,944	$12,378,097

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	Manufacturing								
	333991: Power-Driven Hand Tool Manufacturing	950 Employees	123	110	130	7,246	2,374	$431,216	$4,062,356
	333992: Welding and Soldering Equipment Manufacturing	1,250 Employees	341	331	363	16,213	6,225	$1,182,351	$6,664,593
	333993: Packaging Machinery Manufacturing	600 Employees	471	440	518	20,826	12,357	$1,826,335	$8,329,437
	333994: Industrial Process Furnace and Oven Manufacturing	500 Employees	317	302	344	10,868	7,984	$750,978	$3,045,889
	333995: Fluid Power Cylinder and Actuator Manufacturing	800 Employees	253	221	317	22,529	8,816	$1,675,845	$8,571,075
	333996: Fluid Power Pump and Motor Manufacturing	1,250 Employees	132	116	157	10,484	4,092	$892,979	$5,175,264
	333997: Scale and Balance Manufacturing	700 Employees	73	68	83	3,707	1,686	$231,853	$1,230,627
	333999: All Other Miscellaneous General Purpose Machinery Manufacturing	700 Employees	1,558	1,467	1,645	55,552	29,610	$4,522,513	$19,556,021
	336111: Automobile Manufacturing	1,500 Employees	162	144	175	82,780	2,754	$10,640,547	$124,938,819
	336112: Light Truck and Utility Vehicle Manufacturing	1,500 Employees	49	36	66	99,097	470	$9,691,986	$228,961,336
	336120: Heavy Duty Truck Manufacturing	1,500 Employees	74	59	87	26,487	3,512	$2,137,807	$31,533,599
	336211: Motor Vehicle Body Manufacturing	1,000 Employees	632	590	733	47,964	20,101	$2,900,334	$17,246,267
	336212: Truck Trailer Manufacturing	1,000 Employees	379	363	432	37,081	17,618	$2,006,578	$13,190,742
	336213: Motor Home Manufacturing	1,250 Employees	41	36	49	11,943	1,761	$636,169	$6,590,197
	336214: Travel Trailer and Camper Manufacturing	1,000 Employees	601	585	729	54,221	17,342	$3,295,403	$21,162,015
	336310: Motor Vehicle Gasoline Engine and Engine Parts Manufacturing	1,050 Employees	706	654	758	58,120	16,149	$4,188,464	$39,164,777
	336320: Motor Vehicle Electrical and	1,000	565	513	624	62,867	20,363	$3,635,019	$32,932,311

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	Electronic Equipment Manufacturing	Employees							
	336330: Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing	1,000 Employees	220	192	261	38,255	14,076	$2,087,719	$17,933,893
	336340: Motor Vehicle Brake System Manufacturing	1,250 Employees	139	118	179	23,359	9,684	$1,247,985	$13,488,749
	336350: Motor Vehicle Transmission and Power Train Parts Manufacturing	1,500 Employees	390	346	474	73,386	19,121	$4,999,215	$48,004,088
	336360: Motor Vehicle Seating and Interior Trim Manufacturing	1,500 Employees	307	273	429	72,273	24,943	$3,839,997	$36,931,706
	336370: Motor Vehicle Metal Stamping	1,000 Employees	597	550	757	107,888	53,521	$5,958,475	$43,657,001
	336390: Other Motor Vehicle Parts Manufacturing	1,000 Employees	1,268	1,145	1,483	148,076	56,090	$8,488,570	$75,669,654
	336411: Aircraft Manufacturing	1,500 Employees	262	236	317	166,716	10,736	$19,959,658	$174,304,589
	336412: Aircraft Engine and Engine Parts Manufacturing	1,500 Employees	319	289	410	67,207	16,938	$7,488,721	$44,249,951
	336413: Other Aircraft Part and Auxiliary Equipment Manufacturing	1,250 Employees	750	692	921	103,133	26,327	$8,610,442	$41,415,958
	336414: Guided Missile and Space Vehicle Manufacturing	1,300 Employees	22	12	42	35,386	679	$6,250,662	$19,339,215
	336415: Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	1,250 Employees	16	7	33	16,635	219	$2,417,490	$9,799,835
	336419: Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	1,050 Employees	33	24	37	3,338	467	$466,089	$1,365,767
	336510: Railroad Rolling Stock Manufacturing	1,500 Employees	153	131	229	29,532	6,983	$2,061,548	$15,265,739
	336611: Ship Building and Repairing	1,300 Employees	503	478	588	99,963	22,304	$7,931,248	$29,829,971
	336612: Boat Building	1,000 Employees	833	815	875	37,337	23,117	$2,088,802	$12,226,390
	336991: Motorcycle, Bicycle and Parts Manufacturing	1,050 Employees	423	416	428	9,899	4,644	$533,159	$8,624,700

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	336992: Military Armored Vehicle, Tank and Tank Component Manufacturing	1,500 Employees	38	31	53	9,289	1,528	$1,103,726	$7,405,233
	336999: All Other Transportation Equipment Manufacturing	1,000 Employees	390	380	399	13,699	4,508	$869,605	$9,218,532
	337124: Metal Household Furniture Manufacturing	950 Employees	261	253	272	9,623	4,918	$485,026	$2,431,245
Adhesives, Sealants, Paints and Coatings	313210: Broadwoven Fabric Mills	1,000 Employees	269	257	295	16,912	10,752	$660,186	$4,707,435
	313320: Fabric Coating Mills	1,000 Employees	152	140	163	6,982	5,498	$452,519	$2,842,231
	321992: Prefabricated Wood Building Manufacturing	500 Employees	543	524	635	17,299	9,686	$992,783	$4,746,456
	322220: Paper Bag and Coated and Treated Paper Manufacturing	750 Employees	575	509	740	48,193	20,732	$3,701,901	$24,671,717
	324199: All Other Petroleum and Coal Products Manufacturing	950 Employees	66	54	84	3,021	1,330	$289,472	$4,549,602
	325510: Paint and Coating Manufacturing	1,000 Employees	998	964	1,197	39,139	22,907	$2,989,102	$32,768,919
	325520: Adhesive Manufacturing	550 Employees	403	346	559	24,231	9,109	$1,966,229	$17,661,519
	325998: All Other Miscellaneous Chemical Product and Preparation Manufacturing	650 Employees	1,064	982	1,230	36,900	17,820	$3,363,541	$26,088,857
	326140: Polystyrene Foam Product Manufacturing	1,000 Employees	308	281	438	26,968	13,245	$1,496,959	$11,457,424
	326150: Urethane and Other Foam Product (except Polystyrene) Manufacturing	750 Employees	445	401	653	32,428	16,138	$1,738,902	$13,045,820
	326211: Tire Manufacturing (except Retreading)	1,500 Employees	81	63	114	45,509	2,569	$3,320,091	$21,713,321
	326212: Tire Retreading	500 Employees	261	241	373	6,568	3,379	$329,305	$1,756,248
	326220: Rubber and Plastics Hoses and Belting Manufacturing	800 Employees	196	177	273	19,713	8,697	$1,186,280	$6,330,711
	326299: All Other Rubber Product	650	565	508	666	29,771	15,816	$1,912,224	$12,089,006

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	Manufacturing	Employees							
	331523: Nonferrous Metal Die-Casting Foundries	700 Employees	351	321	396	33,674	18,214	$1,627,554	$9,053,959
	332321: Metal Window and Door Manufacturing	750 Employees	875	831	1,029	52,263	24,857	$3,235,329	$14,858,651
	332812: Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	600 Employees	2,338	2,275	2,590	54,860	39,406	$3,097,271	$16,081,694
	332813: Electroplating, Plating, Polishing, Anodizing and Coloring	500 Employees	2,068	2,032	2,169	51,056	42,608	$2,583,952	$8,564,178
	332993: Ammunition (except Small Arms) Manufacturing	1,500 Employees	43	35	53	11,441	625	$1,333,021	$3,207,404
	332994: Small Arms, Ordnance, and Ordnance Accessories Manufacturing	1,000 Employees	388	377	403	20,333	9,988	$1,509,226	$7,543,375
	332999: All Other Miscellaneous Fabricated Metal Product Manufacturing	750 Employees	3,514	3,458	3,593	66,842	56,916	$3,923,793	$16,669,247
	333515: Cutting Tool and Machine Tool Accessory Manufacturing	500 Employees	1,285	1,253	1,347	26,940	20,611	$1,555,905	$6,244,600
	333914: Measuring, Dispensing, and Other Pumping Equipment Manufacturing	750 Employees	457	410	576	37,181	11,735	$3,055,087	$19,698,490
	334417: Electronic Connector Manufacturing	1,000 Employees	161	144	204	18,962	7,153	$1,575,672	$7,122,743
	334511: Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	1,350 Employees	421	379	549	126,636	10,417	$14,333,232	$60,777,797
	335312: Motor and Generator Manufacturing	1,250 Employees	372	339	424	28,980	9,911	$2,030,495	$11,827,046
	335931: Current-Carrying Wiring Device Manufacturing	600 Employees	357	320	395	25,444	12,764	$1,597,032	$9,979,913
	336211: Motor Vehicle Body Manufacturing	1,000 Employees	632	590	733	47,964	20,101	$2,900,334	$17,246,267
	336213: Motor Home Manufacturing	1,250 Employees	41	36	49	11,943	1,761	$636,169	$6,590,197

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	336350: Motor Vehicle Transmission and Power Train Parts Manufacturing	1,500 Employees	390	346	474	73,386	19,121	$4,999,215	$48,004,088
	336360: Motor Vehicle Seating and Interior Trim Manufacturing	1,500 Employees	307	273	429	72,273	24,943	$3,839,997	$36,931,706
	336390: Other Motor Vehicle Parts Manufacturing	1,000 Employees	1,268	1,145	1,483	148,076	56,090	$8,488,570	$75,669,654
	336411: Aircraft Manufacturing	1,500 Employees	262	236	317	166,716	10,736	$19,959,658	$174,304,589
	336415: Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	1,250 Employees	16	7	33	16,635	219	$2,417,490	$9,799,835
	336611: Ship Building and Repairing	1,300 Employees	503	478	588	99,963	22,304	$7,931,248	$29,829,971
	337110: Wood Kitchen Cabinet and Counter Top Manufacturing	750 Employees	5,907	5,886	5,981	91,250	62,626	$4,383,244	$17,107,293
	337121: Upholstered Household Furniture Manufacturing	1,000 Employees	963	941	1,051	65,529	29,353	$2,695,193	$14,414,742
	337122: Nonupholstered Wood Household Furniture Manufacturing	750 Employees	2,024	2,014	2,049	26,512	20,648	$894,231	$4,722,473
	337211: Wood Office Furniture Manufacturing	1,000 Employees	307	294	320	13,183	6,426	$566,474	$3,128,959
	339113: Surgical Appliance and Supplies Manufacturing	800 Employees	1,651	1,592	1,867	86,837	38,259	$8,060,278	$43,237,782
	339920: Sporting and Athletic Goods Manufacturing	750 Employees	1,586	1,567	1,649	39,326	27,983	$2,215,681	$12,298,212
	339991: Gasket, Packing, and Sealing Device Manufacturing	600 Employees	490	449	562	28,575	10,851	$2,345,444	$8,525,934
	481111: Scheduled Passenger Air Transportation	1,500 Employees	306	274	1,872	421,206	12,988	$42,177,184	$205,880,657
	928110: Other Similar Organizations (except Business, Professional, Labor, and Political Organizations)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spot Removers	561740: Carpet and Upholstery Cleaning Services	$8.5 Million	7,306	7,259	7,501	36,361	33,045	$1,393,222	$4,085,480
	812310: Coin-Operated Laundries and Drycleaners	$13 Million	9,725	9,690	10,798	40,419	36,847	$962,688	$5,174,885

Table 3-1: Industry Statistics

Use Categories	NAICS	Small Business	Number of Firms[1]		Number of	Employment		Annual Payroll	Preliminary Receipts
	812320: Drycleaning and Laundry Services (except Coin-Operated)	$8 Million	18,087	17,953	20,643	131,543	113,492	$2,281,059	$9,510,408
Film Cleaner	512110: Motion Picture and Video Production	$40 Million	13,850	13,680	14,394	135,557	45,274	$13,833,359	$83,599,451
Sources: U.S. Census Bureau 2021; U.S. Census Bureau 2023; U.S. Bureau of Economic Analysis 2023c; SBA 2023									

Table 3-2: Small Business Determinations of Identified Affected Parent Companies, by Use Category

Use Category	Company Name	NAICS Description	Revenue	Employees	SBA Small Business Threshold	Small Business Status
Laboratory Use	New Mexico State University	611310: Colleges, Universities, and Professional Schools	$217.41 M	5,000	$34.5 Million	No
	International Textile Group	561990: All Other Support Services	$407.75 K	9	$16.5 Million	Small
	Government Of the United States	N/A	N/A	2,768,886	N/A	N/A
	TRC Companies, Inc.	561320: Temporary Help Services	$740 M	4,865	$34 Million	No
	California State University System	611310: Colleges, Universities, and Professional Schools	$2.84 B	45,000	$34.5 Million	No
	Chevron Corporation	324110: Petroleum Refineries	$162.47 B	42,595	1,500 Employees	No
Manufacturing	Occidental Petroleum Corporation	211120: Crude Petroleum Extraction	$26.31 B	11,678	1,250 Employees	No
Import/Repackage	Allchem Industries Holding Corp	424690: Other Chemical and Allied Products Merchant Wholesalers	$186.07 M	175	175 Employees	Small
	Itochu Corporation	423990: Other Miscellaneous Durable Goods Merchant Wholesalers	$109.45 B	115,124	100 Employees	No
	First Continental International Inc.	424950: Paint, Varnish, and Supplies Merchant Wholesalers	$11.77 M	15	150 Employees	Small
	Greenchem Industries LLC	424690: Other Chemical and Allied Products Merchant Wholesalers	$135 M	53	175 Employees	Small

Table 3-2: Small Business Determinations of Identified Affected Parent Companies, by Use Category

Use Category	Company Name	NAICS Description	Revenue	Employees	SBA Small Business Threshold	Small Business Status
	Superior Industrial Solutions, Inc.	424690: Other Chemical and Allied Products Merchant Wholesalers	$290.01 M	300	175 Employees	No
	Chemical Solvents Inc.	424690: Other Chemical and Allied Products Merchant Wholesalers	$99.45 M	110	175 Employees	Small
	Norman, Fox & Co.	424690: Other Chemical and Allied Products Merchant Wholesalers	$44.88 M	63	175 Employees	Small
	Univar Solutions Inc.	424690: Other Chemical and Allied Products Merchant Wholesalers	$9.54 B	9,450	175 Employees	No
Battery and Synthetic Paper Processing Aid	Asahi Kasei Corporation	325998: All Other Miscellaneous Chemical Product and Preparation Manufacturing	$21.91 B	46,751	650 Employees	No
	Microporus	326291: Rubber Product Manufacturing for Mechanical Use	$45.49 M	153	750 Employees	Small
	PPG	325510: Paint and Coating Manufacturing	$16.80 B	49,300	1,000 Employees	No
HFC Manufacture	Kaluz, S.A. De C.V.	551112: Offices of Other Holding Companies	$7.60 B	30,000	$45.5 Million	No
	Arkema	551112: Offices of Other Holding Companies	$134.84 M	4,500	$45.5 Million	No
Intermediate in HCl Production	Formosa Plastics Corp	424690: Other Chemical and Allied Products Merchant Wholesalers	$9.79 B	7,436	175 Employees	No
	Westlake Corporation	325211: Plastics Material and Resin Manufacturing	$11.78 B	14,550	1,250 Employees	No
	Occidental Petroleum Corporation	211120: Crude Petroleum Extraction	$26.31 B	11,678	1,250 Employees	No
	Olin Corp	325180: Other Basic Inorganic Chemical Manufacturing	$8.91 B	8,000	1,000 Employees	No
	Bayer Aktiengesellschaft	325412: Pharmaceutical Preparation Manufacturing	$52.14 B	100,802	1,300 Employees	No
	Shin-Etsu Chemical Co., Ltd.	325199: All Other Basic Organic Chemical Manufacturing	$18.47 B	24,069	1,250 Employees	No
	Dow Inc.	325211: Plastics Material and Resin Manufacturing	$54.97 B	35,700	1,250 Employees	No
	Nippon Shokubai Co., Ltd.	325199: All Other Basic Organic Chemical Manufacturing	$3.29 B	4,526	1,250 Employees	No

Table 3-2: Small Business Determinations of Identified Affected Parent Companies, by Use Category

Use Category	Company Name	NAICS Description	Revenue	Employees	SBA Small Business Threshold	Small Business Status
	Ameresco, Inc.	238210: Electrical Contractors and Other Wiring Installation Contractors	$1.22 B	1,272	$19 Million	No
	Republic Services, Inc.	562212: Solid Waste Landfill	$11.30 B	35,000	$47 Million	No
	Saudi Arabian Oil Company	213112: Support Activities for Oil and Gas Operations	$400.47 B	68,000	$47 Million	No
	The Chemours Company	325998: All Other Miscellaneous Chemical Product and Preparation Manufacturing	$6.35 B	6,400	650 Employees	No
	Poet, LLC	325193: Ethyl Alcohol Manufacturing	$950 M	350	1,000 Employees	Small
	Exxonmobil Corp	324110: Petroleum Refineries	$285.64 B	63,000	1,500 Employees	No
	Saint Paul Park Refining Co LLC	N/A	N/A	N/A	N/A	N/A
	Phillips 66 Company	324110: Petroleum Refineries	$114.85 B	14,000	1,500 Employees	No
	HF Sinclair Corporation	324110: Petroleum Refineries	$21.32 B	13,407	1,500 Employees	No
Fluoroelastomer Manufacture	Andersen Corp	321911: Wood Window and Door Manufacturing	$1.78 B	10,000	1,000 Employees	No
	Gates Industrial Corporation PLC	336390: Other Motor Vehicle Parts Manufacturing	$3.47 B	14,300	1,000 Employees	No
Vapor Degreasing	Spirit Aerosystems Holdings, Inc.	336411: Aircraft Manufacturing	$3.4 B	14,000	1,500 Employees	No
	Kopacz Industrial Painting Inc	332812: Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	$430.0 K	3	600 Employees	Small
	General Cable Technologies Corporation	335921: Fiber Optic Cable Manufacturing	$355.0 M	3,800	1,000 Employees	No
	Acorn Engineering Company	332999: All Other Miscellaneous Fabricated Metal Product Manufacturing	$90.0 M	1,200	750 Employees	No
	Valence Surface Technologies LLC	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$103.0 M	270	500 Employees	Small

Table 3-2: Small Business Determinations of Identified Affected Parent Companies, by Use Category

Use Category	Company Name	NAICS Description	Revenue	Employees	SBA Small Business Threshold	Small Business Status
	Integer Holdings Corporation	332119: Metal Crown, Closure, and Other Metal Stamping (except Automotive)	$1.0 B	7,500	500 Employees	No
	Allied Motion Technologies Inc.	335312: Motor and Generator Manufacturing	$366.0 M	1,600	1,250 Employees	No
	Watlow Electric Manufacturing Company	334513: Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables	$586.0 M	2,000	750 Employees	No
	Paint Work, Incorporated	332812: Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	$600.0 K	10	600 Employees	Small
	Superior Technology Corp.	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$14.0 M	120	500 Employees	Small
	Advanced Heat Treat Corp.	332811: Metal Heat Treating	$12.0 M	90	750 Employees	Small
	East - Lind Heat Treat, Inc.	332811: Metal Heat Treating	$5.6 M	36	750 Employees	Small
	Castle Metal Finishing Corp.	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$2.5 M	24	500 Employees	Small
	Streamwood Plating Co	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$724.0 K	9	500 Employees	Small
	Ametek, Inc.	335312: Motor and Generator Manufacturing	$4.5 B	16,000	1,250 Employees	No
	Godfrey & Wing Inc.	339999: All Other Miscellaneous Manufacturing	$19.0 M	50	550 Employees	Small
	General Electric Company	336412: Aircraft Engine and Engine Parts Manufacturing	$79.0 B	174,000	1,500 Employees	No
	Morgan Advanced Materials PLC	335991: Carbon and Graphite Product Manufacturing	$1.1 B	40	900 Employees	Small
	Carpenter Tech	331110: Iron and Steel Mills and Ferroalloy Manufacturing	$1.8 B	4,100	1,500 Employees	No
	The Boeing Company	336411: Aircraft Manufacturing	$58.0 B	141,000	1,500 Employees	No
	Chattanooga Armature Works, Inc.	811310: Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	$4.3 M	40	$12.5 Million	Small

Table 3-2: Small Business Determinations of Identified Affected Parent Companies, by Use Category

Use Category	Company Name	NAICS Description	Revenue	Employees	SBA Small Business Threshold	Small Business Status
	Tubacex, SA	331210: Iron and Steel Pipe and Tube Manufacturing from Purchased Steel	$18.0 M	22	1,000 Employees	Small
	Energizer Holdings Inc.	332215: Metal Kitchen Cookware, Utensil, Cutlery, and Flatware (except Precious) Manufacturing	$3.1 B	5,500	1,000 Employees	No
	Accurate Forming, LLC	332119: Metal Crown, Closure, and Other Metal Stamping (except Automotive)	$9.1 M	47	500 Employees	Small
	MPC Plating Inc.	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$12.5 M	110	500 Employees	Small
	Mullins Rubber Products, Inc.	326299: All Other Rubber Product Manufacturing	$9.6 M	52	650 Employees	Small
	Droitcour Company	332721: Precision Turned Product Manufacturing	$8.1 M	80	500 Employees	Small
	ATW Companies, Inc.	333517: Machine Tool Manufacturing	$87.5 M	390	500 Employees	Small
	Whittet-Higgins Company	332722: Bolt, Nut, Screw, Rivet, and Washer Manufacturing	$7.2 M	50	600 Employees	Small
	Mel-Co-Ed, Inc.	423940: Jewelry, Watch, Precious Stone, and Precious Metal Merchant Wholesalers	$4.0 M	35	125 Employees	Small
	Parts Cleaning Technologies, LLC	423510: Metal Service Centers and Other Metal Merchant Wholesalers	$10.4 M	40	200 Employees	Small
	McMillan Electric Company	335312: Motor and Generator Manufacturing	$54.2 M	300	1,250 Employees	Small
	Milwaukee Plating Company	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$8.0 M	24	500 Employees	Small
	E. C. Styberg Engineering Company	332119: Metal Crown, Closure, and Other Metal Stamping (except Automotive)	$45.1 M	155	500 Employees	Small
	Viking Drill & Tool, Inc.	333515: Cutting Tool and Machine Tool Accessory Manufacturing	$66.6 M	372	500 Employees	Small
	FJC Services, LLC	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$862.0 K	6	500 Employees	Small
	159585 Canada Inc	333515: Cutting Tool and Machine Tool Accessory Manufacturing	$31.6 M	110	500 Employees	Small
	Helical Line Products Co	332618: Other Fabricated Wire Product Manufacturing	$2.7 M	23	500 Employees	Small

Table 3-2: Small Business Determinations of Identified Affected Parent Companies, by Use Category

Use Category	Company Name	NAICS Description	Revenue	Employees	SBA Small Business Threshold	Small Business Status
	Great Lakes Friction Products, Inc.	336340: Motor Vehicle Brake System Manufacturing	$8.7 M	27	1,250 Employees	Small
	Model Finishing Co., Inc.	332999: All Other Miscellaneous Fabricated Metal Product Manufacturing	$1.8 M	15	750 Employees	Small
	Genesis Marketing Group, Ltd.	332312: Fabricated Structural Metal Manufacturing	$1.6 M	14	500 Employees	Small
	Plymouth Tube Company	331210: Iron and Steel Pipe and Tube Manufacturing from Purchased Steel	$188.1 M	700	1,000 Employees	Small
	Amilan Distributors	332812: Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	$2.9 M	7	600 Employees	Small
	Colonial Coatings, Inc.	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$8.4 M	45	500 Employees	Small
	BRC Rubber & Plastics, Inc.	326299: All Other Rubber Product Manufacturing	$95.9 M	500	650 Employees	Small
	Rock River Arms, Inc.	332994: Small Arms, Ordnance, and Ordnance Accessories Manufacturing	$10.6 M	60	1,000 Employees	Small
	Berteau-Lowell Plating Works, Inc.	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$2.2 M	33	500 Employees	Small
	Kangas Enameling, Inc.	339910: Jewelry and Silverware Manufacturing	$570.0 K	6	700 Employees	Small
	D & B Metal Finishing	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$292.0 K	6	500 Employees	Small
	Preci-Manufacturing Inc	336413: Other Aircraft Parts and Auxiliary Equipment Manufacturing	$10.3 M	92	1,250 Employees	Small
	Craftsman Plating & Tinning Corporation	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$4.9 M	48	500 Employees	Small
	Able Electropolishing Company, Inc.	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$16.4 M	150	500 Employees	Small
	Steel Partners Holdings L.P.	332812: Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	$1.52 B	4,300	600 Employees	No
	Hu Friedy Manufacturing Co, Inc	339114: Dental Equipment and Supplies Manufacturing	$61.5 M	500	750 Employees	Small
	Clybourn Metal Finishing Co	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$520.0 K	13	500 Employees	Small

Table 3-2: Small Business Determinations of Identified Affected Parent Companies, by Use Category

Use Category	Company Name	NAICS Description	Revenue	Employees	SBA Small Business Threshold	Small Business Status
	Light Logic LLC	335121: Residential Electric Lighting Fixture Manufacturing	$438.4 M	8	750 Employees	Small
	Dial Tool Industries, Inc.	332111: Iron and Steel Forging	$19.2 M	100	750 Employees	Small
	MJ Celco International, LLC	332119: Metal Crown, Closure, and Other Metal Stamping (except Automotive)	$1.1 M	13	500 Employees	Small
	NN, Inc.	332119: Metal Crown, Closure, and Other Metal Stamping (except Automotive)	$477.6 M	3,172	500 Employees	No
	Dixon Valve Coupling Co	332721: Precision Turned Product Manufacturing	$5.1 M	50	500 Employees	Small
	Stella Vermögensverwaltungs GmbH	332999: All Other Miscellaneous Fabricated Metal Product Manufacturing	$1.2 M	9	750 Employees	Small
	Autotrol Corporation	335312: Motor and Generator Manufacturing	$16.2 M	100	1,250 Employees	Small
	Chem Processing, Inc.	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$12.8 M	75	500 Employees	Small
	Milton Industries, Inc.	332912: Fluid Power Valve and Hose Fitting Manufacturing	$22.2 M	120	1,000 Employees	Small
	General Machinery & Manufacturing Co	332721: Precision Turned Product Manufacturing	$4.0 M	15	500 Employees	Small
	Union Special, LLC	333249: Other Industrial Machinery Manufacturing	$22.7 M	110	750 Employees	Small
	Plano Metal Specialties, Inc.	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$950.0 K	10	500 Employees	Small
	Lenzing Aktiengesellschaft	325220: Artificial and Synthetic Fibers and Filaments Manufacturing	$2.6 B	7,614	1,050 Employees	No
	American/Jebco Corporation	332722: Bolt, Nut, Screw, Rivet, and Washer Manufacturing	$21.1 M	130	600 Employees	Small
	TWR Service Corporation	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$2.1 M	14	500 Employees	Small
	Smalley Steel Ring Co.	332618: Other Fabricated Wire Product Manufacturing	$86.8 M	450	500 Employees	Small
	Smalley Steel Ring Co.	332618: Other Fabricated Wire Product Manufacturing	$86.8 M	450	500 Employees	Small

Table 3-2: Small Business Determinations of Identified Affected Parent Companies, by Use Category

Use Category	Company Name	NAICS Description	Revenue	Employees	SBA Small Business Threshold	Small Business Status
	Bycap, Inc.	334416: Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing	$2.1 M	20	550 Employees	Small
	Universal Coating, Inc.	332812: Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	$9.3 M	55	600 Employees	Small
	Ohio Screw Products, Inc.	332721: Precision Turned Product Manufacturing	$13.4 M	75	500 Employees	Small
	The Nordam Group LLC	336413: Other Aircraft Parts and Auxiliary Equipment Manufacturing	$500.0 K	2,413	1,250 Employees	No
	Spirit Aerosystems Inc	336413: Other Aircraft Parts and Auxiliary Equipment Manufacturing	$8.6 M	6	1,250 Employees	Small
	U S Ring Binder, L.P.	323111: Commercial Printing (except Screen and Books)	$4.3 M	30	650 Employees	Small
	Textron Inc.	336411: Aircraft Manufacturing	$12.4 B	33,000	1,500 Employees	No
	Marquette Tool and Die Company	333511: Industrial Mold Manufacturing	$4.8 M	35	500 Employees	Small
	3p Acquisition Inc	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$5.3 M	2	500 Employees	Small
	Precision Micro Component	332410: Power Boiler and Heat Exchanger Manufacturing	$447.6 K	4	750 Employees	Small
	Globe Engineering Co., Inc	336413: Other Aircraft Parts and Auxiliary Equipment Manufacturing	$50.0 M	230	1,250 Employees	Small
	Rolls-Royce Holdings PLC	336412: Aircraft Engine and Engine Parts Manufacturing	$15.4 B	51,700	1,500 Employees	No
	Anaplex Corporation	332813: Electroplating, Plating, Polishing, Anodizing, and Coloring	$6.0 M	48	500 Employees	Small
	Ironform Holdings Co.	332996: Fabricated Pipe and Pipe Fitting Manufacturing	$121.5 M	289	550 Employees	Small
	Cheniere Energy, Inc.	493110: General Warehousing and Storage	$15.9 B	1,550	$34 Million	No
	Mercury Products Corp.	332996: Fabricated Pipe and Pipe Fitting Manufacturing	$104.7 M	255	550 Employees	Small
	Melrose Industries PLC	336413: Other Aircraft Parts and Auxiliary Equipment Manufacturing	$11.3 B	Not provided	1,250 Employees	No
	Morse Rubber, L.L.C.	326299: All Other Rubber Product Manufacturing	$4.0 M	30	650 Employees	Small

Table 3-2: Small Business Determinations of Identified Affected Parent Companies, by Use Category

Use Category	Company Name	NAICS Description	Revenue	Employees	SBA Small Business Threshold	Small Business Status
Incorp. into.: Mold Release	The Sherwin Williams Company	325510: Paint and Coating Manufacturing	$19.94 B	61,031	1,000 Employees	No
	Plastic Process Equipment, Inc.	333249: Other Industrial Machinery Manufacturing	$10.63 M	28	750 Employees	Small
	IMS Company	423830: Industrial Machinery and Equipment Merchant Wholesalers	$25.10 M	60	100 Employees	Small
Incorp. into.: Liquid Cleaners and Degreasers	NM Z Parent Inc.	525990: Other Financial Vehicles	$980 M	2,300	$40 Million	No
	Delta Foremost Chemical Corporation	325612: Polish and Other Sanitation Good Manufacturing	$34.87 M	150	900 Employees	Small
Incorp. into.: Aerosol Spray Cleaning/Degreasing	American Industries Inc.	424690: Other Chemical and Allied Products Merchant Wholesalers	$3.74 M	14	175 Employees	Small
	ITW Brands	333993: Packaging Machinery Manufacturing	$14.46 B	45,000	600 Employees	No
	Berryman	424690: Other Chemical and Allied Products Merchant Wholesalers	$147.70 M	35	175 Employees	Small
	Brownells	423710: Hardware Merchant Wholesalers	$187.15 M	241	150 Employees	No
	NM Z Parent Inc.	525990: Other Financial Vehicles	$980 M	2,300	$40 Million	No
	Nu-Calgon	424690: Other Chemical and Allied Products Merchant Wholesalers	$72.90 M	52	175 Employees	Small
	Omega Industrial Supply, Inc.	325612: Polish and Other Sanitation Good Manufacturing	$6.22 M	40	900 Employees	Small
	Parker Hannifin Corporation	333995: Fluid Power Cylinder and Actuator Manufacturing	$14.35 B	54,640	800 Employees	No
	Plz Aeroscience Corporation	325120: Industrial Gas Manufacturing	$770 M	350	1,200 Employees	Small
	Pro Chem	424690: Other Chemical and Allied Products Merchant Wholesalers	$24.48 M	100	175 Employees	Small
	The Sherwin Williams Company	325510: Paint and Coating Manufacturing	$19.94 B	61,031	1,000 Employees	No
Incorp. into.: Energized Electrical Cleaners	Pro Chem	424690: Other Chemical and Allied Products Merchant Wholesalers	$24.48 M	100	175 Employees	Small
	The Sherwin Williams Company	325510: Paint and Coating Manufacturing	$19.94 B	61,031	1,000 Employees	No

Table 3-2: Small Business Determinations of Identified Affected Parent Companies, by Use Category

Use Category	Company Name	NAICS Description	Revenue	Employees	SBA Small Business Threshold	Small Business Status
Incorp. into.: Adhesives, Sealants, Paints, and Coatings	Berwind Corporation	531190: Lessors of Other Real Estate Property	$1.87 B	4,500	$34 Million	No
	R.R. Street & Co. Inc.	424690: Other Chemical and Allied Products Merchant Wholesalers	$39.34 M	150	175 Employees	Small
	Brodi Specialty Products	424690: Other Chemical and Allied Products Merchant Wholesalers	$7.46 M	15	175 Employees	No
	Plz Aeroscience Corporation	325120: Industrial Gas Manufacturing	$770 M	350	1,200 Employees	Small
	Centerbridge Partners, L.P.	525990: Other Financial Vehicles	$2.98 B	1,490	$40 Million	No
	Newstar Adhesives Inc	N/A	N/A	N/A	N/A	N/A
	Parker Hannifin Corporation	333995: Fluid Power Cylinder and Actuator Manufacturing	$14.35 B	54,640	800 Employees	No
	Scigrip Smarter Adhesive Solutions	561499: All Other Business Support Services	$7.95 M	35	$21.5 Million	Small
	Stahlgruber Otto Gruber Ag	551112: Offices of Other Holding Companies	$1.06 B	6,897	$45.5 Million	No
Incorp. into.: Lubricants and Greases	Steel Partners Holdings L.P.	332812: Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	$1.52 B	4,300	600 Employees	No
	Midwest Motor Supply Company	339993: Fastener, Button, Needle, and Pin Manufacturing	$129.40 M	670	750 Employees	Small
	K-Chem, Inc	423840: Industrial Supplies Merchant Wholesalers	$4.49 M	11	125 Employees	Small
	Mid-American Research Chemical Corp.	325180: Other Basic Inorganic Chemical Manufacturing	$7.48 M	35	1,000 Employees	Small
	Plz Aeroscience Corporation	325120: Industrial Gas Manufacturing	$770 M	350	1,200 Employees	Small
	Questspecialty Corporation	424690: Other Chemical and Allied Products Merchant Wholesalers	$36 M	172	175 Employees	Small
Incorp. into.: Dry Cleaning and Spot Removers	A.L. Wilson Chemical Co.	325612: Polish and Other Sanitation Good Manufacturing	$3.10 M	17	900 Employees	Small
	R.R. Street & Co. Inc.	424690: Other Chemical and Allied Products Merchant Wholesalers	$39.34 M	150	175 Employees	Small

Table 3-2: Small Business Determinations of Identified Affected Parent Companies, by Use Category

Use Category	Company Name	NAICS Description	Revenue	Employees	SBA Small Business Threshold	Small Business Status
[1]An establishment is a single physical location at which business is conducted or services or industrial operations are performed. A firm is a business organization consisting of one or more domestic establishments in the same geographic area and industry that were specified under common ownership or control. Therefore, a firm can own multiple establishments. Sources: Companies using TCE were identified using 2020 CDR data (EPA 2020j), 2020 TRI data (EPA 2022b), 2017 NEI data (EPA 2020a), and EPA's risk evaluation (EPA 2020e). Companies producing TCE products were identified as described in Chapter 4. Company information was obtained from Dun and Bradstreet Hoovers database (Dun & Bradstreet 2022), and the Experian Business Target IQ database (Experian 2023). The small business determinations were made using SBA's small business thresholds (SBA 2023).						

4. Products Formulated with TCE

This chapter presents the results from EPA's search to identify products that might contain TCE and discusses some of the implications of the prohibition of TCE use in these products. The search was conducted using the Consumer Product Information Database (CPID), at www.whatsinproducts.com, retail websites that sell related products (e.g., www.grainger.com), and the websites of the manufacturers with products that were identified from the CPID, retailer websites, and EPA risk evaluation support documents (EPA 2017c, EPA 2017d, EPA 2017e, EPA 2017f, EPA 2017g).

EPA expects that the manufacturers who already have alternative products would respond to a regulatory option that prohibits or restricts TCE use by discontinuing the TCE product without replacing it with a new product line.[7] Thus, such businesses would not be expected to incur any direct compliance costs. Businesses may incur indirect costs through reduced sales, but these are likely to at least be partially offset by some customers shifting to another one of their products. Since any reduced sales they experience are likely to be a competitor's gain, the net change in producer surplus across all producers is uncertain. Similarly, the net effects on upstream and downstream producers, distributors, and retailers are likely to be close to zero as purchasers shift to an alternative to the prohibited product.

By eliminating some of the choices that purchasers have available to them, there is likely to be a consumer surplus welfare loss that would result from regulatory options that restrict or limit these products. However, the specific value cannot be estimated without knowing the quantity of the prohibited product that is sold and the elasticity of demand for the specific product that would be prohibited. However, when a wide variety of close substitutes are available, the demand for a specific product is likely to be elastic (i.e., a relatively small increase in price is likely to result in customers shifting demand to different products instead). Thus, although EPA is unable to quantify the consumer surplus loss that would result from a regulatory option prohibiting TCE, the welfare loss is likely to be small, because products with similar prices and efficacy are widely available.

Table 4-1 shows the companies and types of products containing TCE by product type.

[7] EPA's reformulation cost estimates, presented in section 7.6, assume that reformulation costs are incurred for all existing TCE products, including formulators with existing TCE-free alternatives.

Table 4-1: Companies and Types of Products Containing Trichloroethylene by Product Type

Product Type	Parent Company Name	Product Name	% Trichloroethylene	% Average	Has Existing Trichloroethylene-Free Alternative
Mold Release	The Sherwin Williams Company	MR™351 Mold Cleaner Aerosol	68.9	65%	Yes
	Plastic Process Equipment, Inc.	Budget Paintable Mold Release (BPR-016)	30-35		Yes
		Carnauba Wax Paintable Mold Release (CW-165)	70-80		Yes
		Heavy Duty Mold Cleaner (DMC-20)	95-100		Yes
		Economic Heavy-Duty Mold Cleaner (EMC-55)	>90		Yes
		Economic Heavy Duty Non-Flammable Mold Cleaner (EMC-18)	85-95		Yes
		Multi-Visc Silicone Spray Mold Release	46.5		Yes
		Non-Flammable Silicone Spray Mold Release (NS-125)	50-60		Yes
		Econo-Spray Paintable Mold Release (EP-161)	45-50		Yes
		Super Lecithin Paintable Mold Release (L-175)	45-50		Yes
		Non-Flammable Paintable Mist Mold Release (NP-121)	50-60		Yes
		Neutral Oil Paintable Spray Mold Release (NOP-169)	45		Yes
	IMS Company	White 2000 Non-Flammable Mold Cleaner	85-98		Yes
		Non-Flammable Economy Mold Cleaner	85-97		Yes
Liquid Cleaners and Degreasers	NM Z Parent Inc.	Top Solv	90-<100	95%	Yes
	Delta Foremost Chemical Corporation	Foremost 582 Safety Solvent II	Proprietary		Yes
		Foremost 510 Carburetor Cleaner	Proprietary		Yes
Aerosol Spray Cleaning/Degreasing	American Industries Inc.	Blast Away	70-100	84%	Yes
	ITW Brands	LPS HDX (Aerosol)	90-100		Yes
	Berryman	Electric Motor Cleaner	>90		Yes
	Brownells	TCE Degreaser	Not provided		No
	NM Z Parent Inc.	Parts Cleaner	Not provided		Yes
		A07310 ZEP AEROSOLVE II 018101 20N20	>=90 - <=100		Yes

Table 4-1: Companies and Types of Products Containing Trichloroethylene by Product Type

Product Type	Parent Company Name	Product Name	% Trichloroethylene	% Average	Has Existing Trichloroethylene-Free Alternative
		A07311 ZEP PRO NF SLVT DGRS R12201 20N20	>=90 - <=100		Yes
		A07328 ZEP PARTS CLNR 003601 20N20	>=30 - <=50		Yes
		A07311 ZEP POWER SOLV II 020301 20N20	>=90 - <=100		Yes
		Zep 45 Aero DZ	>=30 - <60		Yes
		Zep Top Solv	>=90 - <=100		Yes
	Nu-Calgon	Nu-Blast Aerosol	95-98		Yes
	Omega Industrial Supply, Inc.	A1065 Blast	60-100		Yes
	Parker Hannifin Corporation	Blast-A-Coil	60-100		Yes
	PLZ Aeroscience Corporation	Solvent Degreaser	90-100		Yes
		Industrial C 60 Solvent Degreaser SW 064	90-100		Yes
		Fusing Machine Cleaner	40-60		Yes
		SW C60 SOLVENT DEGREASER	50-100		Yes
	Pro Chem	Pro Tools NF Solvent Degreaser	90-100		Yes
	The Sherwin Williams Company	MR 351 Mold Cleaner Aerosol	50-75		Yes
		SP 709 Chlorinated Brake and Parts Cleaner Aerosol	90-98		Yes
Energized Electronic Cleaner	Pro Chem	Electro Blast	90-100		Yes
		Electro Solv	90-100		Yes
	The Sherwin Williams Company	EL 848 Heavy Duty Flash Free Electrical Solvent Aerosol	90-98		Yes
		EL 2001 Electric Contact Cleaner and Protectant Aerosol	90-98		Yes
Lubricants and Greases	Midwest Motor Supply Company	Ultra Cut Cutting Tool Coolant`	40-60	21%	Yes
	K-Chem, Inc	Nut Buster	15.7-25.8		No
	Mid-American Research Chemical Corp.	Marc 100 Pen-A-Lube	7-13		No
	PLZ Aeroscience Corporation	Penetrating Lube	>= 5 - < 10		No
		Moisture Guard	>=5-<10		No

Table 4-1: Companies and Types of Products Containing Trichloroethylene by Product Type

Product Type	Parent Company Name	Product Name	% Trichloroethylene	% Average	Has Existing Trichloroethylene-Free Alternative
		Zep 45	>=30 - <50		No
	QuestSpecialty Corporation	Loose Srew	7-13		Yes
Adhesives, Sealants, Paints and Coatings	Berwind Corporation	TERAND COLD PIPE INSULATION	40-60	55%	No
	R.R. Street & Co. Inc.	ANTI-SWEAT V2.0 COLD PIPE INSULATION - HVAC-882	25-<50		No
	Brodi Specialty Products	Pipe Wrap	Not provided		No
	PLZ Aeroscience Corporation	Sprayway Cold Pipe Insulation	25-<50		Yes
	Centerbridge Partners, L.P.	SCIGRIP® 3 Low VOC Solvent Cement for Acrylic	5-15		No
	NewStar Adhesives Inc	EverStrong ES132 Contact Adhesive – Air Assist Canister	70-80		Yes
	Parker Hannifin Corporation	CHEMLOK 218	20-25		Yes
	SCIGRIP Smarter Adhesive Solutions	SCIGRIP® 4 Solvent Cement for Acrylic	40-60		No
	Stahlgruber Otto Gruber AG	Special Cement BL (Non-Flammable)	80-95		Yes
		OTR Special BL Cement (Non-Flammable)	80-95		Yes
		Thermopress MTR Solution	75-90		Yes
		Rim & Bead Sealer (Non-Flammable)	75-90		Yes
		Innerliner Repair Sealant (Non-Flammable)	70-85		Yes
		SC2000 Black Cement (Non-Flammable)	>80		Yes
	Steel Partners Holdings L.P.	STA'-PUT S100 Contact Adhesive	15-40		Yes
		STA'-PUT S170/S171 Contact Adhesive	3-10		Yes
Spot Removers	A.L. Wilson Chemical Co.	TarGo Dry	15% ≤ - ≤ 25%	57%	Yes
	R.R. Street & Co. Inc.	Puro	> 75		Yes
		Picrin	> 75		Yes
Film Cleaner	Hurst Chemical Company	Film Cleaner 90	95	95%	No

5. Use and Alternatives Analysis

This Chapter discusses the uses and alternatives for TCE. Section 5.1 presents the overview of the use and alternatives analysis presented in this Chapter. The remainder of the chapter is organized according to the product categories considered in the analysis and Table 5-1 presents a map between the use categories and the sections of the chapter where they are discussed.

Table 5-1: Use Categories Mapped to Applicable Section of Chapter

Use Category	Use and Alternatives Analysis
• Laboratory Use	• Not considered/applicable, see section 5.2, Use Categories and COUs Not Considered in the Use and Alternatives Analysis.
• Manufacturing	• Not considered/applicable, see section 5.2, Use Categories and COUs Not Considered in the Use and Alternatives Analysis.
• Import/Repackage	• Not considered/applicable, see section 5.2, Use Categories and COUs Not Considered in the Use and Alternatives Analysis.
• Battery and Synthetic Paper Processing Aid	• Not considered/applicable, see section 5.2, Use Categories and COUs Not Considered in the Use and Alternatives Analysis.
• HFC Manufacturing	• Not considered/applicable, see section 5.2, Use Categories and COUs Not Considered in the Use and Alternatives Analysis.
• Intermediate in HCl Production	• Not considered/applicable, see section 5.2, Use Categories and COUs Not Considered in the Use and Alternatives Analysis.
• Fluoroelastomer Manufacture	• Not considered/applicable, see section 5.2, Use Categories and COUs Not Considered in the Use and Alternatives Analysis.
• Disposal to Wastewater	• Not considered/applicable, see section 5.2, Use Categories and COUs Not Considered in the Use and Alternatives Analysis.
• Vapor Degreasing (open top, enclosed, conveyorized and web) and Batch Cold Cleaning	• See section 5.3, Vapor Degreasing
• Mold Release	• See section 5.4, Mold Release and Aerosol Spray Cleaning/Degreasing: Mold Releases and Cleaners
• Liquid Cleaners and Degreasers	• See sections 5.5, Liquid Cleaners and Degreasers and Aerosol Spray Cleaning/Degreasing: AC Coil Cleaners, and 5.6, Liquid Cleaners and Degreasers and Aerosol Spray Cleaning/Degreasing: Energized Electrical Equipment Degreasers
• Aerosol Spray Cleaning/Degreasing	• See sections 5.5, Liquid Cleaners and Degreasers and Aerosol Spray Cleaning/Degreasing: AC Coil Cleaners, and 5.6, Liquid Cleaners and Degreasers and Aerosol Spray Cleaning/Degreasing: Energized Electrical Equipment Degreasers
• Lubricants and Greases	• See section 5.7, Lubricants and
• Adhesives, Sealants, Paints and Coatings	• See sections 5.8, Adhesives, Sealants, Paints and Coatings: Adhesives, and 5.9, Adhesives, Sealants, Paints and Coatings: Cold pipe insulation
• Spot Removers	• See section 5.10, Spot Removers
• Pepper Spray	• See section 5.11, Pepper Spray
• Uses believed to be inactive or fully overlap with other conditions of use	• Toner Aid[1]
	• Film Cleaner[1]
	• Polish[1]

[1] Based on market research, EPA believes these are inactive uses.

5.1 Overview of Use and Alternatives Analysis Approach

Products discussed in this chapter were identified through a series of online searches, or through an inventory of products described in Chapter 4. The searches encompassed products available for purchase either by large and small businesses or by individual consumers. Certain product categories are relevant only for industrial or commercial use, while others are relevant for both.

This review provides a representative, but not exhaustive, listing of commercially available products for each product category evaluated. Therefore, the calculated market share percentages, price ranges, and conclusions about efficacy factors would likely change if more products were included in the review of various product categories. These changes would be most significant for broad product categories with numerous sub applications such as adhesives, caulks, and conventional press washes. The products included in the analysis were the products with the largest number of online customer reviews for products. This measure was used as a proxy for quantity of use. Products with relatively few or no online customer reviews were omitted from the analysis if several products with a higher number of customer reviews were available. Products with no online customer reviews were sometimes included, especially if there were limited products available with customer reviews within a product category.

For each product, the Safety Data Sheet (SDS) was obtained and was used as the source of information for ingredients, ingredient concentrations, VOC content, evaporation rate, flash point, other fire safety information, and substrate compatibility in some cases. It is worth noting that SDSs sometimes contain inconsistencies or inaccuracies, but additional data sources for these data points were not reviewed, except where specifically noted. In addition, SDSs sometimes provide a range of ingredient concentrations, rather than providing an exact formulation. The search for SDSs was not exhaustive for each product; therefore, additional SDS versions may exist for the same products.

5.1.1 Substitute Chemicals

For any effort to eliminate or replace a TCE, several approaches may be possible. Options include drop-in substitution; reformulation; process change; upstream changes; or elimination of the activity requiring the use of the chemical. For example, for the use of TCE in degreasing applications, an example of a drop-in substitution would be adoption of an alternative organic solvent that does not require any change in equipment or processes. An example of a process change would be a shift from an aerosol spray to an aqueous cleaning system using different equipment. An example of an upstream change would be a change in the use of oils or greases, shifting to a material that is easier to remove from parts. Similarly, a degreasing step can sometimes be eliminated entirely by changing oils or greases upstream.

Where applicable, this analysis examines drop-in solvent substitutes. In some cases, the analysis includes products that would be associated with a process change. It is important to note that in many cases, additional process change options are available to both businesses and consumers. Other TSCA priority chemicals were not considered as viable substitutes.

5.1.2 Analysis Sections for Each Product Category

The following analysis sections were included for each product category. For ease of reviewing the analysis, the rows are shaded orange in all tables for products containing TCE and are shaded grey for products containing another one of the first 10 TSCA work plan chemicals. All rows with products containing other alternatives are not shaded.

5.1.2 (A) Description

A brief description of the product used in the product category is provided.

5.1.2 (B) Solvent Ingredients

The solvent ingredients are provided for each of the products reviewed. The solvent names and concentrations were obtained from product Safety Data Sheets (SDSs). In some cases, it may not be clear if the primary function of a particular ingredient is as a solvent, or an ingredient may serve additional functions, such as acting as an emulsifier. If the listed ingredient appeared to have a solvency role, it was included.

5.1.2 (C) Chemical Ranking/ Market Share

A chemical ranking procedure was developed as a proxy for market share percentage of the chemicals used in products. This procedure provides a coarse estimate of 1) market share percentage of chemicals used within the current marketplace, and 2) the anticipated market share percentage of alternative chemicals if TCE were restricted for a certain product category. This procedure is further described in Appendix A. Note that the estimated "market share" refers to the amount of solvent/chemicals used in a particular product category, not the number of products based on a particular chemistry.

For several product categories, there were many more alternative products commercially available than products with TCE. When including only products with higher number of customer reviews, the number of alternative products excluded from the analysis was greater than for methylene chloride products. Consequently, the current market share percentage may be overstated for the TCE products in these product categories. However, this would have no impact on the estimated market share percentage after TCE restrictions.

Water is often not included in product SDSs. For this evaluation, water was included as an ingredient only if it was listed in the SDS or the product description specifically states that the product is water based. Otherwise, it was not assumed that water is an ingredient. It is likely that some products may have water as an ingredient and the product description may not state water based. Therefore, the approximate market share percentages calculated with this procedure may understate the actual representation of water used in products.

5.1.2 (D) Volatile Organic Content

This section provides VOC regulatory limits established by the U.S. EPA at the federal level, the South Coast Air Quality Management District (SCAQMD) at the regional level, and the Ozone Transport Commission (OTC) at the state level. The regulatory definition of VOCs used by the U.S. EPA is as follows: "Any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participate in atmospheric photochemical reactions" (Tucker 2001). OTC is a multi-state organization that was created under the Clean Air Act. OTC is responsible for advising the U.S. EPA on transport issues and for developing and implementing regional solutions to the ground-level ozone problem in the Northeast and Mid-Atlantic regions (OTC 2020). SCAQMD is the regulatory agency responsible for improving air quality for large areas of Los Angeles, Orange County, Riverside and San Bernardino counties (SCAQMD 2021). In addition to this regulatory information, the VOC information available in product SDSs is provided for each of the products reviewed. In some cases, VOC information was absent from the SDS but was present in a technical data sheet for the same product.

Methylene chloride and perchloroethylene are VOC exempt chemicals, while 1-bromopropane, NMP, and TCE are not VOC exempt chemicals. Commonly used solvents in chemical product formulations that are VOC exempt include water, acetone, dimethyl carbonate, methyl acetate, parachlorobenzotrifluoride, propylene carbonate, and tert butyl acetate.

5.1.2 (E) Fire Safety

The products reviewed were mainly composed of liquid solvents. "Flash point" is defined by the U.S. Occupational, Safety and Health Administration and the U.S. Department of Transportation in the U.S. Code of Federal Regulations as: "The minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid" (OSHA 2009, U.S. Department of Transportation 2009). Under the Federal Hazardous Substances Act label requirements, the Consumer Product Safety Commission (CPSC) classifies a liquid with a flash point less than 20 °F as "Extremely Flammable"; greater than 20 °F and less than 100 °F as "Flammable"; and 100 °F to 150 °F as "Combustible." Products with flash points greater than 150 F are considered non-flammable. There are other definitions for flammable and combustible liquids. For example, OSHA designates liquids used in the construction industry with flash points up to 140 F as flammable and liquids with flash points up to 200 F as combustible (OSHA 2010). This analysis used the flash points found in product SDSs or technical data sheets and translated those to ratings based on CPSC flammability classifications.

The primary way to mitigate fire hazard for products containing organic solvents is to utilize solvents with higher flash points, so that the overall product has a flash point that would be considered either combustible or non-flammable. In some cases, there is also the option to incorporate evaporation barrier additives that diminish the evaporation rate of the solvents. Paint and coating removal products often contain evaporation barriers, as the objective is to keep the product from evaporating to extend contact time. No evidence was found that evaporation barrier additives are used for the other product categories reviewed.

Flash points found in product SDSs or technical data sheets are provided for each of the products reviewed. Note that a flammability rating given on an SDS may be based on a different system than the CPSC ratings used in this analysis. For example, the SDS may list a product as combustible, while under the CPSC system it is non-flammable.

5.1.2 (F) Pricing and Customer Reviews

Pricing and customer review information obtained from publicly available websites are provided. This includes product prices, the number of customer reviews, and the average rating level for each of the products reviewed. It is important to note that prices can change over time, and are affected by a range of factors, including demand, availability of raw materials, and economies of scale, among other factors. In addition, products may be sold as concentrates or ready to use. Price comparisons assume that a similar amount of product would be used compared with the TCE product for any given application. Thus, they do not account for differences in effectiveness between products that effects the amount of product needed per use.

5.1.2 (G) Conclusion

The conclusion to each section summarizes findings and assesses whether any efficacy elements (e.g., VOC and fire safety), or cost barriers exist to using the alternative products as replacements for products containing TCE.

5.2 Use Categories and COUs Not Considered in the Use and Alternatives Analysis

The use categories and the COUs not considered in the use and alternatives analysis and the reasons they excluded are presented in Table 5-2 below. Sections 5.1-5.3 provide more information on certain uses and why alternatives are not more fully considered.

Table 5-2: Conditions of Use from the TCE TSCA Risk Evaluation Which Are Not Analyzed Further in This Use and Alternatives Analysis

Use Category	Conditions of Use (COUs)	Explanation
Laboratory Use	• Industrial and commercial use in hoof polish; gun scrubber; pepper spray; other miscellaneous industrial and commercial uses	Alternatives for TCE as a lab standard were not considered because EPA is not prohibiting or restricting laboratory uses in a manner substantially preventing activities in this use category until a viable alternative becomes available in the future. EPA has not identified any currently technically or economically feasible alternatives for TCE use as a laboratory chemical for essential laboratory uses. Note that methylene chloride and 1-bromopropane are alternatives that can be used to test hot mix asphalt binder content. Other alternatives include different testing methods. The alternative methods are Nuclear Asphalt Content (NAC) Gauge and the Ignition Method.
Manufacturing	• Manufacturing: domestic manufacture	Domestic manufacturing and import are alternatives for one another. The neat chemical must either be made domestically or imported into the United States. Chemical alternatives to TCE are accounted for in later stages of the chemical's life cycle based on specific uses.
Import/Repackage	• Manufacturing: import	
	• Processing: repackaging	The alternative for domestic repackaging is importing a repackaged product. Therefore, chemical alternatives for this COU are not identified.
Processing Aid (Battery and Synthetic Paper)	• Industrial and commercial use as processing aids in process solvent used in battery manufacture; process solvent used in polymer fiber spinning, fluoroelastomer manufacture and Alcantara manufacture; extraction solvent used in caprolactam manufacture; precipitant used in beta-cyclodextrin manufacture	EPA has focused this assessment on alternative chemical ingredients performing the same or similar functions as TCE in products for consumer or commercial/industrial use. For these COUs, EPA did not find it practicable to consider whether there are alternative processes that directly replace TCE with an alternative chemical or represent larger changes in multiple process steps in the production of a given chemical, due to the complexity of the analysis. However, EPA has included some information regarding the lack of alternatives for these uses where available. The lack of known alternatives for these COUs is accounted for in the development of the regulatory options.
HFC Manufacturing	• Processing: processing as a reactant/intermediate	
Intermediate in HCl Production	• Processing: processing as a reactant/intermediate	
Fluoroelastomer Manufacture	• Industrial and commercial use as processing aids in process solvent used in battery manufacture; process solvent used in polymer fiber spinning, fluoroelastomer manufacture and Alcantara manufacture; extraction solvent used in caprolactam manufacture; precipitant used in beta-cyclodextrin manufacture	
Disposal to Wastewater	• The disposal of TCE by industrial pre-treatment, industrial treatment, or publicly owned treatment works	In assessing the scenarios in which there is market adoption of these alternative commercial and consumer products that do not contain TCE, the earlier and later life cycle stages are no longer relevant to the assessment: these COUs for TCE are dependent on continued use in the commercial and consumer life cycle stages. As such, this Alternatives Assessment excludes manufacturing (including import), processing, distribution in commerce, disposal, and recycling. EPA did not identify alternative disposal options in the case of disposal of TCE to industrial pre-treatment, industrial

Table 5-2: Conditions of Use from the TCE TSCA Risk Evaluation Which Are Not Analyzed Further in This Use and Alternatives Analysis

Use Category	Conditions of Use (COUs)	Explanation
		treatment, or publicly owned treatment works for the purposes of cleanup projects of TCE-contaminated groundwater and other wastewater. Approaches used for cleanup of TCE-contaminated water are specific to the specific circumstances of individual sites and information is not available to determine what those approaches may be.
Incorporation into Formulation, Mixture, or Reaction Product	• Processing: incorporation into a formulation, mixture or reaction product	The alternatives are the processing or industrial/commercial use of a solvent to make products that do not contain TCE. Therefore, chemical alternatives to TCE are accounted for in later stages of the chemical's life cycle.
Toner Aid	• Industrial and commercial use as ink, toner and colorant products in toner aid • Consumer use in toner aid	There is evidence that TCE has historically been used in select products in this category. Based on market research, EPA was unable to find reasonably available information in support of the ongoing use of TCE for this use category (other than uses that fall under other conditions of use).
Polish	• Consumer use in hoof polish	There is evidence that TCE has historically been used in select products in this category. Based on market research, EPA was unable to find reasonably available information in support of the ongoing use of TCE for this use category (other than uses that fall under other conditions of use).

5.2.1 Battery Separator Manufacture

EPA received two 6(g) exemption requests for the use of TCE as a process solvent in battery separator manufacture, one from Microporous, LLC and one from ENTEK[8] . Microporous is a manufacturer of Pb acid battery separators and ENTEK manufactures both Pb acid and lithium-ion battery separators and both use TCE as a process solvent. Both companies included information on alternatives in their exemption requests (ENTEK International LLC 2021b , Microporous 2022).

Both companies use a wet process to manufacture battery separators and indicated that TCE is used in the extraction of process oil from extruded battery separator sheets. When the process oil is removed, the solvent is evaporated/removed from the separator to yield the required porosity to allow ion flow in the finished battery. One characteristic of TCE noted by both companies is that TCE reliably produces pores in the separator sheet in the range of 9-12 micrometer (µm) which is the choice for electric vehicle applications (ENTEK 2021b; Microporous 2022).

Within their submissions, the companies indicate that an alternative to battery separators manufactured in the U.S. would include imported battery separators, which could result in additional costs to users and also could affect national security by affecting the domestic supply chain. They also indicated that battery separators manufactured using a dry process (or mechanical process for creating pores) might be considered an alternative, however, the necessary porosity needed for some applications cannot be reliably achieved through this process. (ENTEK 2021b; Microporous 2022)

[8] According to their submission, ENTEK International LLC, produces separators for lead-acid batteries, and ENTEK Membranes LLC, produces separators for lithium-ion batteries. They are collectively referred to as ENTEK here as well as in their submission. (ENTEK 2021a)

ENTEK also included an "Analysis of Alternatives for the Use of Trichloroethylene as an Extraction Solvent for Removal of Process Oil and Formation of the Porous Structure in Polyethylene Based Separators Used in Lead-Acid Batteries "(ENTEK 2021a) identifying 17 chemicals or mixtures of chemicals (within a product) as potential alternatives to TCE as process solvent. The analysis was developed for ENTEK's submission for authorization in Europe under the Registration, Evaluation, Authorisation and Restriction of Chemicals program ("REACH"). Potential alternatives included n-hexane, methylene chloride, perchloroethylene, HFE-72DE (1,2-transdichloroethylene), Vertrel® SDG, N-Propyl Bromide, D-Limonene, and acetone. Microporous also identified some of these as potential alternatives (Microporous 2022). None of the named potential alternatives are drop-in alternatives and would likely require process changes including replacement of equipment and process reengineering. Most have only been tested at a lab scale. Additionally, there are concerns with respect to human health and the environment with each potential alternative, some having significant flammability concerns. In general, given the technical and economic considerations, the conclusion from both submitters was that no suitable alternatives were available at this time.

5.2.2 Synthetic Paper Processing Aid

EPA received a 6(g) exemption request for the use of TCE as a process solvent in battery separator manufacture from PPG. PPG is a global maker of paints, coatings and specialty materials. Information in this section is based on information provided in PPG's exemption request (PPG 2023).

One of PPG's specialty materials, TESLIN substrate, is a unique polymeric microporous sheet material that is a fundamental component in a wide range of products including but not limited to:

- Secure credentials, ID cards, Driver Licenses and Passports / e-Passports
- Durable labels and tags having stringent requirements, including blood bag labels and chemical drum labels
- Energy recovery ventilators
- Filtration elements and cartridges especially for challenging oil/water and bilge water separations

TCE is used in the production process to facilitate the controlled removal of process oil required in order to achieve a microporous film. TCE possesses the following properties that allows its use, recovery, and reuse:

- Non-flammable
- Rapidly extracts process (mineral) oil from sheet
- Amenable to separation via distillation allowing reuse of TCE and oil
- Low solubility in water and higher density than water that enables water/solvent separation for recovery
- Vapor pressure that allows for evaporation but can be condensed from steam atmosphere

TCE is used in the production process to extract oil from the synthetic paper sheet. The solvent displaces the process oil from the pores of the precipitated silica, transforming the oil-filled sheet into a sheet/substrate with the required micro-porosity and other physical properties which are key to the performance attributes and value in essentially all end-use applications. The sheet filled with process oil is converted to sheet filled with TCE. In the reverse-process direction, process solvent is converted into a process solvent/process oil mixture, which is subsequently separated in a distillation system by taking advantage of the relatively low boiling point of TCE as compared to oil. The pure TCE that comes off of the distillation system is fed back into the extractor, and the process oil that comes off of the distillation system is fed into a process oil storage tank where it is re-used for subsequent TESLIN mixes. The process oil and process solvent TCE are both recycled and reused.

Withing their submission, they summarized the following potential alternative solvents and asserted that none are technically or economically feasible alternatives to TCE in their production process:

- Trans-1,2-dichloroethylene
- 3M Novec 73DE
- Chemours Vertrel MCA
- Chemours Vertrel CCA
- NuGenTec FluoSolv CX
- Chemours Opteon SF79
- Cemours Opteon SF80
- Aero-Tron 100
- Hexane

5.2.3 HFC Manufacture

The majority of the annual production volume of TCE processed as an intermediate under this condition of use goes almost entirely toward the manufacture of one HFC, HFC-134a (EPA 2020e). HFC-134a can also be manufactured using perchloroethylene as a feedstock. While it would appear that perchloroethyene could be an alternative to TCE, it is not a drop-in substitute and facilities that currently use TCE would need to make major changes to their production equipment and processes to switch to perchloroethylene from TCE. According to one of the manufacturers, Koura, the plant design would be drastically different and, while some parts of a facility might be able to be used in both processes, the "heart of the process" could not without costly retrofitting and would probably not be a reasonable alternative given the response to the phasedown of HFC-134a resulting from the AIM Act (EPA 2021b).

5.2.4 Fluoroelastomer Production

In Europe, TCE was identified as a solvent in the synthesis of crosslinking agents for fluoropolymers. A single request for authorization under REACH was submitted for this use of TCE. As part of that request, the submitter provided an economic analysis and an alternatives assessment evaluating over 30 chemicals and/or products that may be potential alternatives. These two documents were used a basis to demonstrate that there were no suitable alternatives at the time of the authorization request (Azienda Lavorazione Prodott Ausiliari 2014) and an authorization for the use was granted. However, based on a more recent ECHA report, there is now a viable alternative to TCE, acetonitrile, which can be used with no changes in configuration in the specific process originally authorized needing no new plant or safety (ECHA 2022).

Regardless, EPA does not believe this to be an ongoing use of TCE in the U.S. In its 2021 Multi-Industry Per- and Polyfluoroalkyl Substances (PFAS) Substances (PFAS) Study (Preliminary) EPA identified 2 domestic manufacturers of fluoroelastomers and one processor. None of these companies appeared in the 2020 TRI or NEI with reports for TCE, suggesting they are not using TCE in their process. While EPA does not believe that domestic manufacture of fluoroelastomers using TCE occurs, 2 companies were identified as those reporting TCE on TRI or NEI reports that had a NAICS code that related to an industry where rubber-type products were potentially manufactured. Therefore, to account for the uncertainty in knowing if this is an ongoing use, EPA conservatively used these companies to estimate impacts of the rule, however, has low confidence that they are using TCE as a process solvent in the manufacture of fluoroelastomers.

5.3 Vapor Degreasing

It is anticipated that the facilities that use TCE for vapor degreasing and batch cold cleaning will transition to technologically and economically feasible alternative cleaning methods, which could include vapor degreasing with another solvent, aqueous cleaning, or another non-water alternative such as hydrocarbon solvents, oxygenated solvents, terpene-based cleaners, parachlorobenzotrifluoride, volatile methyl siloxanes, or soy-based cleaners (IRTA 2016b; 2016a). Three solvents commonly used for vapor degreasing are also included in the first 10 TSCA work plan chemicals: methylene chloride, perchloroethylene, and 1-bromopropane. The risk evaluations for these three chemicals all found an unreasonable risk under TSCA for their use in vapor degreasing. Given the regulatory uncertainty while EPA considers risk management options for these chemicals, this analysis assumes that these chemicals would not be adopted as alternative open-top vapor degreasing solvents for TCE while this regulatory uncertainty exists. Since the proposed perchloroethylene rule allows for its continued use in airless vapor degreasers and EPA believes that the emissions below the ECEL under the proposed rule are achievable, EPA believes that the use of perchloroethylene in an airless degreaser may be a popular choice as an alternative to TCE vapor degreasing.

EPA consulted with critical cleaning experts who help manufacturers develop and/or optimize their cleaning processes about alternatives to TCE in vapor degreasing. According to these experts, the alternatives that would be technological and economically feasible would be dependent on:

- the soils being removed,
- the level of cleanliness required,
- the characteristics of the components being cleaned,
- the volume of components being cleaned,
- and other factors.

The critical cleaning consultants noted that users may need to test multiple different cleaning processes before identifying a successful process, and some users might need to transition from using TCE in vapor degreasing to more than one alternative cleaning chemical/method.

The critical cleaning consultants considered alternatives to the use of TCE in different sized degreasers used in the different cleaning categories in the first two columns of Table 5-3 to the different cleaning methods presented the last column in Table 5-3.

The analysis defines Small, Medium, and Large degreasers according to the cleaning chamber tank size (small–12 x 12 x 10; medium–36 x 36 x 22; large–60 x 42 x 36).

The critical cleaning consultants defined four “cleaning categories” that would have different processes and cleaning requirements for switching to alternative cleaning methods to vapor degreasing with TCE:

- **General Cleaning** is defined as having relatively low process development and low cost of process verification. Primary costs will include equipment and performance testing.
- **High Precision Cleaning** covers the cleaning of high value parts where very small residue is acceptable, at best. Significant process development is needed; however, customer or other regulatory performance standards are not the driving force.

- **Safety Critical Cleaning** includes product processes where performance failure is not an option. This category will have higher costs for process verification and validation and may also cover situations with very high-cost consequences of failure. Primary costs will include evaluation, initial performance testing and capital costs.
- **Start-up/R&D Critical Cleaning** covers the development process of new high precision or high value products prior to production; these would typically not require large degreasers and would need adaptable cleaning systems.

Table 5-4 presents the cleaning methods that are applicable for each combination of size and cleaning category. Table 5-5 presents the descriptions of the baseline and alternative cleaning methods that would be the most likely to be economically and technically feasible.

Table 5-3: Sizes, Cleaning Categories, and Cleaning Methods Considered in the Vapor Degreasing Alternatives Analysis

Size	Cleaning Category	Cleaning Method
Small	General	Replace with Airless Degreaser with PCE
Medium	High Precision	Convert OTVD to use Flashpoint inerted t-DCE
Large	Safety Critical	Replace with OTVD using FlashPoint inerted t-DCE
	Start-Up/R&D	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)
		OTVD for Low boiling point (<100C) Alcohol or other flammable
		OTVD for Very low flashpoint (<0C) solvent
		EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols
		Co-Solvent, Bi-Solvent
		High boiling, non-vacuum, non-rinse
		Semi-Aqueous
		Replace with Aqueous Cleaning
		Hybrid system (example: Inventec, HEMO)

Table 5-4: Size and Cleaning Categories and Applicable Alternative Cleaning Methods

Cleaning Method	General Cleaning			High Precision Cleaning			Safety Critical Cleaning			Start-Up R&D	
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium
Replace with Airless Degreaser with PCE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Convert OTVD to use Flashpoint inerted t-DCE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Replace with OTVD using Flashpoint inerted t-DCE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
OTVD for Low boiling point (<100C) Alcohol or other flammable	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
OTVD for Very low flashpoint (<0C) solvent	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Co-Solvent, Bi-Solvent	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
High boiling, non-vacuum, non-rinse	✓	✓	✓	×	×	×	×	×	×	×	×
Semi-Aqueous	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Replace with Aqueous Cleaning	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hybrid system (e.g., Inventec, HEMO)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 5-5: Baseline and Alternative Cleaning Methods and their Definitions

Cleaning Method	Definition
Baseline - OTVD with TCE	An OTVD uses heated solvent in the liquid and/or vapor phase. For this analysis, the baseline OTVD uses TCE as the solvent. An OTVD may or may not have a cover. It may be characterized by the equipment supplier using terms like "well-sealed" or having "minimal solvent emissions." As defined here, OTVDs have an atmospheric air-solvent interface, which is why it is difficult to get very low emissions. Nearly all OTVDs using TCE should be "National Emission Standards for Hazardous Air Pollutants (NESHAP) compliant" OTVDs, in that they may have double-coils and a high freeboard ratio. An OTVD may include ultrasonic cleaning and/or a spray wand.
Replace with Airless Degreaser with PCE	An airless degreaser (sometimes referred to as an airless/airtight cleaning system) is equipment for which there is never an atmospheric air-solvent interface. Solvent does not enter the working chamber until the product to be cleaned has been placed in the chamber, the chamber has been sealed and air has been evacuated, usually to a level of one torr or less. Cleaning then can occur, usually by computer control, either by immersion (with or without ultrasonics), spray, or vapor degreasing. As with aqueous cleaning, solvent immersion cleaning could also include cyclic nucleation or cyclic cavitation, where the pressure is changed to provide boiling cycles. Following cleaning and rinsing cycles, the solvent is pumped back into sealed reservoirs, and the chamber is again pumped to a vacuum (sometimes through a carbon filter to capture residual traces of solvent vapors), thus providing vacuum drying. A closed-loop degreaser is not the same as an airless degreaser. An OTVD recirculates/redistills/reuses the solvent; but such systems have not been demonstrated to match the low level of solvent loss achieved with an airless system. EPA believes that the emissions levels below the ECEL in the 2023 proposed section 6 regulation for PCE are achievable when using PCE in an airless degreaser.
Convert OTVD to use Flashpoint inerted t-DCE	An OTVD uses heated solvent in the liquid and/or vapor phase. For these cleaning methods, flashpoint inerted trans-DCE is the solvent. An OTVD may or may not have a cover. It may be characterized by the equipment supplier using terms like "well-sealed" or having "minimal solvent emissions." Since flashpoint inerted trans DCE blends are more expensive, it may make sense for users to replace their OTVD if their existing machine is an older, more emissive model. The fluorinated inerting agents are also under scrutiny by the U.S. EPA and other regulators because of concerns about PFAS.
Replace with OTVD using Flashpoint inerted t-DCE	
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	An OTVD uses heated solvent in the liquid and/or vapor phase. For these cleaning methods, flashpoint inerted trans-1-chloro-3,3,3,trifluoropropene is the solvent. An OTVD may or may not have a cover. It may be characterized by the equipment supplier using terms like "well-sealed" or having "minimal solvent emissions." Since flashpoint inerted trans-1-chloro-3,3,3,trifluoropropene blends are more expensive, it may make sense for users to replace their OTVD if their existing machine is an older, more emissive model. The fluorinated inerting agents are also under scrutiny by the U.S. EPA and other regulators because of concerns about PFAS.
OTVD for Low boiling point (<100C) Alcohol or other flammable	These systems are vapor degreasers where engineering controls have been employed to eliminate ignition and oxidation sources in order to ensure that flammable liquids can be used.
OTVD for Very low flashpoint (<0C) solvent	
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	These are systems containing combustible (flashpoint > 37.8C) solvents, with boiling points greater than 100C. The solvents in current use are either medium chain (~10-12 carbons) iso-paraffins or those that are called "modified alcohols", such as iso-propanol connected to a butane (4-carbon) chain. Because the primary concern is reducing flammability concerns rather than toxic exposure, these systems may be the same as airless degreasers, but need not be designed to completely eliminate an atmospheric air-solvent interface.
Co-Solvent, Bi-Solvent	**Flashpoint-inerted trans DCE** These are systems that use two organic solvents. For the purposes of this analysis, these terms are interchangeable. In some cases,

Table 5-5: Baseline and Alternative Cleaning Methods and their Definitions

Cleaning Method	Definition
	the cleaning agent (sometimes referred to as the solvating agent) is in one chamber and the rinsing agent (sometimes referred to as the displacement agent) is in a second tank and is used sequentially. In other designs, the washing step is a mixture of cleaning agent and displacement agent. Nearly all current co-solvent or bi-solvent systems use flashpoint-inerted trans-DCE as the displacement agent. The fluorinated inerting agents are also under scrutiny because of concerns about PFAS. **Solvent and alcohol (cost estimates do not reflect this possibility)** If ingredients of flashpoint-inerted trans DCE were to become unavailable through regulatory actions or business decisions, co-solvent and bi-solvent systems are options. Based on Barbara Kanegsburg's studies at Litton Guidance and Control Systems in the late 1980s- early 1990s for what we now term safety/critical military applications, cleaning should be able to be accomplished using cleaning agents such as d-limonene or some of the Axarel hydrocarbon blends followed by rinsing with isopropyl alcohol. Modified alcohol could be tested as the solvating agent. There are provisos. Additional process development, including testing, would be needed. Low flashpoint cleaning systems would be needed – this would add to equipment costs.
High boiling, non-vacuum, non-rinse	Examples of solvents used in such systems include d-limonene and soy methyl esters. The FP is above 37.8 deg C (100 deg F), so they would be considered not flammable by NFPA. Equipment would consist of a dip tank, most often but not necessarily heated. There could be ultrasonics or agitation. Depending on local regulations (notably those restricting VOC), there may or may not be a cover. Examples: D-limonene (aliphatic hydrocarbon classified as a cyclic monoterpene, the major component in oils from citrus rinds) flashpoint 48 deg C boiling point 176 Deg C Methyl Soyate (a mixture of long-chain, typically 16-18 carbons, fatty acid methyl esters) flashpoint 130C boiling point 200C
Semi-Aqueous	A semi-aqueous cleaning process consists of a water-miscible blend, with high solvent concentration (including emulsions), used as an immersion or spray followed by an aqueous rinse (see the description of aqueous process). Some semi-aqueous processes are referred to as aqueous (by the supplier of cleaning agent, or cleaning equipment, or by the end-user) for marketing purposes even though this is not an accurate description of the process.
Replace with Aqueous Cleaning	Aqueous cleaning involves washing with a cleaning agent that could be water alone but that typically contains organic and inorganic chemistry and typically contains significant amounts of water. Aqueous cleaning may be used at many stages of production. The quality of the water and the amount of water used is highly variable. Depending on the application, the water quality can range from tap water to purified water, for example, de-ionized or reverse osmosis. What manufacturers consider to be an aqueous cleaning agent is highly variable. Aqueous formulations vary in their composition (organic and inorganic additives) and in the concentration at which they are used. Some may have a very high pH. What is described as an aqueous process may actually be a semi-aqueous process, in large part because it has become more acceptable to avoid the concept of using any organic solvent for cleaning. Heat and various types of cleaning action like ultrasonics, underwater agitation (like a jacuzzi or tubulation) may be used to enhance cleaning. In most instances there is significant amount of rinsing with water to displace the cleaning agent. In some

Table 5-5: Baseline and Alternative Cleaning Methods and their Definitions

Cleaning Method	Definition
	instances, the rinse water may include chemicals (rust preventative (RP)) to forestall corrosion. Depending on the substrate to be cleaned and the end-use of the product, there is most often a drying step. In our model for cost comparison, we have used a wash tank followed by rinse tanks followed by a drying chamber. While we have used immersion tanks as a model to describe the aqueous process to allow comparison among the cleaning processes, in fact there is an enormous variability in aqueous cleaning processes and aqueous cleaning equipment. Here are a few non-encompassing examples of aqueous cleaning equipment that are not cleaning tanks. For general cleaning applications, cleaning agent may be applied to the part either by spray or immersion. Rinsing, if it occurs may be as simple as holding the part over a tap and rinsing all residue down the drain. In some metal cleaning, the part may be washed in a spray chamber, with or without rinsing. Where rinsing occurs, it may be accomplished by placing the part over a grate and spraying water on it. Drying may not be necessary. In-line aqueous cleaning equipment is widely used to remove “no-clean” (low residue) flux from electronics assemblies, post-soldering. The cleaning action (washing and rinsing) typically involves spray-in-air. There are wash, rinse, and drying chambers. In some applications such as in some hybrid cleaning water (and/or an aqueous cleaner) is introduced into a chamber containing the parts to be cleaned. Ultrasonic cleaning and/or in cyclic cavitation (cyclic nucleation) may be used to enhance cleaning.
Hybrid system (e.g., Inventec, HEMO)	Hybrid systems use two or more cleaning methods in a single piece of cleaning equipment. Sometimes, the parts are cleaned in a single chamber and cleaning solutions are introduced. Others systems use sequential chambers. One equipment manufacturer described the use of an aqueous cleaning step but with a solvent rinse. This would be distinguished from a semi-aqueous process where the high-solvent cleaner is used for washing and water used for rinsing. As contrasted with co-solvent or bi-solvent systems, hybrid systems, in our definition, use an aqueous process as one of the methods, either sequentially or together as an emulsion.

5.4 Mold Release and Aerosol Spray Cleaning/Degreasing: Mold Releases and Cleaners

For this report, the categories of mold releases and cleaners were combined, as they are used for similar purposes and contain similar ingredients. Mold releases are applied to molds between molding cycles to prevent materials from sticking to the molds. Mold cleaners are used on molds to dissolve and remove greases, silicones, oils, and residues. Both releases and cleaners are used across a variety of applications and on different mold materials, including plastics and rubber. The products found in the market review were aerosols sold in volumes of 12 to 16 ounces.

5.4.1 Solvent Ingredients

The review included one product containing TCE (White 2000 Non-Flammable Mold Cleaner), one product containing perchloroethylene (Heavy Duty Mold Cleaner), and two products containing 1-Bromopropane (General Purpose Silicone Mold Release and Slide Resin Remover Aerosol). The Slide Resin Remover Aerosol product also contains N-Methyl-2-pyrrolidone. EPA also reviewed five products containing alternative solvents, including d-limonene, dimethyl ether, and others. Table 5-6 shows the list of products reviewed for this report and their primary solvent ingredients.

Table 5-6: Reviewed Mold Release and Mold Cleaner Products: Safety Data Sheets and Solvent Ingredients with Concentrations 5% or Higher

Supplier	Product	SDS	SDS date	Solvent ingredients	Concentration (%)
IMS Company	White 2000 Non-Flammable Mold Cleaner	https://imscompany.com/assets/pdf/sds/118308%20White%202000%20SDS%20091718.pdf	9 October 2018	Trichloroethylene	85 - 98
CRC Industries, Inc.	Heavy Duty Mold Cleaner	http://docs.crcindustries.com/msds/1003500E.pdf	13 September 2017	Perchloroethylene	90 - 100
CRC Industries, Inc.	General Purpose Silicone Mold Release	http://docs.crcindustries.com/msds/1003488E.pdf	27 December 2016	Dimethyl ether	60 - 70
				1-Bromopropane	20 - 30
Slide Products Inc.	Slide Resin Remover Aerosol	https://static.rshughes.com/wm/p/wm-asis/094db1b44335b0d948f96eb51dd18482b3ab8a19.pdf?uf=	01 January 2015	Gamma-butyrolactone	35 - 40
				1-Methyl-2-pyrrolidone	35 - 40
				1-Bromopropane	25 - 30
Smooth-On	Universal Mold Release	https://www.smooth-on.com/msds/files/Universal_Mold_Release_Aerosol.pdf	31 January 2019	Dimethyl ether	25 - 50
CRC Industries, Inc.	Food Grade Mold Release	http://docs.crcindustries.com/msds/1003498E.pdf	25 November 2016	Dimethyl ether	50 - 60
IMS Company	Biodegradable Citrus Spray Mold Cleaner	https://imscompany.com/assets/pdf/sds/111598%20Citrus%20SDS%20041315.pdf	13 April 2015	D-Limonene	70 - 80
CRC Industries, Inc.	Heavy Duty Silicone Mold Release	http://docs.crcindustries.com/msds/1003492E.pdf	28 December 2016	Dimethyl ether	40 - 50
CRC Industries, Inc.	Food Grade Silicone Mold Release	http://docs.crcindustries.com/msds/1003490E.pdf	18 January 2018	Dimethyl ether	50 - 60

Note: Orange shaded row(s) indicate products that contain TCE. Grey shaded row(s) indicate products that contain another one of the first 10 TSCA work plan chemicals.

Table 5-7 shows the anticipated, approximate market share percentage of primary solvents used in products estimated using the chemical ranking procedure. If restrictions were implemented for TCE, then it is anticipated that dimethyl ether would be the most prevalent solvent used in replacement products.

Table 5-7: Estimated Percentage Share of Solvent Ingredients for Reviewed Mold Release and Mold Cleaner Products

Solvent	Current market share	Projected after restrictions
Trichloroethylene	17%	0%
Perchloroethylene	22%	0%
1-Bromopropane	6%	0%
N-Methyl-2-pyrrolidone	2%	0%
Dimethyl ether	41%	78%
D-limonene	9%	18%
Other	2%	4%

Notes: The figures shown here are based on a proxy chemical ranking procedure, which draws upon factors including concentration in the product and availability and quality of product reviews. Orange shading indicates TCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals.

5.4.2 Volatile Organic Compounds (VOC) Content

VOC information was reviewed in product SDSs and summarized findings are in Table 5-8. EPA did not identify any federal or state VOC regulatory limits for mold release or mold cleaner products. The product containing TCE did not have VOC information in the SDS. The three products containing 1-Bromopropane, perchloroethylene, and N-Methyl-2-pyrrolidone had VOC information in their SDSs. Heavy Duty Mold Cleaner had 0% VOC content, where General Purpose Silicone Mold Release and Slide Resin Remover Aerosol both had VOC content around 100%. There was VOC information for three of the five alternative products, ranging from 48.4% (Heavy Duty Silicone Mold Release) to 59.6% (Food Grade Silicone Mold Release).

Table 5-8: VOC Content for Mold Release and Mold Cleaner Products Based on Information in SDSs or Technical Data Sheets

Supplier	Product	VOC (% weight, g/L)
IMS Company	White 2000 Non-Flammable Mold Cleaner	No information in SDS
CRC Industries, Inc.	Heavy Duty Mold Cleaner	0%, 0 g/L Technical product sheet: http://api.crcindustries.com/auto-services/get-pds/03315
CRC Industries, Inc.	General Purpose Silicone Mold Release	97%, 756.6 g/L
Slide Products Inc.	Slide Resin Remover Aerosol	100%
Smooth-On	Universal Mold Release	No information in SDS
CRC Industries, Inc.	Food Grade Mold Release	55.8%, 430 g/L
IMS Company	Biodegradable Citrus Spray Mold Cleaner	No information in SDS
CRC Industries, Inc.	Heavy Duty Silicone Mold Release	48.4%, 485 g/L
CRC Industries, Inc.	Food Grade Silicone Mold Release	59.6%, 448 g/L

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

5.4.3 Fire Safety

EPA reviewed flash points and flammability ratings in product SDSs and summarized findings are in Table 5-9. White 2000 Non-Flammable Mold Cleaner, which contains TCE, was rated non-flammable. Heavy Duty Mold Cleaner, which contained perchloroethylene, was also rated as non-flammable. The two products containing 1-Bromopropane did not have flammability ratings available. Four of the alternative products, Universal Mold Release, Food Grade Mold Release, Biodegradable Citrus Spray Mold Cleaner, and Food Grade Silicone Mold Release were rated non-flammable. Based on the review, there are non-flammable alternatives to choose from if TCE is restricted in mold release and cleaner products.

Table 5-9: Flash Point and Flammability Ratings for Mold Release and Mold Cleaner Products Based on Information in SDSs or Technical Data Sheets

Supplier	Product	Flash Point	Flammability Rating
IMS Company	White 2000 Non-Flammable Mold Cleaner	None	Non-flammable
CRC Industries, Inc.	Heavy Duty Mold Cleaner	None	Non-flammable
CRC Industries, Inc.	General Purpose Silicone Mold Release	Not available	None
Slide Products Inc.	Slide Resin Remover Aerosol	Not determined	Not determined
Smooth-On	Universal Mold Release	>300 °F	Non-flammable
CRC Industries, Inc.	Food Grade Mold Release	350 °F (176.7 °C)	Non-flammable
IMS Company	Biodegradable Citrus Spray Mold Cleaner	Flash point of propellant <0 °F	Non-flammable
CRC Industries, Inc.	Heavy Duty Silicone Mold Release	Not determined	None
CRC Industries, Inc.	Food Grade Silicone Mold Release	> 572 °F (> 300 °C)	Non-flammable

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

5.4.4 Pricing and Customer Reviews

Pricing and customer review information was accessed on publicly available websites in August 2021 and summarized findings are in Table 5-10. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Pricing for products containing TCE and 1-Bromopropane ranged from $0.29 (White 2000 Non-Flammable Mold Cleaner) to $1.37 (General Purpose Silicone Mold Release) per ounce. Pricing for alternative products ranged from $0.52 (Biodegradable Citrus Spray Mold Cleaner) to $1.75 (Universal Mold Release) per ounce.

Two products containing perchloroethylene and 1-Bromopropane had customer reviews, ranging from 4 (Heavy Duty Mold Cleaner) to 4.5 (General Purpose Silicone Mold Release) with an average rating of 4.3. Three of the alternative products had reviews ranging from 4.4 (Heavy Duty Silicone Mold Release) to 4.6 (Food Grade Mold Release and Food Grade Silicone Mold Release) with an average rating of 4.5. The average rating of alternative products was also over 4, indicating overall customer satisfaction with these products.

Table 5-10: Pricing and Customer Review Information for Mold Release and Mold Cleaner Products Based on Manufacturer and Retailer Web Pages

Supplier	Product	Retail information	Price per ounce	Customer ratings (out of 5)	Number of customer reviews
IMS Company	White 2000 Non-Flammable Mold Cleaner	https://imscompany.com/product/118308	$0.29	None	None
CRC Industries, Inc.	Heavy Duty Mold Cleaner	https://www.amazon.com/CRC-Heavy-Duty-Cleaner-Aerosol/dp/B00CSX3RO8	$0.91	4	2
CRC Industries, Inc.	General Purpose Silicone Mold Release	https://www.amazon.com/CRC-03300-Silicone-Release-Aerosol/dp/B0013IZSDM	$1.37	4.5	1,718
Slide Products Inc.	Slide Resin Remover Aerosol	https://www.rshughes.com/p/Slide-The-Stripper-Resin-Remover-16-Oz-Aerosol-Can-14-Oz-Net-Weight-41914/41914/	$0.60	None	None
Smooth-On	Universal Mold Release	https://www.amazon.com/Smooth-Universal-Mold-Release-fl/dp/B004BNHLOK	$1.75	4.6	1,336
CRC Industries, Inc.	Food Grade Mold Release	https://www.grainger.com/product/19MW96	$1.18	None	None
IMS Company	Biodegradable Citrus Spray Mold Cleaner	https://imscompany.com/product/111598	$0.52	None	None
0CRC Industries, Inc.	Heavy Duty Silicone Mold Release	https://www.amazon.com/CRC-Heavy-Silicone-Release-Aerosol/dp/B000R80OMO	$1.54	4.4	11
CRC Industries, Inc.	Food Grade Silicone Mold Release	https://www.amazon.com/CRC-03301-Silicone-Release-Weight/dp/B0013J3ZP4	$0.75	4.6	282

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

5.4.5 Conclusion

The review of mold release and mold cleaning products included one product containing TCE, one product containing perchloroethylene, two products containing 1-Bromopropane and five products containing alternative solvents. There were no barriers around VOCs, fire safety, or customer satisfaction that may be caused by restricting the use of TCE in this product category. Alternative products had VOC content between 45-49%. All the alternative products with flammability information were rated non-flammable. Average customer ratings were above 4 out of 5 for alternative products, indicating overall customer satisfaction.

5.5 Liquid Cleaners and Degreasers and Aerosol Spray Cleaning/Degreasing: AC Coil Cleaners

Air conditioner (AC) coil cleaners are used to maintain AC systems by cleaning away dust, dirt, debris, and buildup from coil fins. Keeping coils clean allows the AC system to transfer heat more efficiently. Cleaning solvents may be used in conjunction with other cleaning methods, such as blowing compressed air, vacuuming, or spraying a mixture of household detergent and water with a low-pressure sprayer. Air conditioner cleaners are available in several forms, including self-rinsing cleaners or foaming cleaners. These options are available for commercial or consumer use in aerosol form or in bulk form for use in low-pressure sprayers. Some cleaners require rinsing or wiping of excess solution.

5.5.1 Solvent Ingredients

The review included two products containing TCE, one product containing methylene chloride, and five products containing chemical alternative solvents, including, diethylene glycol ethyl ether, water, 2-

butoxy-ethanol, and others. Table 5-11 shows the list of products reviewed for this analysis and their primary solvent ingredients.

Table 5-11: Safety Data Sheets and Solvent Ingredients with Concentrations 5% or Higher for Reviewed AC Coil Cleaners

Supplier	Product	SDS	SDS date	Solvent ingredients	Concentration (%)
Parker Hannifin Corporation	Blast-A-Coil	https://www.parker.com/parkerimages/Parker.com/Literature/Sporlan/Sporlan%20pdf%20files/SDS/Blast%20A%20Coil%20February%202019.pdf?elqTrackId=3832459666564432a6bdab823ec2f110&elqaid=16362&elqat=2	08 February 2019	Trichloroethylene	80 - 100
				Carbon Dioxide	1 - 5
Nu-Calgon	Nu-Blast Aerosol	https://www.nucalgon.com/media/4757/4290-75_sds_eng_v1.pdf	Nu-Calgon	Trichloroethylene	95 - 98
Nu-Calgon	Cal-Blast	https://www.nucalgon.com/media/4751/4132-20_sds_eng_v11.pdf	26 August 2019	Methylene Chloride	80 - 100
				d-Limonene	1 - 5
Nu-Calgon	Evap Foam No Rinse Aerosol	https://www.nucalgon.com/media/4754/4171_sds_eng_v2.pdf	26 February 2018	Diethylene glycol ethyl ether	1 - 5
				2-Butoxyethanol	1 - 5
CRC	Foaming Coil Cleaner	http://docs.crcindustries.com/msds/1003453E.pdf	07 October 2020	Water	60 - 70
				2-butoxyethanol	1 - 5
Nu-Calgon	Evap Pow'r C (4168)	https://www.nucalgon.com/media/5479/4168_sds_eng_v1.pdf	13 March 2019	2-butoxyethanol	3 - 7
Nu-Calgon	Blackhawk Foaming Coil Cleaner	https://www.nucalgon.com/media/4748/4127-75_sds_eng_v1.pdf	26 February 2018	Diethylene glycol monoethyl ether	1 - 5
				2-butoxyethanol	1 - 5
Sunshine Makers, Inc.	Simple Green® Foaming Coil Cleaner-non-aerosol	https://cdn.simplegreen.com/downloads/SDS_EN-US_SimpleGreenFoamingCoilCleaner.pdf	1 March 2014	Water	>77
				Triethanolamine	<10
				Propylene glycol Butyl ether	<5

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

Table 5-12 shows the anticipated, approximate market share percentage of primary solvents used in this product category. This share percentage was estimated using the chemical ranking procedure. If restrictions were implemented for TCE, then it is anticipated that aqueous and semi-aqueous solutions would be the most used alternative in replacement products.

Table 5-12: Estimated Percentage Market Share of Solvent Ingredients for AC Coil Cleaners

Solvent	Current market share	Projected after restrictions
Trichloroethylene	20%	0%
Methylene Chloride	20%	0%
Water	42%	70%
2-butoxyethanol	7%	11%
Diethylene glycol monoethyl ether	7%	11%
Other	4%	8%

Notes: The figures shown here are based on a proxy chemical ranking procedure, which draws upon factors including concentration in the product and availability and quality of product reviews. Orange shading indicates TCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals.

5.5.2 Volatile Organic Compounds (VOC) Content

VOC information was reviewed in product SDSs and summarized findings are in Table 5-13. No regulatory VOC limits for AC coil cleaners were identified. There were no VOC content data available for the two products containing TCE and methylene chloride. Only two products had VOC content information listed on the SDS: Evap Foam No Rinse Aerosol (10.4%) and Simple Green® Foaming Coil cleaner- non-aerosol (2%). It was difficult to compare VOC content between products with trichloroethylene and methylene chloride and alternative products due to lack of VOC information in SDSs. However, the two alternative products with information had VOC content of around 10% or less, indicating a market share of low VOC products without TCE.

Table 5-13: VOC Content for AC Coil Cleaners Based on Information in SDSs or Technical Data Sheets

Supplier	Product	VOC (% weight, g/L)
Parker Hannifin Corporation	Blast-A-Coil	No information in SDS; likely high VOC content since 80 to 100% of product is TCE
Nu-Calgon	Nu-Blast Aerosol	No information in SDS; likely high VOC content since 95 to 98% of product is TCE
Nu-Calgon	Cal-Blast	No information in SDS; likely low VOC content since 80 to 100% of product is methylene chloride
Nu-Calgon	Evap Foam No Rinse Aerosol	10.4%, 113.4 g/L
CRC	Foaming Coil Cleaner	No information in SDS
Nu-Calgon	Evap Pow'r C (4168)	No information in SDS
Nu-Calgon	Blackhawk Foaming Coil Cleaner	No information in SDS
Sunshine Makers, Inc.	Simple Green Foaming Coil Cleaner- non-aerosol	2%, 20 g/L

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

5.5.3 Fire Safety

Flash points and flammability ratings were reviewed in product SDSs and summarized findings are in Table 5-14. The two products containing TCE were rated non-flammable. Cal-Blast containing methylene chloride was the only product reviewed with a rating of extremely flammable. One alternative product, Evap Foam No Rinse Aerosol, did not have fire safety data. All other alternative products were rated non-flammable. Based on the review, restricting TCE from AC coil cleaners is unlikely to limit availability of non-flammable products on the market.

Table 5-14: Flash Point and Flammability Ratings for AC Coil Cleaners Based on Information in SDSs or Technical Data Sheets

Supplier	Product	Flash Point	Flammability Rating
Parker Hannifin Corporation	Blast-A-Coil	No information in SDS	Non-flammable
Nu-Calgon	Nu-Blast Aerosol	No information in SDS	Non-flammable
Nu-Calgon	Cal-Blast	No information in SDS	Extremely flammable
Nu-Calgon	Evap Foam No Rinse Aerosol	No information in SDS	Non-flammable
CRC	Foaming Coil Cleaner	None	No information in SDS
Nu-Calgon	Evap Pow'r C (4168)	No information in SDS	Non-flammable
Nu-Calgon	Blackhawk Foaming Coil Cleaner	No information in SDS	Non-flammable
Sunshine Makers, Inc.	Simple Green Foaming Coil Cleaner- non-aerosol	> 212° F (100° C)	Non-flammable

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

5.5.4 Pricing and Customer Reviews

Pricing and customer review information was accessed on publicly available websites in July 2021 and summarized findings are in Table 5-15. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Pricing for products containing TCE and methylene chloride ranged from $0.99 (Cal-Blast) to $1.52 (Nu-Blast Aerosol) per ounce. Pricing for alternative products ranged from $0.26 (Evap Pow'r C (4168) to $0.90 (Blackhawk Foaming Coil Cleaner) per ounce. Assuming equal effectiveness per ounce, the price range for alternative products was lower than price range for products containing TCE.

Cal-Blast and Simple Green Foaming Coil Cleaner- non-aerosol had fewer than 10 reviews. Ratings for products containing TCE and methylene chloride ranged from 4.4 (Nu-Blast Aerosol) to 5 (Cal-Blast), with an average rating of 4.7. Ratings for alternative products ranged from 3.7 to 4.6 with an average rating of 4.2. The average customer rating for alternative products was slightly lower than that of products with TCE. However, the average rating of alternative products was over 4, indicating overall customer satisfaction with these products.

Table 5-15: Pricing and Customer Review Information for AC Coil Cleaners Based on Manufacturer and Retailer Web Pages

Supplier	Product	Retail information	Price per ounce	Number of Customer Reviews	Customer ratings (out of 5)
Parker Hannifin Corporation	Blast-A-Coil	https://www.ptacsolutions.com/Parker-Hannifin-Virginia-KMP-BAC20-475248-Blast-A-Coil-CLEANER-Case-of-18-oz-Spray-Cans-Case-of-12-Cans--Sold-only-by-the-case-not-sold-individually_p_26822.html	$1.40	None	None
Nu-Calgon	Nu-Blast Aerosol	https://www.amazon.com/Nu-Calgon-4290-75-18-ounce-Condenser/dp/B00HWMXGZA	$1.52	25	4.4
Nu-Calgon	Cal-Blast	https://www.amazon.com/Nu-Calgon-4132-20-Cal-Blast-Condenser-Cleaner/dp/B01FBXMI1O	$0.99	5	5
Nu-Calgon	Evap Foam No Rinse Aerosol	https://www.amazon.com/Nu-Calgon-4171-75-Rinse-Evaporator-Cleaner/dp/B00DM8KQ3I	$0.61	6099	4.6
CRC	Foaming Coil Cleaner	https://www.amazon.com/CRC-Foaming-Cleaner-Aerosol-Yellow/dp/B009YO1FFM	$0.53	545	4.4
Nu-Calgon	Evap Pow'r C (4168)	https://www.amazon.com/Nu-Calgon-4168-08-Evap-Rinse-Cleaner/dp/B000R7ZS08	$0.26	351	4.4
Nu-Calgon	Blackhawk Foaming Coil Cleaner	https://www.amazon.com/Nu-Calgon-4127-75-Coil-Cleaner/dp/B00UNRCQQQ	$0.90	24	4
Sunshine Makers, Inc.	Simple Green Foaming Coil Cleaner- non-aerosol	https://www.amazon.com/SIMPLE-GREEN-Condenser-Evaporator-Cleaner/dp/B01LZHDQGW	$0.28	6	3.7
Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.					

5.5.5 Conclusion

The market review of AC coil cleaners included one product containing TCE, one product containing methylene chloride and five products containing a variety of alternative solvents. Barriers were not found for fire safety, pricing, or customer satisfaction that may be caused by restricting use of TCE in this product category. VOCs were more difficult to compare, as none of the products containing TCE and most of the alternative products lacked VOC information in their SDSs. However, two of the alternative products had VOC content close to or lower than 10%, showing that there are alternative low VOC options on the market. Most of the alternative products reviewed were rated non-flammable. The price range for alternative products was lower than price range for products containing TCE. Average customer ratings of alternative products were slightly lower than that of products containing TCE. Customer satisfaction was still high for alternative product ratings, as average ratings were over 4 out of 5 stars. In summary, based on the factors considered in this review, alternatives that appear to be technologically and economically feasible for users are available for TCE for this product category.

5.6 Liquid Cleaners and Degreasers and Aerosol Spray Cleaning/Degreasing: Energized Electrical Equipment Degreasers

Energized electrical equipment degreasers and cleaners are used to remove dust, dirt, grease, and oxidation from electronic components that are energized while they are being cleaned or may be energized before the solvent evaporates. These products are like general electronic degreasers but are formulated to have high flash points and high dielectric strength (maximum electric field that the cleaner can withstand before insulating properties break down). The product search yielded limited results for products labeled for specialized use on energized equipment, and there is some overlap with products in the electronics degreasers product category (CRC's Electrical Parts Cleaner). Products are sold in aerosol (around 12 - 19 ounces) and liquid form (1 gallon or more), both represented in the product review.

5.6.1 Solvent Ingredients

The review included one product with TCE and two products with perchloroethylene. EPA also reviewed two products containing alternative solvents, including trans-DCE and methylcyclohexane. Table 5-16 shows the list of products reviewed for this analysis and their primary solvent ingredients.

Table 5-16: Safety Data Sheets and Solvent Ingredients with Concentrations 5% or Higher for Reviewed Energized Electrical Equipment Degreasers

Supplier	Product	SDS	SDS date	Solvent ingredients	Concentration (%)
Berryman	Energized Electrical Parts Cleaner	https://www.berrymanproducts.com/assets/5B-1520-1540-SDS-R02.pdf	22 December 2020	Trichloroethylene	>90
CRC	Lectra Clean Heavy Duty Energized Electrical Parts Degreaser	http://docs.crcindustries.com/msds/1003182E.pdf	01 November 2017	Perchloroethylene	90 - 100
CRC	Electrical Parts Cleaner	http://docs.crcindustries.com/msds/1003236E.pdf	25 October 2017	Perchloroethylene	90 - 100
Chemtronics	Pow-R-Wash CZ	https://www.chemtronics.com/content/msds/ES7300,%20ES7308_United%20States%20(US)%20SDS%20HCS%202012_English%20(US).pdf	1 July 2019	Trans DCE	≥10 - ≤25
				Methylcyclohexane	≤5
Chemtronics	Pow-R-Wash Delta	https://www.chemtronics.com/content/msds/DEL1681_ISS%20SDS%20GHS%20United%20States%20(US)%20-%20HCS%202012%20V4.4_English%20(US).pdf	4 May 2015	Trans DCE	10 - 15

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

Table 5-17 shows the anticipated, approximate market share percentage of primary solvents used in products estimated using the chemical ranking procedure. Perchloroethylene is currently the most used solvent in energized electrical equipment degreaser products. If restrictions were implemented for TCE, then it is anticipated that trans-DCE and methylcyclohexane would be the most prevalent solvents used in replacement products.

Table 5-17: Estimated Percentage Share of Solvent Ingredients for Reviewed Energized Electrical Equipment Degreasers

Solvent	Current market share	Projected after restrictions
Trichloroethylene	25%	0%
Perchloroethylene	65%	0%
Trans DCE with Methylcyclohexane	10%	100%
Other	0%	0%
Notes: The figures shown here are based on a proxy chemical ranking procedure, which draws upon factors including concentration in the product and availability and quality of product reviews. Orange shading indicates TCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals.		

5.6.2 Volatile Organic Compounds (VOC) Content

EPA reviewed VOC information in product SDSs and summarized the findings in Table 5-18. No regulatory VOC limits were identified specific for energized electrical equipment degreasers; however, regulatory VOC limits were identified for electronics cleaners in several states (75%). The two products containing perchloroethylene, Lectra Clean Heavy Duty Energized Electrical Parts Degreaser and Electrical Parts Cleaner, had 0% VOC, and Energized Electrical Parts Cleaner containing TCE contained less than 90% VOC. The two alternative products did not have VOC data in their SDSs. Therefore, more research is needed to understand how availability of low VOC products on the market may be affected with restrictions on TCE in this product category.

Table 5-18: VOC Content for Energized Electrical Equipment Degreasers Based on Information in SDSs or Technical Data Sheets

Supplier	Product	VOC (% weight, g/L)
Berryman	Energized Electrical Parts Cleaner	>90%
CRC	Lectra Clean Heavy Duty Energized Electrical Parts Degreaser	0%
CRC	Electrical Parts Cleaner	0%
Chemtronics	Pow-R-Wash CZ	No information in SDS
Chemtronics	Pow-R-Wash Delta	No information in SDS
Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.		

5.6.3 Fire Safety

EPA reviewed flash points and flammability ratings in product SDSs and summarized the findings in Table 5-19. All five of the products reviewed were rated non-flammable. Restricting TCE in this product category is unlikely to affect non-flammable options currently on the market as energized electrical degreasers are formulated to have non-flammable properties.

Table 5-19: Flash Point and Flammability Ratings for Energized Electrical Equipment Degreasers Based on Information in SDSs or Technical Data Sheets

Supplier	Product	Flash Point	Flammability Rating
Berryman	Energized Electrical Parts Cleaner	None	Non-flammable
CRC	Lectra Clean Heavy Duty Energized Electrical Parts Degreaser	None	Non-flammable
CRC	Electrical Parts Cleaner	None	Non-flammable
Chemtronics	Pow-R-Wash CZ	None	Non-flammable
Chemtronics	Pow-R-Wash Delta	>199.9° F (>93.3° C)	Non-flammable
Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.			

5.6.4 Pricing and Customer Reviews

EPA accessed pricing and customer review information on publicly available websites in August and May 2022 and summarized the findings in Table 5-20. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Pricing for products containing TCE or perchloroethylene ranged from $0.57 (Energized Electrical Parts Cleaner) to $2.31 per ounce (Lectra Clean Heavy Duty Energized Electrical Parts Degreaser). Pricing for alternative products ranged from $2.74 (Pow-R-Wash Delta) to $5.63 (Pow-R-Wash CZ) per ounce. The price range for alternative products was higher than the price range for products containing TCE.

It was not possible to compare customer satisfaction between products containing TCE and alternative products, as only two products, both containing perchloroethylene or TCE had customer review information. Electrical Parts Cleaner had an average rating of 4.3, and Energized Electrical Parts Cleaner had a rating of 5 (product had fewer than 10 reviews).

Table 5-20: Pricing and Customer Review Information for Energized Electrical Equipment Degreasers Based on Manufacturer and Retailer Web Pages

Supplier	Product	Retail information	Price per ounce	Customer ratings (out of 5)	Number of customer reviews
Berryman	Energized Electrical Parts Cleaner	https://www.amazon.com/Berryman-Products-1540-Energized-Electric/dp/B072JSKVD2	$0.57	5	4
CRC	Lectra Clean Heavy Duty Energized Electrical Parts Degreaser	https://www.amazon.com/CRC-02020CS-Energized-Electrical-Degreaser/dp/B01MYFCVIO	$2.31	None	None
CRC	Electrical Parts Cleaner	https://www.amazon.com/CRC-Electrical-Liquid-Cleaner-Aerosol/dp/B000P1HKFW	$0.96	4.3	55
Chemtronics	Pow-R-Wash CZ	https://www.chemtronics.com/pow-r-wash-cz	$5.63	None	None
Chemtronics	Pow-R-Wash Delta	https://www.chemtronics.com/pow-r-wash-delta-2	$2.74	None	None

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

5.6.5 Conclusion

The review included one product containing TCE, two products containing perchloroethylene, and two products containing alternative solvents. No barriers were found around fire safety which may be caused by restricting use of TCE in this product category, as energized electrical degreasers are formulated to have non-flammable properties. It was not possible to compare VOC or customer satisfaction due to lack of information for alternative products. The price range for alternative products was higher than the price range for products containing TCE which may be a barrier. However, the review was limited, and there may more affordable electronics degreasers on the market that can be used on energized equipment, like CRC's Electrical Parts Cleaner, that use alternative solvents.

5.7 Lubricants and Greases

Lubricants are used on metals to reduce friction, clean, and/ or protect against corrosion and rust. There are many types of lubricants on the market ranging for specialized uses, such as anti-seize and wire lubricants, to more general use lubricants, such as multi-purpose lubricants and penetrants. Products are sold in liquid, liquid spray, and aerosol form. Many lubricants are available for commercial and consumer use; however, these are likely available in larger quantities for industrial use as well. The review focuses on multi-purpose lubricants and penetrants in liquid spray or aerosol form in volumes from 11 to 14 ounces.

5.7.1 Solvent Ingredients

The review included products with perchloroethylene and TCE. Four products were also reviewed containing alternative solvents, including heptane, LVP Aliphatic Hydrocarbon, C9-11-iso-alkanes, petroleum distillates, and others. Table 5-21 shows the list of products reviewed for this analysis and their primary solvent ingredients.

Table 5-21: Safety Data Sheets and Solvent Ingredients with Concentrations 5% or Higher for Reviewed Multi-Purpose Lubricants

Supplier	Product	SDS	SDS date	Solvent ingredients	Concentration (%)
Zep	Zep 45	https://zsds3.zepinc.com/ehswww/zep/result/direct_link.jsp?P_LANGU=E&P_SYS=2&P_SSN=11337&C001=MSDS&C002=US&C003=E&C013=17401&C123=SDS*	18 June 2018	Trichloroethylene	≥30 - < 50
				Distillates (petroleum), hydrotreated heavy naphthenic	≥20 - < 30
				Distillates (petroleum), straight-run middle	≥5 - < 10
				2-(2-butoxyethoxy) ethanol	≥1 - < 5
Sprayway	L2 Moisture Displacer Deep Penetrant	https://www.spraywayinc.com/sites/all/themes/theme687/msds/sw290.pdf	09 December 2019	Perchloroethylene	50 - <100%
CRC	Dry Graphite Lube	https://docs.crcindustries.com/MSDS/3094.pdf	13 December 2017	Heptane	30 - 40
				Isopropyl alcohol	20 - 30
				n-heptane	10 - 20
WD-40	WD-40 Multi-Use Product Aerosol	https://images.thdstatic.com/catalog/pdfImages/df/dfea3209-9e1f-4185-a596-6a59a2f17ff9.pdf	5 March 2019	LVP Aliphatic Hydrocarbon	45-50
B'laster	Silicone Lubricant	https://blasterproducts.com/wp-content/uploads/2018/04/SL-Silicone-Lubricant-Aerosol-EN-OSHA-GHS-SDS-2020-10-20.pdf	20 October 2020	Alkanes, C9-11-iso-	30 - 60
				Petroleum distillates, hydrotreated light	15 - 40
Super Lube	Super Lube Multi-Purpose Synthetic Lubricant	https://images.thdstatic.com/catalog/pdfImages/a1/a107e724-a1f8-465b-80f1-a0f67e6086ff.pdf	14 August 2019	Distillates (petroleum), hydrotreated light	50 - 75

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

Table 5-22 shows the anticipated, approximate market share percentage of primary solvents used in products estimated using the chemical ranking procedure. Petroleum distillates is currently the most used solvent in lubricants. If restrictions were implemented for TCE, then it is anticipated that petroleum distillates would be the most prevalent solvent used in replacement products.

Table 5-22: Estimated Percentage Share of Solvent Ingredients for Reviewed Multi-Purpose Lubricants

Solvent	Current market share	Projected after restrictions
Trichloroethylene	11%	0%
Perchloroethylene	24%	0%
Petroleum distillates	49%	75%
Heptane	7%	10%
Isopropyl alcohol	5%	8%
Other	4%	7%
Total	100%	100%

Notes: The figures shown here are based on a proxy chemical ranking procedure, which draws upon factors including concentration in the product and availability and quality of product reviews. Orange shading indicates TCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals.

5.7.2 Volatile Organic Compounds (VOC) Content

EPA reviewed VOC information in product SDSs and summarized findings in Table 5-23. EPA identified VOC limits for several lubricant types in several states, including multipurpose (25 - 50%) and silicone multipurpose lubricants (60%) excluding dry lubricants (such as CRC's Dry Graphite Lube), and penetrants (25 - 50%). The two products containing perchloroethylene and TCE did not have VOC data in their SDSs. Only two of the alternative products had VOC content information. Dry Graphite Lube and Silicone Lubricant had high VOC content at 97.9% and WD-40 Multi-Use Product Aerosol had lower VOC content around 24%. VOC content could not be compared between products containing perchloroethylene and TCE with alternative products due to lack of VOC data for alternatives. At least one lubricant product (WD-40 Multi-Use Product Aerosol meets VOC requirements, but more research is needed to fully determine if low VOC alternatives are available.

Table 5-23: VOC Content for Multi-Purpose Lubricants Based on Information in SDSs or Technical Data Sheets

Supplier	Product	VOC (% weight, g/L)
Zep	Zep 45	No information in SDS
Sprayway	L2 Moisture Displacer Deep Penetrant	No information in SDS
CRC	Dry Graphite Lube	97.9%
WD-40	WD-40 Multi-Use Product Aerosol	24.1%
B'laster	Silicone Lubricant	No information in SDS
Super Lube	Super Lube Multi-Purpose Synthetic Lubricant	No information in SDS

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

5.7.3 Fire Safety

Flash points and flammability ratings in product SDSs were reviewed and summarized findings are in Table 5-24. The six products reviewed had mixed flammability ratings. The two products containing perchloroethylene and TCE, L2 Moisture Displacer Deep Penetrant and Zep 45 had ratings of combustible and non-flammable respectively. Two of the alternative products are aerosols and were rated extremely flammable (Dry Graphite Lube and Super Lube Multi-Purpose Synthetic Lubricant) and two were rated combustible. It is unclear how restriction of TCE in this product category will affect fire safety, which depends, in part, on whether products utilize aerosol delivery. The review shows one non-flammable option and one combustible option that would be eliminated, leaving behind combustible and extremely flammable options. The review was limited and may not have captured the alternative products with the lowest flammability ratings available.

Table 5-24: Flash Point and Flammability Ratings for Multi-Purpose Lubricants Based on Information in SDSs

Supplier	Product	Flash Point	Flammability Rating
Zep	Zep 45	Not applicable	Non-flammable
Sprayway	L2 Moisture Displacer Deep Penetrant	>106 °F (> 41 °C)	Combustible
CRC	Dry Graphite Lube	-20.2 °F (-29 °C)	Extremely flammable, aerosol
WD-40	WD-40 Multi-Use Product Aerosol	138 °F (59 °C)	Combustible
B'laster	Silicone Lubricant	130 °F (54 °C)	Combustible
Super Lube	Super Lube Multi-Purpose Synthetic Lubricant	No information in SDS	Extremely flammable, aerosol
Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.			

5.7.4 Pricing and Customer Reviews

Pricing and customer review information was assessed on publicly available websites in May 2022 and a summary of the findings are in Table 5-25. To assist in comparing the prices across various products and product sizes, the prices were normalized to price per ounce. Pricing for products containing perchloroethylene and TCE ranged from $1.08 (L2 Moisture Displacer Deep Penetrant) to $1.21 per ounce (Zep 45). Pricing for alternative products ranged from $0.41 (Silicone Lubricant) to $1.10 (Dry Graphite Lube) per ounce. Three alternative products (Silicone Lubricant, WD-40, and Super Lube) had lower prices than any of the products containing TCE.

All products in the review had customer reviews. The ratings for products containing perchloroethylene and TCE ranged from 4.1 (L2 Moisture Displacer Deep Penetrant, note this product had fewer than 10 reviews) to 4.8 (Zep 45) with an average rating of 4.5. Customer ratings for alternative products ranged from 3.9 (WD-40 Multi-Use Product Aerosol) to 4.9 (Super Lube Multi-Purpose Synthetic Lubricant) with an average of 4.6. Based on the similar average customer ratings for both groups of products, products containing alternative solvents may have similar customer satisfaction as products containing TCE.

Table 5-25: Pricing and Customer Review Information for Multi-purpose Lubricants Based on Manufacturer and Retailer Web Pages

Supplier	Product	Retail information	Price per ounce	Customer ratings (out of 5)	Number of customer reviews
Zep	Zep 45	https://www.amazon.com/Zep-Lubricant-Penetrant-Aerosol-374301/dp/B082Q6DNLV	$1.21	4.8	34
Sprayway	L2 Moisture Displacer Deep Penetrant	https://www.amazon.com/Sprayway-SW290-Moisture-Displacer-Penetrant/dp/B001JN0VIS	$1.08	4.1	3
CRC	Dry Graphite Lube	https://www.amazon.com/CRC-Graphite-Lube-Aerosol-Black/dp/B007I9XUD0	$1.10	5	908
WD-40	WD-40 Multi-Use Product Aerosol	https://www.homedepot.com/p/WD-40-12-oz-Multi-Use-Product-Multi-Purpose-Lubricant-Spray-with-Smart-Straw-49005/204777420	$0.46	3.9	451
B'laster	Silicone Lubricant	https://www.homedepot.com/p/Blaster-11-oz-B-laster-Silicone-Lubricant-16-SL/202529794	$0.41	4.5	168
Super Lube	Super Lube Multi-Purpose Synthetic Lubricant	https://www.homedepot.com/p/Super-Lube-11-oz-Aerosol-31110/202932707	$0.63	4.9	51
Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.					

5.7.5 Conclusion

The review focused only on multi-purpose lubricants and penetrants in liquid spray or aerosol form and included one product containing TCE, one product containing perchloroethylene, and four products containing alternative solvents. There were no barriers found around pricing and customer satisfaction. VOC was unable to be compared due to lack of VOC information in SDSs for products containing perchloroethylene and TCE. For fire safety, the non-aerosol alternatives are combustible which may be acceptable replacements for product containing TCE. Three alternative products (Silicone Lubricant, WD-40, and Super Lube) had lower prices than the product containing TCE. Average customer satisfaction ratings were similar between the product with TCE and products using alternative solvents.

5.8 Adhesives, Sealants, Paints and Coatings: Adhesives

An adhesive is a formulated product that binds two objects together and can be applied to one or both surfaces of the two initially separate objects. Adhesives are often referred to as "glue," "paste," or "cement." There are many methods for curing adhesives. These include evaporative drying for solvent-based adhesives, cooling for hot melt adhesives, contact, and light pressure for pressure sensitive adhesives. Factors affecting choice of adhesive product include drying time, cure time, bond strength, substrate compatibility, application temperature, and interior/exterior use.

The product category is vast and diverse; there are many adhesives on the market formulated for different purposes, substrates, application methods, and users. The *Chemical Economics Handbook* divides adhesives into five categories -- water emulsions, hot-melts, solvent-based, reactive, and natural polymers. (IHS Markit 2019) It is beyond the scope of this analysis to investigate products for each adhesive application. Instead, the analysis includes two general purpose adhesives (high strength mist spray adhesive and high strength non-spray adhesive) and one specific purpose adhesive (for acrylic substrate). The results for these types of adhesives may or may not be representative for other adhesive applications.

5.8.1 Solvent Ingredients

The review included one product containing both TCE and methylene chloride, one product containing methylene chloride, and one product containing perchloroethylene. Four products containing alternative solvents, including methyl acetate, toluene, acetone, and others were also reviewed. Table 5-26 shows the list of products reviewed for this analysis and their primary solvent ingredients.

Table 5-26: Safety Data Sheets and Solvent Ingredients with Concentrations 5% or Higher for Reviewed Adhesives

Supplier	Product	Application	SDS	SDS date	Solvent ingredients	Concentration (%)
IPS	Weld On #3 Acrylic Plastic Cement	Acrylic	https://www.acplasticsinc.com/media/Weld-On%203%20SDS.pdf	6 May 2015	Methylene Chloride	75 - 90
					Trichloroethylene	5 - 15
3M	3M™ Hi-Strength Non-Flammable 98NF Bulk Adhesive	High strength spray	https://multimedia.3m.com/mws/mediawebserver?mwsId=SSSSSuUn_zu8l00xM82SNY_Bnv70k17zHvu9lxtD7SSSSS--	5 August 2019	Methylene Chloride	60 - 85
E6000	E6000 MV clear industrial strength adhesive	High strength non-spray	https://images.thdstatic.com/catalog/pdfImages/c3/c362ff98-8080-4009-984e-3cf4c0cde7db.pdf	6 May 2020	Perchloroethylene	≥50 - ≤72
3M	Scotch-Weld Low Odor Acrylic Adhesive DP8810N	Acrylic	https://multimedia.3m.com/mws/mediawebserver?mwsId=SSSSSuUn_zu8l00xm8txoxmZlv70k17zHvu9lxtD7SSSSSS--	11 November 2019	Dibenzoate Propanol	80
Gorilla	Heavy Duty Spray Adhesive	High strength spray	https://gorillaglue.com.au/wp-content/uploads/Gorilla-Spray-Adhesive-1.pdf	24 February 2019	Methyl acetate	10 - 30
					Acetone	10 - 30
					Cyclohexane	10 - 30
Homax	All Purpose Adhesive Industrial Strength Welder	High strength non-spray	https://bigcatrescue.org/wp-content/uploads/2014/04/Household-Welder.pdf	21 March 2006	Toluene	30 - 60
Henkel	Loctite Professional Performance Spray Adhesive	High strength spray	https://dm.henkel-dam.com/is/content/henkel/sds-us-loctite-spray-adhesive-professional-performance	7 November 2018	Acetone	30 - 60
					Methyl acetate	5 - 10
					Naphtha, petroleum, hydrotreated light	5 - 10
					Parachlorobenzotrifluoride	5 - 10
					n-Heptane	5 - 10
					Methylcyclohexane	5 - 10

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

Table 5-27 shows the anticipated, approximate market share percentage of primary solvents used in products estimated using the chemical ranking procedure. If restrictions were implemented for TCE, then it is anticipated that acetone would be the most prevalent solvent used in replacement products. In addition, a process change (e.g., adoption of a hot-melt technology) may be an option in some cases. There are several solvents used in alternative products that contain GreenScreen Benchmark 1 chemicals such as toluene and Parachlorobenzotrifluoride.[9] These Benchmark 1 solvents are potential regrettable substitutions for TCE. There are numerous commercially available alternative products for adhesive products without Benchmark 1 solvents.

Table 5-27: Estimated Percentage Share of Solvent Ingredients for Reviewed Adhesive Applications Only

Solvent	Current market share	Projected after restrictions
Trichloroethylene	2%	0%
Methylene Chloride	32%	0%
Perchloroethylene	13%	0%
Acetone	15%	28%
Dibenzoate propanol	12%	24%
Methyl acetate	8%	15%
Toluene	7%	13%
Cyclohexane	4%	8%
Other	6%	12%

Notes: The figures shown here are based on a proxy chemical ranking procedure, which draws upon factors including concentration in the product and availability and quality of product reviews. Orange shading indicates TCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals.

5.8.2 Volatile Organic Compounds (VOC) Content

The VOC information was reviewed in product SDSs and summarized findings are in Table 5-28. The VOC limit for mist spray adhesives is 30% in California and 65% for many other states. The VOC limit for general purpose adhesives is 10% for the EPA and many states. A VOC limit for acrylic specific adhesives was not identifiable, e.g., Weld On #3 Acrylic Plastic Cement.

Two of the products containing methylene chloride and TCE had VOC content data available: 3M Hi-Strength Non-Flammable 98NF Bulk Adhesive (0 g/L) and Weld On #3 Acrylic Plastic Cement (> 250 g/L). The 3M Hi-Strength Non-Flammable 98NF Bulk Adhesive product would meet the VOC limit for general purpose adhesives. Two alternative products had VOC content information: Loctite Professional Performance Spray Adhesive (38.8%), and 3M Scotch-Weld Low Odor Acrylic Adhesive DP8810N (59.4 g/L). The Loctite Professional Performance Spray Adhesive would meet the VOC limit for spray adhesives in all states except California. VOC content information was not available for the other two alternative products (Gorilla and Homax).

[9] GreenScreen for Safer Chemicals is a method for chemical hazard assessment designed to identify chemicals of high concern and safer alternatives. Each chemical evaluated under GreenScreen is assigned a Benchmark between 1 and 4, with each increasing Benchmark defining progressively safer chemicals. See GreenScreen® Method | GreenScreen® For Safer Chemicals (greenscreenchemicals.org), https://www.greenscreenchemicals.org/learn/full-greenscreen-method.

Table 5-28: VOC Content for Adhesives Based on Information In SDSs or Technical Data Sheets

Supplier	Product	VOC (% weight, g/L)
IPS	Weld On #3 Acrylic Plastic Cement	250 g/L
3M	3M Hi-Strength Non-Flammable 98NF Bulk Adhesive	VOC Less H2O & Exempt Solvents: 0 g/L
E6000	E6000 MV clear industrial strength adhesive	No information in SDS
3M	Scotch-Weld Low Odor Acrylic Adhesive DP8810N	59.4 g/L
Gorilla	Heavy Duty Spray Adhesive	No information in SDS
Homax	All Purpose Adhesive Industrial Strength Welder	No information in SDS
Henkel	Loctite Professional Performance Spray Adhesive	38.8%
Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.		

5.8.3 Fire Safety

The flash points and flammability ratings in product SDSs were reviewed and summarized findings are in Table 5-29. The product containing TCE and methylene chloride was rated non-flammable. The alternative products were rated non-flammable, flammable, or extremely flammable. Restricting TCE in this product categories may limit non-flammable options currently on the market. However, this product review was limited, and other non-flammable adhesive options are likely to be available for other adhesive types.

Table 5-29: Flash Point and Flammability Ratings for Adhesives Based on Information in SDSs Or Technical Data Sheets

Supplier	Product	Flash Point	Flammability Rating
IPS	Weld On #3 Acrylic Plastic Cement	None	Non-flammable
3M	3M Hi-Strength Non-Flammable 98NF Bulk Adhesive	No flash point	Non-flammable
E6000	E6000 MV clear industrial strength adhesive	>230° F (>110° C)	Non-flammable
3M	Scotch-Weld Low Odor Acrylic Adhesive DP8810N	> 200 F	Non-flammable
Gorilla	Heavy Duty Spray Adhesive	-155° F (-104° C)	Extremely flammable
Homax	All Purpose Adhesive Industrial Strength Welder	45 °F (7° C)	Flammable
Henkel	Loctite Professional Performance Spray Adhesive	-155° F (-104° C)	Extremely flammable
Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.			

5.8.4 Pricing and Customer Reviews

Pricing and customer review information was assessed on publicly available websites in August 2021 and a summary of the findings is in Table 5-30. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Reviewed products ranged widely in volume from two ounces (E6000 MV clear industrial strength adhesive and All Purpose Adhesive Industrial Strength Welder) to 54 gallons (3M Hi-Strength Non-Flammable 98NF Bulk Adhesive).

Pricing for products containing TCE, methylene chloride and perchloroethylene ranged from $0.43 (3M Hi-Strength Non-Flammable 98NF Bulk Adhesive; note that this product volume was 54 gallons) to $4.24 per ounce. Pricing for alternative products ranged from $0.68 (Heavy Duty Spray Adhesive) to $4.55 (All Purpose Adhesive Industrial Strength Welder) per ounce. The price range for alternative products had considerable overlap with products containing TCE, methylene chloride and perchloroethylene.

Two of the products containing TCE, methylene chloride and perchloroethylene had reviews of 4.7 (E6000 MV clear industrial strength adhesive) and 4.6 (Weld On #3 Acrylic Plastic Cement) with an average rating around 4.7. Ratings for alternative products ranged from 3.5 to 5.0 with an average rating of 4.4. The average customer ratings for alternative products were slightly lower than those of products with TCE. However, the average rating of alternative products was 4.4, indicating overall customer satisfaction with these products.

Table 5-30: Pricing and Customer Review Information for Adhesives Based on Manufacturer and Retailer Web Pages

Supplier	Product	Retail information	Price per ounce	Customer ratings (out of 5)	Number of customer reviews
IPS	Weld On #3 Acrylic Plastic Cement	https://www.amazon.com/Weld-Acrylic-Plastic-Cement-Applicator/dp/B0149IG548	$4.22	4.6	826
3M	3M Hi-Strength Non-Flammable 98NF Bulk Spray Adhesive	https://www.amazon.com/3M-Scotch-Weld-98NF-Spray-Adhesive/dp/B0046VQQBG	$0.43	None	None
E6000	E6000 MV clear industrial strength adhesive	https://www.homedepot.com/p/E6000-2-fl-oz-Clear-Adhesive-237032/203279322	$4.24	4.7	4,523
3M	Scotch-Weld Low Odor Acrylic Adhesive DP8810N	https://www.amazon.com/3M-Scotch-Weld-Acrylic-Adhesive-DP8810NS/dp/B00IOQ6W0E	$1.13	5.0	2
Gorilla	Heavy Duty Spray Adhesive	https://www.amazon.com/dp/B0752XM8VN	$0.68	4.5	5,390
Homax	All Purpose Adhesive Industrial Strength Welder	https://www.amazon.com/Purpose-Adhesive-Industrial-Strength-Welder/dp/B074M7BW62	$4.55	4.7	170
Henkel	Loctite Professional Performance Spray Adhesive	https://www.homedepot.com/p/Loctite-Professional-Performance-13-5-oz-Spray-Adhesive-1629134/205506865	$0.73	3.5	10

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

5.8.5 Conclusion

The market review of adhesives was limited to three representative types of adhesives. The review included one product containing methylene chloride, one product containing both TCE and methylene chloride, one product containing perchloroethylene, and several products containing alternative solvents. At least one alternative product would meet the VOC limit for spray adhesives in all states except California. Restricting TCE in the adhesives reviewed here may potentially limit non-flammable options currently on the market. However, the product review was limited, and other non-flammable adhesive options may be available. In addition, the review did not include non-solvent-based adhesive technologies which may be adopted through a process change. The price range for alternative products had considerable overlap with products containing trichlorethylene. Average customer ratings of alternative products were slightly lower than that of products containing TCE. Customer satisfaction was still high for alternative product ratings, as average ratings were 4.4 out of 5 stars.

5.9 Adhesives, Sealants, Paints and Coatings: Cold pipe insulation

Cold pipe insulation products are aerosols or paints used on "cold pipes," such as air conditioning lines, refrigeration lines, to create a moisture barrier and eliminate condensation buildup resulting in sweating and dripping. Sprays are typically used in hard-to-reach areas or odd shaped fittings. There seems to be a limited market for these sprays and paints, as EPA identified few products to review. There are many other methods and products used to insulate cold pipes available, particularly for lengths of straight pipe, including flexible foam and mineral fiber insulation. Most products identified were sold in 15-ounce aerosol cans. However, this analysis also included two paint-on products available in liquid form and larger volumes as potential alternatives.

5.9.1 Solvent Ingredients

EPA's review of cold pipe insulation products identified four cold pipe insulation products containing TCE and one product containing methylene chloride. EPA also reviewed one product containing alternative solvents, though limited information was available on the composition of this product. Table 5-31 shows the list of products reviewed for this analysis and their primary solvent ingredients.

Table 5-31: Safety Data Sheets and Solvent Ingredients with Concentrations 5% or Higher for Reviewed Cold Pipe Insulation Products

Supplier	Product	SDS	SDS date	Solvent ingredients	Concentration (%)
Brodi Specialty Products	Pipe Wrap	https://www.brodi.com/index.php?route=product/sds/download&sds_id=276	08 June 2020	Trichloroethylene	30 - 60
CPC	Terand Cold Pipe Insulation	https://www.techno-ms.com/mt-content/uploads/2016/08/770-sds-cold-pipe.pdf	07 June 2015	Trichloroethylene	40 - 60
Creative Chemical	Anti-Sweat 2.0 Cold Pipe Insulator Spray	https://www.adcosupplies.com/index.php/product/anti-sweat-2-0-cold-pipe-insulation-spray-can/?attachment_id=8879&download_file=uiqar20z5v5um	28 July 2020	Trichloroethylene	25 - 50
Sprayway	Sprayway Cold Pipe Insulation	https://www.spraywayinc.com/sites/all/themes/theme687/msds/sw620.pdf	19 Nov 2020	Trichloroethylene	25 - <50
Quest Specialty Corporation	Surround Cold Pipe Insulation Spray	http://questspecialty.com/sds/5880_SDS_QS.pdf	07 February 2017	Methylene Chloride	30 - 60
Robson Thermal	No-Sweat FX	https://www.dropbox.com/s/78pgtept3rud8gt/No%20Sweat%20FX%20MSDS%20long%20form.pdf?dl=0	3 September 2019	Water-based https://www.dropbox.com/s/cnrq7jxhkz8pxu0/data%20sheet-no%20sweat-fx%20logo.pdf	Not available

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

Table 5-32 shows the estimated approximate market share percentage of primary solvents used in products estimated using the chemical ranking procedure. Water and TCE are currently the most used solvents in cold pipe insulation products. For this analysis EPA assumes that replacement products will not be formulated with priority chemicals with completed final risk evaluations. Thus, it is anticipated that water would be the most prevalent solvent used in replacement products.

Table 5-32: Estimated Percentage Share of Solvent Ingredients for Reviewed Cold Pipe Insulation Products

Solvent	Current market share	Projected after restrictions
Trichloroethylene	38%	0%
Methylene Chloride	19%	0%
Water	43%	100%
Other	0%	0%
Notes: The figures shown here are based on a proxy chemical ranking procedure, which draws upon factors including concentration in the product and availability and quality of product reviews. Orange shading indicates TCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals.		

5.9.2 Volatile Organic Compounds (VOC) Content

EPA reviewed VOC information in product SDSs and summarized findings in Table 5-33. No regulatory VOC limits for cold pipe insulation products were identified. Two of the products containing TCE and methylene chloride had VOC content data available: Terand Cold Pipe Insulation (87.8%) and Surround Cold Pipe Insulation Spray (32%). Only one alternative product had VOC content information: No-Sweat FX (60 g/ L). The density of the No Sweat FX product is not provided in the SDS, but it can be assumed that the density is approximately 1,000 g per litre since it is a water-based product. Therefore, the 60 g/L VOC content can be estimated as approximately 6% VOC which is much less than the VOC content for the Terand Cold Pipe Insulation (87.8%) and Surround Cold Pipe Insulation Spray (32%) products.

Table 5-33: VOC Content for Cold Pipe Insulation Products Based on Information in SDSs or Technical Data Sheets

Supplier	Product	VOC (% weight, g/L)
Brodi Specialty Products	Pipe Wrap	No information in SDS
CPC	Terand Cold Pipe Insulation	87.8% estimated
Creative Chemical	Anti-Sweat 2.0 Cold Pipe Insulator Spray	No information in SDS
Sprayway	Sprayway Cold Pipe Insulation	No information in SDS
Quest Specialty Corporation	Surround Cold Pipe Insulation Spray	32%
Robson Thermal	No-Sweat FX	60 g/ L
Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.		

5.9.3 Fire Safety

EPA reviewed flash points and flammability ratings in product SDSs and summarized findings in Table 5-34. All five of the products containing TCE were rated extremely flammable. The anti-condensation coating, No-Sweat FX was rated non-flammable, and Permaseal Damp Proof Paint had no fire safety information in the SDS. Restricting TCE in this product category is unlikely to affect non-flammable options currently on the market. However, the cold pipe insulator product market seems to lack non-flammable options overall.

Table 5-34: Flash Point and Flammability Ratings for Cold Pipe Insulation Products Based on Information in SDSs or Technical Data Sheets

Supplier	Product	Flash Point	Flammability Rating
Brodi Specialty Products	Pipe Wrap	-156 °F (-104.4 °C)	Extremely flammable
CPC	Terand Cold Pipe Insulation	-156 °F (-104.4 °C)	Extremely flammable
Creative Chemical	Anti-Sweat 2.0 Cold Pipe Insulator Spray	Estimated -156 °F (-104.4 °C)	Extremely flammable
Sprayway	Sprayway Cold Pipe Insulation	-156 °F (-104.4 °C)	Extremely flammable
Quest Specialty Corporation	Surround Cold Pipe Insulation Spray	Not determined	Flammable aerosol
Robson Thermal	No-Sweat FX	Not applicable	Non-flammable
Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.			

5.9.4 Pricing and Customer Reviews

EPA accessed pricing and customer review information on publicly available websites in August 2021 and the summarized findings are in Table 5-35. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. The methylene chloride cold pipe insulation spray was less expensive compared to the TCE containing products ($0.53 versus costs up to $2.35 per ounce). However, the alternative water-based product was similar in price to the methylene chloride product (also $0.53 per ounce).

Overall, it was difficult to compare customer satisfaction between products containing trichlorethylene and alternative products due to lack of available information. Only one product, Anti-Sweat 2.0 Cold Pipe Insulator Spray, had customer rating information. The product was rated 5 out of 5 by one reviewer. Though no public reviews were available for alternative products, a representative at Roberson reported better performance and customer satisfaction with the water-based No-Sweat FX anti-condensation paint formula versus their original spray formula (No-Sweat Spray) containing methylene chloride.

Table 5-35: Pricing and Customer Review Information for Cold Pipe Insulation Products Based on Manufacturer and Retailer Web Pages

Supplier	Product	Retail information	Price per ounce	Customer ratings (out of 5)	Number of customer reviews
Brodi Specialty Products	Pipe Wrap	https://www.brodi.com/pipewrap-anti-sweat-cold-pipe-spray-on-insulating-coating	$2.35	None	None
CPC	Terand Cold Pipe Insulation	https://www.aerosolstore.com/terand-cold-pipe-insulation.html?gclid=CjwKCAjw95yJBhAgEiwAmRrutD9tb8j95CH6H1f0ZN1brbLTLtazMLtu1niaTJFB160Q6dTYVSmKhRoC2FsQAvD_BwE	$0.63	None	None
Creative Chemical	Anti-Sweat 2.0 Cold Pipe Insulator Spray	https://www.adcosupplies.com/index.php/product/anti-sweat-2-0-cold-pipe-insulation-spray-can/	$1.07	5	1
Sprayway	Sprayway Cold Pipe Insulation	https://www.aerosolstore.com/sprayway-cold-pipe-insulation.html	$0.63	None	None
Quest Specialty Corporation	Surround Cold Pipe Insulation Spray	https://www.aerosolstore.com/questspecialty-surround-cold-pipe-insulation-spray.html	$0.53	None	None
Robson Thermal	No-Sweat FX	http://www.robsonthermal.com/products-and-data-sheets#TOC-No-Sweat-FX-Anti-Condensation-Coating---Water-Base-	$0.53	None	None
Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.					

5.9.5 Conclusion

EPA did not find barriers around fire safety or pricing that may be caused by restricting use of TCE in this product category. There was limited VOC information available for the products reviewed and based on this limited information it appears that replacement products can have less VOC content than products containing TCE. Restricting TCE in cold pipe insulation products is unlikely to affect non-flammable options on the market, as the only non-flammable option was a water-based alternative product. Most of the products in this review were rated extremely flammable (see Table 5-34, above in section 5.9.3). The pricing for the alternative product was similar to the TCE product. Making a reliable comparison in customer satisfaction between product groups was not possible due to lack of available customer review information. It is reasonable to conclude technologically, and economically viable alternatives exist in the marketplace.

5.10 Spot Removers

Spot cleaners are used to treat stains or spots on textiles. Spot cleaners are available for a wide range of textiles and formulated for use with commercial wet and dry cleaning solvents, and for residential use. The analysis focused on carpet and laundry spot cleaners for commercial and consumer use. Products are available in aerosol or liquid form, and in sizes ranging from ounces to gallons. Note that the products containing TCE and 1-bromopropane are geared toward commercial or specialty difficult to clean applications, whereas consumer general purpose laundry and carpet products do not contain them.

5.10.1 Solvent Ingredients

The review included three dry cleaning spot cleaners containing TCE and a carpet spot cleaner containing 1-bromopropane. Six spot cleaner products containing alternative solvents, including ethanol, water, 2-butoxy-ethanol, ethoxylated isotridecyl alcohol, and others were also reviewed. Table 5-36 shows the list of products reviewed for this analysis and their primary solvent ingredients.

Table 5-36: Safety Data Sheets and Solvent Ingredients with Concentrations 5% or Higher for Reviewed Spot Cleaners

Supplier	Product	SDS	SDS date	Solvent ingredients	Concentration (%)
Adco Professional Products LLC	Puro	https://a-1products.com/wp-content/uploads/2016/06/Puro-GHS-SDS.pdf	26 May 2015	Trichloroethylene	>75
R.R. Street & Co. Inc.	Picrin	https://a-1products.com/wp-content/uploads/2016/06/Picrin-GHS-SDS.pdf	3 June 2015	Trichloroethylene	>75
A.L. Wilson Chemical Co.	TarGo Dry	https://www.alwilson.com/products/targo_dry/TarGo%20Dry%20MSDS.pdf	30 August 2018	Ethanol 2-(2-butoxyethoxy)	30 - 50
				Trichloroethylene	15 - 25
				Methyl Isoamyl Ketone [5-methylhexan-2-one]	5 - 15
Pettyjohn's Solutions	Pettyjohn's Solutions® Homerun Cleaning Fluid	https://pettyjohnsolutions.com/wp-content/uploads/2017/08/MSDS-Homerun-Cleaning-Fluid.pdf	July 2012	1-Bromopropane	>96
A.L. Wilson Chemical Co.	TarGo EF	https://www.alwilson.com/products/targo_ef/TarGo%20EF-%20IMPROVED%20%20MSDS.pdf	09 August 2017	2-(2 Propoxyethoxy) Ethanol	20 - 30
				2-(2-Ethoxyethoxy) Ethyl Acetate	15 - 25
				2-(2 Butoxy Ethoxy) Ethyl Acetate	15 - 25
				DPNB (Dipropylene glycol n-butylether)	10 - 20
				Distillate Hydrotreated Light	5 - 10
Chem-Dry	Professional Strength Spot Remover	https://mbyc.net/MSDS/pdf_1308896204.pdf	June 2010	Water	60 - 100
				Dipropylene glycol methyl ether	1 - 5
				1-methoxy-2-propanol	1 - 5
Zep	Instant Carpet and Upholstery Spot Remover	https://images.thdstatic.com/catalog/pdfImages/27/272c04c8-f1b7-4c71-93a4-7cd31d498fc4.pdf	17 September 2018	2-butoxyethanol	≥5 – 10
				Acetone	1 – 5%
Resolve	Professional Spot and Stain Carpet Cleaner	https://images.thdstatic.com/catalog/pdfImages/ae/ae21a0d7-3b39-4395-9ba6-c8311021f09f.pdf	05 November 2015	No solvents listed in the SDS	N/A
SC Johnson	Shout Triple-Action Laundry Stain Remover	https://images.thdstatic.com/catalog/pdfImages/1b/1b1ddf4b-f4a3-4f43-80bc-942e85a6f297.pdf	10 September 2018	Ethoxylated Isotridecyl Alcohol	1- 5
Seventh Generation	Laundry Stain Remover	https://www.seventhgeneration.com/sites/default/files/2020-07/sdsfm000082-00-12laundrystainremoversprayen2020-06-16.pdf	16 June 2020	Water	30 - 100

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

Table 5-37 shows the anticipated, approximate market share percentage of primary solvents used in products estimated using the chemical ranking procedure. The current market share percentage for TCE and 1-bromopropane may be skewed higher since there are many more products without these chemicals that were not included in the review. If restrictions were implemented for TCE, then it is anticipated that water would be the most prevalent solvent used in replacement products.

Table 5-37: Estimated Percentage Share of Solvent Ingredients for Reviewed Spot Cleaners

Solvent	Current market share	Projected after restrictions
Trichloroethylene	20%	0%
1-Bromopropane	11%	0%
Water	45%	66%
Ethanol 2-(2-butoxyethoxy)	5%	8%
Other	18%	26%

Notes: The figures shown here are based on a proxy chemical ranking procedure, which draws upon factors including concentration in the product and availability and quality of product reviews. Orange shading indicates TCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals.

5.10.2 Volatile Organic Compounds (VOC) Content

VOC information in product SDSs were reviewed and a summary of the findings are in Table 5-38. The EPA does not have a VOC limit in spot cleaners. However, several states have limits for aerosol spot cleaners (15-25% VOC) and non-aerosol spot cleaners (3-8% VOC). None of the product SDSs included VOC information which makes it difficult to ascertain if any of these products are VOC compliant with state regulations. The products containing TCE and 1-bromopropane likely have high VOC content given their non-VOC exempt ingredients. Two alternative products (Chem-Dry and Seventh Generation) contain significant amounts of water and likely have low VOC content.

Table 5-38: VOC Content for Spot Cleaners Based on Information in SDSs or Technical Data Sheets

Supplier	Product	VOC (% weight, g/L)
Adco Professional Products LLC	Puro	No information in SDS; likely high VOC content since >75% trichloroethylene
R.R. Street & Co. Inc.	Picrin	No information in SDS; likely high VOC content since >75% trichloroethylene
A.L. Wilson Chemical Co.	TarGo Dry	No information in SDS; likely high VOC content since 50 - 90% non-VOC exempt ingredients
Pettyjohn's Solutions	Pettyjohn's Solutions Homerun Cleaning Fluid	No information in SDS; likely high VOC content since >96% 1-BP
A.L. Wilson Chemical Co.	TarGo EF	No information in SDS
Chem-Dry	Professional Strength Spot Remover	No information in SDS; likely low VOC content since contains 60 – 100% water
Zep	Instant Carpet and Upholstery Spot Remover	No information in SDS
Resolve	Professional Spot and Stain Carpet Cleaner	No information in SDS
SC Johnson	Shout Triple-Action Laundry Stain Remover	No information in SDS
Seventh Generation	Laundry Stain Remover	Not available; likely low VOC content since contains 30 – 100% water

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

5.10.3 Fire Safety

Flash points and flammability ratings were reviewed in product SDSs and summarized findings are in Table 5-39. For products containing TCE, Puro and Picrin were rated non-flammable and TarGo Dry was rated combustible. Pettyjohn's Solutions Homerun Cleaning Fluid which contains 1-Bromopropane was rated non-flammable. All products with alternative solvents were rated non-flammable. Based on the review, there are numerous non-flammable alternatives to products containing TCE.

Table 5-39: Flash Point and Flammability Ratings for Spot Cleaners Based on Information in SDSs or Technical Data Sheets

Supplier	Product	Flash Point	Flammability Rating
Adco Professional Products LLC	Puro	No information available	Non-flammable
R.R. Street & Co. Inc.	Picrin	No information available	Non-flammable
A.L. Wilson Chemical Co.	TarGo Dry	116° F (46.7° C)	Combustible
Pettyjohn's Solutions	Pettyjohn's Solutions Homerun Cleaning Fluid	None	Non-flammable
A.L. Wilson Chemical Co.	TarGo EF	>200° F (93.3° C)	Non-flammable
Chem-Dry	Professional Strength Spot Remover	> 212° F (100° C)	Non-flammable
Zep	Instant Carpet and Upholstery Spot Remover	No information available	Non-flammable
Resolve	Professional Spot and Stain Carpet Cleaner	>199.9° F (93.3° C)	Non-flammable
SC Johnson	Shout Triple-Action Laundry Stain Remover	Does not flash	Non-flammable
Seventh Generation	Laundry Stain Remover	Not available	Non-flammable
Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.			

5.10.4 Pricing and Customer Reviews

The review accessed pricing and customer review information on publicly available websites in August 2021 and summarized the findings in Table 5-40. List prices for A.L. Wilson Chemical Co. were not available online and a sales associate was contacted via phone for pricing. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Pricing for products containing TCE and 1-Bromopropane ranged from $0.70 (Pettyjohn's Solutions Homerun Cleaning Fluid) to $0.85 (Puro) per ounce. Pricing for alternative products ranged from $0.09 (Shout Triple-Action Laundry Stain Remover) to $0.98 (TarGo EF) per ounce. There are four alternative products with prices lower than the products containing TCE.

The three products containing TCE did not have customer ratings. Five of the alternative products had customer ratings available. Ratings for alternative products ranged from 4.2 (Laundry Stain Remover) to 4.8 (Shout Triple-Action Laundry Stain Remover) with an average rating of 4.6. Though reviews could not be compared between products with TCE and alternative products, the average rating for alternative products was well above 4, indicating overall customer satisfaction with these alternative products.

Table 5-40: Pricing and Customer Review Information for Spot Cleaners Based on Manufacturer and Retailer Web Pages

Supplier	Product	Retail information	Price per ounce	Customer ratings (out of 5)	Number of customer reviews
Adco Professional Products LLC	Puro	https://garmentcleaningsupply.com/puro-1-gal-adco.html	$0.85	None	None
R.R. Street & Co. Inc.	Picrin	https://garmentcleaningsupply.com/picrin-1-gal-streets.html	$0.85	None	None
A.L. Wilson Chemical Co.	TarGo Dry	https://www.alwilson.com/products/targo_dry/index.html	$0.82	None	None
Pettyjohn's Solutions	Pettyjohn's Solutions Homerun Cleaning Fluid	https://pettyjohnsolutions.com/product/homerun-cleaning-fluid-1-gallon/	$0.70	None	None
A.L. Wilson Chemical Co.	TarGo EF	https://www.alwilson.com/products/targo_ef/index.html	$0.98	None	None
Chem-Dry	Professional Strength Spot Remover	https://www.amazon.com/Chem-Dry-Professional-Strength-Spot-Remover/dp/B01B02RUU4/ref=sr_1_4?dchild=1&keywords=dry+cleaning+spot+remover&qid=1628783569&s=home-garden&sr=1-4	$0.78	4.7	101
Zep	Instant Carpet and Upholstery Spot Remover	https://www.homedepot.com/p/ZEP-19-oz-Instant-Spot-and-Carpet-Stain-Remover-ZUSPOT19/202858110	$0.40	4.6	82
Resolve	Professional Spot and Stain Carpet Cleaner	https://www.homedepot.com/p/Resolve-32-oz-Procare-Carpet-Spot-and-Stain-Remover-974022/202820652?MERCH=REC-_-pip_alternatives-_-100670274-_-202820652-_-N&	$0.21	4.6	238
SC Johnson	Shout Triple-Action Laundry Stain Remover	https://www.homedepot.com/p/Shout-60-fl-Oz-Triple-Acting-Liquid-Refill-Fabric-Stain-Remover-624323/308629742#product-overview	$0.09	4.8	241
Seventh Generation	Laundry Stain Remover	https://www.target.com/p/seventh-generation-laundry-stain-removers-free-38-clear-16-fl-oz/-/A-53346810	$0.28	4.2	121

Note: Orange shaded rows indicate products that contain TCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals.

5.10.5 Conclusion

The spot cleaner review included three spot cleaners containing TCE, one spot cleaner containing 1-bromopropane, and six spot cleaners containing alternative solvents. Barriers were not found around fire safety, pricing, or customer satisfaction that may be caused by restricting use of TCE in this product category. Product VOC content was difficult to compare, as none of the products had VOC information in their SDSs. However, it is likely that the water-based alternative products will have low VOC content and would be an improvement over products containing TCE. All the alternative products reviewed were rated non-flammable. All alternative products had prices lower than the products containing TCE.

Customer satisfaction was high for alternative product ratings, as average ratings were over 4 out of 5 stars. Dry cleaners that convert to professional wet cleaning often switch to spot cleaners without TCE.

These wet cleaners find they spend much less time and therefore less product on spot cleaning as compared to the dry cleaning process.

5.11 Pepper Spray

5.11.1 Description

Pepper spray products are aerosol-based sprays used by law enforcement and also by individuals for self-defense. These products typically contain an irritant, solvent(s), and an aerosol propellant. Some pepper spray products contain trichloroethylene.

Numerous manufacturers and distributors sell pepper spray in stores and online. EPA called, emailed, and/or reviewed the websites of major pepper spray manufacturers in December 2022 and January 2023. Companies were identified via online searches and a list included in a 2021 report prepared by ICF for EPA (ICF 2021).

5.11.2 Findings Regarding TCE/PCE in Pepper Spray

Ten major manufacturers of pepper spray were identified. Only one was identified as producing pepper sprays that contain TCE.

The pepper spray products for which Fox Labs provides SDSs on its website (other than the four that contain TCE as noted above) include Keychain, Serious Business Foam, Stream DB, Cone Fog DB, Mean Green Stream, Mean Green Fog, Sudecon, Inert Fogger, and Inert Stream.

Defense Technology posts many SDSs on one webpage, but they appear to be for a number of products other than pepper spray. SDSs were looked at for the products that were assumed to be pepper sprays, based on the names. None of the following products reviewed have TCE listed on their SDSs:

- First Defense .7% MK-EU and MK-North America
- First Defense .7% MK-4 Stream OC Aerosol US
- Pepper Fog CS Formulation
- Pepper Fog Smoke Formulation
- Pepper Fog – Flush Mix
- Pepper Fog OC Formulation

Two products with TCE were selected for further review, along with two products with diethylene glycol monobutyl ether, and one product with unknown solvent ingredients. Table 5-41 shows the safety data sheets and solvent ingredients for reviewed pepper spray products.

Table 5-41: Safety Data Sheets and Solvent Ingredients for Reviewed Products

Manufacturer	Product	SDS URL and Date	Solvent ingredients	Concentration
Fox Labs	Cone Fog 1.4 and Cone Fog 5.3: OC Fogger, Nonflammable	https://cdn.shopify.com/s/files/1/1590/2179/files/5.3-Fog-Tri_4.pdf?v=1647286348 February 2018	Trichloroethylene	Weight % proprietary
			1,1,1,2-Tetrafluoroethane (CAS 811-97-2)	Weight % proprietary
Fox Labs	Stream 1.4 and Stream 5.3: OC Stream	https://cdn.shopify.com/s/files/1/1590/2179/files/5.3-Stream-Tri_4.pdf?v=1647286336 January 2014	Trichloroethylene	Weight % proprietary
Fox Labs	**Keychain 5.3: OC/DB/PG (Stream)**	https://cdn.shopify.com/s/files/1/1590/2179/files/5.3_Stream_2017_DB.pdf?7364507807329022273 January 2017	Diethylene glycol monobutyl ether (CAS 112-34-5)	% proprietary
Defense Technology	First Defense .7% MK Cone OC Aerosol-North America	https://sds.chemtel.net/docs/Safariland%20LLC-0001221/finished_goods/Defense%20Technology%203035%203045%2056764%2056784%20-%20First%20Defense%20.7%20Percent%20MK-North%20America.pdf October 2018	2-(2-butoxyethoxy)ethane (CAS 112-34-5)	20 - 40%
SABRE (Security Equipment Corporation)	Red USA Civilian	https://images.homedepot-static.com/catalog/pdfImages/a7/a731c556-db4f-468b-9fce-46c49832ae05.pdf January 2013	None listed	Not applicable

Note: Orange shaded rows indicate products that contain TCE.

5.11.3 Volatile Organic Compounds (VOC) Content

VOC information was reviewed in product SDSs and summarized findings are in Table 5-42. No federal or state VOC regulatory limits for pepper spray products were identified. VOC information was not provided on any product SDS reviewed. Each of the Fox Labs and Defense Technology products reviewed contain solvents that are not VOC exempt and therefore would contain some level of VOC content. The Sabre product did not list any solvents and it is not known if the product contains any VOC solvents. Restricting the use of TCE in pepper spray products does not seem to be a barrier for acceptance of alternative products based on VOC content.

Table 5-42: VOC Content, Based on Information in SDSs

Supplier	Product	VOC (% weight, g/L)
Fox Labs	Cone Fog 1.4 and Cone Fog 5.3	Not provided on SDS
Fox Labs	Stream 1.4 and Stream 5.3	Not provided on SDS
Fox Labs	Keychain 5.3, **OC/DB/PG (Stream)**	Not provided on SDS
Defense Technology	First Defense .7% MK-North America	Not provided on SDS
SABRE (Security Equipment Corporation)	Red USA Civilian	Not provided on SDS
Note: Orange shaded rows indicate products that contain TCE.		

5.11.4 Fire Safety

Flash points and flammability ratings were reviewed in product SDSs and summarized findings are in Table 5-43. All products reviewed containing TCE had a flammability rating of "non-flammable". All products reviewed containing alternative solvents had high flash point solvents in non-flammable aerosol propellants and were described on the SDSs as "non-flammable". Restricting the use of TCE in pepper spray products is unlikely to impact the acceptance of alternative products based on fire safety.

Table 5-43: Flash Point and Flammability Ratings, Based on Information in SDSs or Technical Data Sheets

Supplier	Product	Flash Point	Flammability Rating
Fox Labs	Cone Fog 1.4 and Cone Fog 5.3: OC Fogger, Nonflammable	None when tested in accordance with DOT requirements	Non-flammable
Fox Labs	Stream 1.4 and Stream 5.3: OC Stream	None when tested in accordance with DOT requirements	Non-flammable
Fox Labs	Keychain 5.3**: OC/DB/PG (Stream)**	Solvent: 78 degrees Celsius (172 degrees Fahrenheit)	Class IIIA Combustible liquid in Non-flammable aerosol propellant
Defense Technology	First Defense .7% MK-North America	Not Available; SDS NFPA Fire Rating: 3	Class IIIA Combustible liquid in Non-flammable aerosol propellant
SABRE (Security Equipment Corporation)	Red USA Civilian	>106 degrees Celsius (228 degrees Fahrenheit)	Class IIIB Combustible liquid in Non-flammable aerosol propellant
Note: Orange shaded rows indicate products that contain TCE.			

5.11.5 Pricing

Pricing information was collected on publicly available websites when available. Pricing was collected during January 2023. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Pepper spray products containing TCE had prices ranging from $10.99 to $11.49 per ounce. Alternative products without TCE had pricing ranging from $7.33 to $44.34 per ounce for the products reviewed. Pricing was obtained for five products without TCE to get a representative price range of alternative products.

Table 5-44: Pricing Information for Pepper Spray Products Based on Manufacturer and Retailer Web Pages

Supplier	Product	Retailer	Price and URL	Price per ounce
Fox Labs	1.4 Pepper Spray, 2 oz., Police Carry Model	Fox Labs website	$22.99 https://foxlabs.com/products/24fts?pr_prod_strat=use_description&pr_rec_id=1076cbf9d&pr_rec_pid=7786304045290&pr_ref_pid=7487914410218&pr_seq=uniform	$11.49
Fox Labs	5.3 Legacy Pepper Spray, 2 oz.	Fox Labs website	$21.99 https://foxlabs.com/collections/five-point-three-legacy-formula	$10.99
Fox Labs	Mean Green Staining Pepper Spray – 1.5 oz.	Fox Labs website	$21.99 https://foxlabs.com/products/156mgs	$14.66
Fox Labs	"Serious Business" Foam Pepper Spray, 1.7 oz.	Fox Labs website	$24.99 https://foxlabs.com/products/serious-business-foam	$14.70
Defense Technology	Defense Technology 6005 First Defense MK-6 Stream .7% Orange .68 oz Pepper Spray	Amazon	$30.15 https://www.amazon.com/Defense-Technology-Stream-Orange-Pepper/dp/B001LZ0DNC/ref=sr_1_4?crid=1EP3BY1AG74TC&keywords=defense+technology+first+defense+mk-6+pepper+spray&qid=1673910883&sprefix=defense+technology+first+defense+mk-6+pepper+spray%2Caps%2C164&sr=8-4	$44.34
SABRE	Sabre Advanced Pepper Spray, 3 in 1 Formula, 0.75 oz each, 2 pack (1.5 oz total)	Amazon	$14.99 ($7.50/unit) https://www.amazon.com/SABRE-Advanced-Compact-Pepper-Spray/dp/B09SBP27CF/ref=sr_1_10?crid=C688AOW2SGOR&keywords=pepper%2Bspray&qid=1674588140&sprefix=pepper%2Bspray%2Caps%2C93&sr=8-10&th=1	$9.99
SABRE	Sabre Red 52CFT30 Crossfire Stream (MK-4) Pepper Spray, 1.33% MC, 3 oz.	Amazon	$21.99 https://www.amazon.com/Rothco-Sabre-Crossfire-Pepper-52Cft30/dp/B001C44824/ref=sr_1_1?crid=38YSC52W0LRY&keywords=Sabre+Red+52CFT30+Crossfire+Stream&qid=1673910974&sprefix=sabre+red+52cft30+crossfire+stream%2Caps%2C222&sr=8-1	$7.33
Note: Orange shaded rows indicate products that contain TCE.				

5.11.6 Conclusion

The product review included two pepper spray products containing TCE, and three products containing alternative solvents. Barriers were not found around VOC content or fire safety that would be caused by restricting the use of TCE in this product category. The pricing range for the alternative products overlapped with the pricing range for the pepper spray products containing TCE. Therefore, no pricing barriers are anticipated for switching to alternative products without TCE for this product category.

6. Baseline Analysis

This chapter presents the estimated baseline consumption levels for TCE (section 6.1) and the estimated number of firms and individuals with occupational exposure to TCE (section 6.2). The estimated numbers of facilities and individuals affected under the rule presented in this chapter are used to estimate the number of firms with cost impacts attributable to the options and the number of individuals expected to benefit from reduced exposures under the options.

6.1 Baseline TCE Consumption Volumes by Use Category

This section presents estimates for the amount of TCE consumed for the use categories considered in the economic analysis where sufficient data were available. EPA's risk evaluation for TCE indicates that approximately 172 million lbs of TCE are produced each year, based on 2016 CDR data. It further indicates that approximately 83.6% of TCE production is used as an intermediate in the manufacture of HFC-134a, 14.7% is used as a degreasing solvent, a 1.7% is attributed to other uses (EPA 2020e).

EPA uses several sources to derive the volume estimates, which differ according to the type of emission source associated with the use category. Figure 6-1 presents an overview of the approach to estimating TCE consumption volume associated with each use category.

Figure 6-1: Overview of Approach

Point Sources	Point and Non-Point Sources	Other
• Vapor degreasing • Batch cold cleaning • Mold release	• Aerosol spray cleaning/degreasing • Adhesives and sealants • Paint and coatings • Spot removers • Wipe/liquid spray cold cleaning	• HFC Manufacturing • Lubricants and greases
Overview of Methodology		
1. Estimate an emissions factor for each use category to convert National Emissions Inventory (NEI) emissions estimates to consumption estimates 2. Map NEI submissions to use categories 3. Sum total NEI emissions by use category 4. Divide emissions from (3) by the emissions factor from (1) to estimate TCE consumption for each use category	1. Estimate total solvent usage 2. Allocate total solvent usage to relevant use categories 3. Apply TCE speciation factors to approximate the market share of TCE in each use category	Various Sources

6.1.1 Point Sources

This analysis uses emissions estimates reported by the 2017 National Emissions Inventory (NEI) (EPA 2020a) to estimate TCE consumption for the following use categories:

- Vapor degreasing
- Cold cleaning
- Mold release

The approach for these uses consisted of the following steps:

1. Map NEI submissions to use categories
2. Estimate an emissions factor for each use category in order to convert NEI emissions estimates to consumption estimates
3. Sum total NEI emissions by use category
4. Divide emissions from (3) by the emissions factor from (1) to estimate TCE consumption for each use category

The next step is to estimate an emissions factor that will allow for the conversion of TCE emissions to TCE consumption. These emission factors are presented in Table 6-1.

While many NEI submitters reported the emissions factors they used to generate their estimates, EPA was not able to use these reported factors because the units were not provided. However, some NEI submitters reported the input quantities (e.g., tons solvent used) that they used to calculate their emissions. In these cases, reported emissions (Table 6-1; Column A) to estimate an emissions factor. Note that input quantities that are not based on solvent use (e.g., “fuel”, “material”, “product”) are not included in the average emission factor calculation because it would not be possible to use these inputs to convert emissions to TCE input. EPA also includes identified emission factors for each use category from WebFIRE, an EPA database of emissions factors for criteria and hazardous air pollutants (EPA 2020m).

The emissions factors in Table 6-1 vary widely, as they are affected by differences in equipment, process, and control technologies. Because the type of equipment and controls used by both the NEI submitters and the industries at large is not reported, the analysis uses the average of the identified emissions factors for the analysis estimates.

Table 6-1: TCE Emission Factors

Calculation Input Quantity[1]	Total emissions (lb)	Emission Factor	Emission Factor[2] (lb emitted/lb solvent)	Source
A	B	C = B ÷ A		
Vapor Degreasing				
24,862 gal solvent	58,121	2 lb/gal	0.1869	EPA 2020a
120 gal trichloroethylene	1,453	12 lb/gal	0.9679	
9 ton solvent	16,340	1816 lb/ton	0.9078	
11 ton solvent	15,000	1420 lb/ton	0.7102	
259 gal trichloroethylene	3,136	12 lb/gal	0.9679	
2 ton solvent	3,060	1545 lb/ton	0.7727	
495 gal trichloroethylene	5,994	12 lb/gal	0.9680	
762 gal trichloroethylene	9,296	12 lb/gal	0.9752	
952 gal trichloroethylene	11,580	12 lb/gal	0.9722	
137 gal trichloroethylene	1,656	12 lb/gal	0.9682	
5 ton make-up solvent	10,680	2000 lb/ton	1.0000	
14 ton solvent	16	1 lb/ton	0.0006	
1,054 gal solvent	12,840	12 lb/gal	0.9742	
1 ton process unit	5,040	3500 lb/ton	1.7500	
2 ton make-up solvent	2,120	977 lb/ton	0.4885	
18 ton process unit	42,204	2398 lb/ton	1.1990	
2 ton process unit	3,497	1953 lb/ton	0.9767	
16 ton process unit	30,234	1898 lb/ton	0.9490	
5 ton make-up solvent	9,240	2000 lb/ton	1.0000	
2 ton make-up solvent	1,200	694 lb/ton	0.3468	
2 ton make-up solvent	1,360	795 lb/ton	0.3977	
11 ton solvent	21,620	2000 lb/ton	1.0000	
6 ton product	12,700	2000 lb/ton	1.0000	
4 ton make-up solvent	8,000	1988 lb/ton	0.9940	
3 ton make-up solvent	5,060	1988 lb/ton	0.9940	
3 ton make-up solvent	6,760	1988 lb/ton	0.9940	
2 ton make-up solvent	4,334	1860 lb/ton	0.9300	
13 ton process unit	25,035	1911 lb/ton	0.9555	
1 ton process unit	1,020	2000 lb/ton	1.0000	
1 ton make-up solvent	1,887	1320 lb/ton	0.6600	
2 ton solvent	3,300	2000 lb/ton	1.0000	
125 gal trichloroethylene	1,522	12 lb/gal	0.9753	
2 ton make-up solvent	4,050	1999 lb/ton	0.9995	
75 gal trichloroethylene	908	12 lb/gal	0.9681	
3 ton make-up solvent	1,280	446 lb/ton	0.2230	
3 ton trichloroethylene	5,688	2000 lb/ton	1.0000	
2 ton trichloroethylene	4,720	2000 lb/ton	1.0000	
9,372 lb trichloroethylene	7,440	1 lb/lb	0.7939	
18,766 lb trichloroethylene	18,330	1 lb/lb	0.9768	

Table 6-1: TCE Emission Factors

Calculation Input Quantity[1]	Total emissions (lb)	Emission Factor	Emission Factor[2] (lb emitted/lb solvent)	Source
A	B	C = B ÷ A		
16,500 lb solvent	15,960	1 lb/lb	0.9673	
220 gal trichloroethylene	2,880	13 lb/gal	1.0464	
-	-	-	0.9300	EPA emissions factor; OTVD uncontrolled (EPA 2020m)
-	-	-	0.7900	EPA emissions factor; OTVD miscellaneous control devices (EPA 2020m)
-	-	-	0.9600	EPA emissions factor; CVD uncontrolled (EPA 2020m)
-	-	-	0.8300	EPA emissions factor; CVD miscellaneous control devices (EPA 2020m)
		Average Emissions Factor[3]	**0.8770**	
Batch Cold Cleaning				
1 ton solvent	958	1680 lb/ton	0.8400	EPA 2020a
427 gal trichloroethylene	4,348	10 lb/gal	0.8139	
0.06 ton solvent	120	2000 lb/ton	1.0000	
0.39 ton make-up solvent	320	821 lb/ton	0.4103	
2 ton solvent	4,950	2000 lb/ton	1.0000	
2 ton solvent	36	20 lb/ton	0.0101	
0.07 ton trichloroethylene	140	2000 lb/ton	1.0000	
22 ton solvents: all	8,040	362 lb/ton	0.1808	
98 lb degreaser	98	1 lb/lb	1.0000	
7 ton solvent	4	0.49 lb/ton	0.0002	
-	-	-	0.8400	EPA emissions factor; cold cleaning uncontrolled (EPA 2020m)
-	-	-	0.7200	EPA emissions factor; cold cleaning miscellaneous control devices (EPA 2020m)
-	-	-	0.8200	EPA emissions factor; cold cleaning freeboard refrigeration device (EPA 2020m)
		Average Emissions Factor[3]	**0.6643**	
Mold Release				
532 lb solvent	204	0.38 lb/lb	0.3835	EPA 2020a

[1] Make-up solvent is solvent that is used to top-off a degreaser to replace solvent lost through evaporation, leakage, splashing, etc. While input solvent may contain other chemicals in addition to TCE, EPA assumes that the input solvent is solely comprised of TCE for the purposes of calculating an emissions factor.
[2] Conversion of Column C to units of lb emitted/lb input solvent using the following conversion factors: 2000 ton/lb; 2.20462 kg/lb; 12.51 lb/gal.
[3] The average emissions are calculated from values using more significant digits than presented in the table.

The next step is to categorize the remainder of the NEI submissions into a use category. For this analysis, EPA assigned the most likely use to each facility based on the NAICS, unit type, unit description, process description, and source classification codes reported. In some cases, the use category could not be determined based on the reported information. These emissions were reallocated based on the assumption that uses in metal manufacturing and primary metal production are attributed to vapor degreasing; and uses in plastic and rubber manufacturing and polystyrene foam manufacturing are attributed to mold release.

Finally, the emissions by use category are summed and then divided by the average emissions factors from Table 6-1 to estimate TCE consumption for the point sources.

6.1.1 (A) Summary and Discussion

Table 6-2 summarizes the TCE consumption estimates for the three use categories expected to be primarily comprised of only point sources in industrial settings.

Table 6-2: Point Source Annual Volume of TCE Consumed

Use Category	Total Emissions (lbs)[1]	Average Emission Factor[2] (lb emitted/lb solvent)	TCE Consumption (lb)
	A	B	C = A ÷ B
Vapor Degreasing	770,196	0.88	878,169
Batch Cold Cleaning	108,052	0.66	162,666
Mold release	34,188	0.38	89,157

[1] Source: EPA 2020a

[2] Source: Table 6-1 emission factors.

The limitations of this approach include the following:

- There is some uncertainty around the emissions factors. As previously discussed, the type of control technologies users have implemented is not known and how the calculated emissions factors relate to those controls is also not known.

- Due to the subjective nature of mapping NEI reports to use categories, some emissions may have been attributed to the wrong use, some irrelevant emissions sources that are not actually a result of a regulated use category may have been inadvertently included and/or relevant emissions sources that should be included may have been inadvertently excluded.

- Given NEI reporting requirements, point source TCE emissions are likely under-reported. TCE is not required to be reported to NEI, although some states voluntarily do report. For the industries where EPA expects TCE to be reported but it is not, NEI applies a scaling factor to reported emissions to best estimate a complete inventory of TCE emissions (EPA 2020b). However, NEI only applies this scaling factor to degreasing and chemical manufacturing point sources, such that emissions estimates for the remaining point sources are comprised solely of voluntary reports (EPA 2020h).

6.1.2 Point and Non-Point Sources

This section estimates use volumes for the following use categories that EPA believes are emitted from both point and nonpoint sources:

- Aerosol spray cleaning/degreasing
- Adhesives and sealants
- Paint and coatings
- spot removers

- Wipe/liquid spray cold cleaning

While many of these uses are reported in NEI as point and/or nonpoint sources, this analysis uses a different approach to estimate the consumption volumes than that described in the previous section because NEI may significantly underestimate nonpoint emissions of TCE. As with the point sources, nonpoint emissions of TCE and other hazardous air pollutants are not required to be reported to NEI, although states may voluntarily do so. NEI thus produces its own national emissions estimates for those pollutants that are included on its Expectant Pollutant List, which lists the pollutants EPA expects to observe for each use. If a state submits a pollutant that is not on the list for a given use, NEI will remove it unless the state provides documentation supporting its submission (EPA 2020b). Of the relevant use categories, EPA only lists TCE as an expected nonpoint pollutant for degreasing uses (EPA 2020i). Thus, all nonpoint emissions of TCE reported in NEI that are not degreasing only reflect voluntary submissions by states that provided documentation.

This analysis follows NEI's general approach for estimating nonpoint source emissions of TCE, but accounts for the uses that NEI does not. This approach methodology is described below.

6.1.2 (A) Methodology

The analysis approach for these uses consisted of the following steps:

1. Estimate total solvent usage
2. Allocate total solvent usage to relevant use categories
3. Apply TCE speciation factors to approximate the market share of TCE in each use category

Step 1: Estimate total solvent usage

NEI bases its emission estimates on national-level projections of solvent usage from the Freedonia Group (The Freedonia Group 2016), which are reproduced in Table 6-3 below. These estimates encompass both point and nonpoint sources.

Table 6-3: Solvent Usage Projections in the U.S.

Description	Solvent Usage (Million Pounds)		
	2015	2017	2020
Paints & Coatings Solvent Demand: Architectural	735	777	840
Paints & Coatings Solvent Demand: Other	1,318	1,321	1,325
Printing Ink Solvent Demand	1,132	1,134	1,138
Cleaning Products Solvent Demand: Household	653	657	662
Cleaning Products Solvent Demand: Industrial & Institutional	385	390	398
Cosmetics & Toiletries Solvent Demand	628	645	670
Adhesives & Sealants Solvent Demand	572	600	643
Transportation Solvent Demand: Motor Vehicles	61	62	64
Dry Cleaning	20	18	16
Source: The Freedonia Group 2016			

Step 2: Allocate total solvent usage to relevant use categories

Because the Freedonia solvent categories in Table 6-3 are broader than the use categories in this analysis, they need to be disaggregated into the consumption volumes of the constituent use categories. Table 6-4 provides a crosswalk of the use categories with the Freedonia categories.

This analysis uses California Air Resources Board (CARB)'s 2015 Consumer and Commercial Product Survey to estimate the market share of each use category within the Freedonia categories (CARB 2019b). CARB's survey reports consumer and commercial product sales volumes for over 400 categories of products. The survey was mandatory for consumer product manufacturers, and reflects reports of approximately 1,400 companies and over one million products (CARB 2019a). EPA mapped the product categories in the CARB survey data to both the Freedonia categories and the use categories (Table 6-4). Note that this step includes any CARB product category EPA determined might reasonably include any solvent, not just TCE, because the Freedonia estimates reflect total solvent use. The total solvent volume attributed to each use category will be further disaggregated into the volume attributed to just TCE in the next step.

Table 6-4: Crosswalk of Freedonia Solvent, Product, and Use Categories

Freedonia Solvent Category	Use Category	2015 CARB Survey Category
Adhesives & Sealants Solvent Demand	Adhesives and Sealants	Arts and Crafts Adhesive
		Automobile Headliner Adhesive
		Automotive Engine Compartment Adhesive
		Carpet and Tile Adhesive
		Construction, Panel, or Floor Covering Adhesive
		Contact Adhesive - General Purpose
		Contact Adhesive - Special Purpose
		Fabric/Textiles Adhesive
		Flexible Vinyl Adhesive
		General Purpose Adhesive
		Household Glues and Paste
		Laminate Repair/Edgebanding Adhesive
		Mist Spray Adhesive
		Mounting Adhesive
		Plastic Pipe Cement and Primer
		Polyolefin Adhesive
		Polystyrene Foam Adhesive
		Rubber Cement
		Screen Printing Adhesive
		Specialty Automotive Adhesive
		Tackifying Agent (semi-permanent)
		Temporary/Removable Adhesive
		Thread Locking Compound
		Wallpaper Adhesive
		Web Spray Adhesive
		Woodworking Glue
		Other adhesives

Table 6-4: Crosswalk of Freedonia Solvent, Product, and Use Categories

Freedonia Solvent Category	Use Category	2015 CARB Survey Category
		Cold Process Roof Cement (aerosol only)
		Driveway Patching Compound
		Floor Seam Sealer
		Insulating and Sealing Spray Foam
		Painter's Putty
		Pipe Thread Sealant/Pipe Joint Compound
		Plumber's Putty
		Rubberized Sealant
		Sealant or Caulking Compound -- Chemically Curing
		Sealant or Caulking Compound -- Nonchemically Curing
		Spackling Compound
		Tile and Grout Sealer
		Window Glazing Compound
		Wood Filler
		Other sealants and caulks
		Tire Sealants and Inflator
Cleaning Products Solvent Demand: Household	Aerosol Spray Cleaning/Degreasing	Cooktop Cleaner
		General Purpose Degreaser (aerosol)
		Metal Polish/Cleanser (aerosol)
		Oven or Grill Cleaner (aerosol)
		Single Purpose Cleaner
		Single Purpose Degreaser
		Grill Cleaner
		Electrical Cleaner
		Electronic Cleaner
		Other electronic-related cleaning products
		Multi-purpose Solvent (aerosol)
	Wipe/Liquid Spray Cold Cleaning	General Purpose Cleaner (nonaerosol)
		General Purpose Degreaser (nonaerosol)
		Jewelry Cleaner, Polish, and Soap
		Metal Polish/Cleanser (nonaerosol)
		Oven or Grill Cleaner (nonaerosol)
		Other cleaners and degreasers
		Clean Up Solvent
		Specialty Degreasers (specific use)
		Multi-purpose Solvent (nonaerosol)
Cleaning Products Solvent Demand: Industrial & Institutional		General Purpose Degreaser (labeled not for retail sale)
Dry Cleaning	Spot Removers	Spot Remover (aerosol)
		Spot Remover (nonaerosol)

Table 6-4: Crosswalk of Freedonia Solvent, Product, and Use Categories

Freedonia Solvent Category	Use Category	2015 CARB Survey Category
		Spot Remover (aerosol)
		Spot Remover (nonaerosol)
Transportation Solvent Demand: Motor Vehicles	Aerosol Spray Cleaning/Degreasing	Tire or Wheel Cleaner (aerosol)
		Brake Cleaner
		Carburetor or Fuel-Injection Air Intake Cleaner
		Engine Degreaser (aerosol)
		Engine Degreaser (nonaerosol)
		Home-Use Metal Parts Immersion Wash
	Wipe/Liquid Spray Cold Cleaning	Tire or Wheel Cleaner (nonaerosol)

Based on the total sales weight of each CARB product category, the analysis then estimates the market share of each use category as a percentage of the Freedonia solvent category. Multiplying the market share by the total solvent consumption from Table 6-3 yields total solvent consumption by use category, shown in Table 6-5 below.

Table 6-5: Total Use Category Annual Solvent Demand

Use Category	Freedonia Solvent Category	2020 Total Solvent Demand (million lbs)[1]	2015 CARB Survey Total Solvent Sales (tons per day)	2015 CARB Survey Use Category Solvent Sales (tons per day)	Market Share of Solvent Category[2]	Total Use Category Consumption (million lbs)
		A	B	C	D = C/B	E = A x D
Aerosol Spray Cleaning/Degreasing	Transportation Solvent Demand: Motor Vehicles	64	49	15	0.55	35
	Cleaning Products Solvent Demand: Household	662	940	11	0.03	19
Adhesives and Sealants	Adhesives & Sealants Solvent Demand	643	156	156	1.00	643
Paint and Coatings [3]	Paints & Coatings Solvent Demand: Architectural	840	-	-	1.00	840
Spot Removers	Cleaning Products Solvent Demand: Household	662	940	26	0.03	18
Wipe/Liquid Spray Cold Cleaning				569	0.60	400

[1] Source: The Freedonia Group 2016

[2] Source: CARB 2019b

[3] The CARB survey did not include products in the paints and coatings category. This analysis assumes that 100 percent of the Freedonia category "Paints & Coatings Solvent Demand: Architectural" can be attributed to this use category.

Step 3: Apply TCE speciation factors to approximate the market share of TCE in each use category

This analysis follows NEI's approach by applying a speciation factor to the Freedonia solvent usage estimates to estimate TCE usage. The speciation factors are the estimates for the percentage of total volatiles that TCE constitutes. The underlying assumption of this analysis is that the TCE speciation factors are also a proxy for TCE's market share of total solvent usage.[10] This analysis uses speciation factors from EPA's SPECIATE database, which is a repository of speciation factors of air pollutant sources (EPA 2020k). The database contains approximately 95 speciation profiles for TCE, which are mapped to the use categories (Table 6-6). The last column of Table 6-6 includes the NEI descriptive names for the product or use that the speciation factor represents.

The TCE profiles in the SPECIATE database are dated from 1994 to 2018 and may cover a range of values for the same use category. In particular, there is a group of about 13 profiles corresponding to CARB's consumer product categories from 2018, and a group of equivalent profiles from 2004. The 2018 estimates are significantly lower than the 2004 factors, which is the result of regulations CARB implemented in the intervening years that prohibit TCE use in a range of consumer product categories (CARB 2019c). Where possible, EPA therefore uses CARB's 2018 factors for states that regulate TCE in a given use and CARB's 2004 factors for states that do not have TCE regulations. The analysis identified 18 states from ISSA (2018) and EPA (2020b) that regulate TCE in adhesives, spot removers, lubricants and greases, apparel and footwear care products, and cleaners/degreasers.

Table 6-6 presents these speciation factors for each use category.

[10] This is consistent with the approach used by NEI. By applying the speciation factors directly to input solvent volume to estimate pollutant emissions, NEI implicitly assumes that 100 percent of the solvents are emitted to the air. Thus, by this assumption, the make-up of solvent emissions would mirror the make-up of the solvent input.

Table 6-6: TCE Speciation Factors

Use Category	TCE Speciation Factor (Weight %)		TCE Speciation Factor Profile Names
	State TCE Limit	No State TCE Limit	
Aerosol Spray Cleaning/Degreasing	0.02	0.66	CONS PRD- AUTOMOTIVE BRAKE CLEANER (2010 UPDATE) Consumer Products: Automotive Brake Cleaners
Adhesives and Sealants	0.040	0.01	Consumer Products: Aerosol Adhesive (Including Industrial) Consumer and Commercial Products: Adhesives and Sealants: All Adhesives and Sealants
Paint and Coatings	0.12	0.12	Consumer and Commercial Products: Coatings and Related Products: All Coatings and Related Products[1]
Spot Removers	0.08	10.98	CONS PRD- SPOT REMOVER - AEROSOL (2010 UPDATE) Consumer Products: Spot Removers - Aerosols
Wipe/Liquid Spray Cold Cleaning	0.00	0.16	Consumer Products: Solvent Parts Cleaner - Non-Aerosols[1]
[1]While state limits on paint thinners were identified, no states limiting using of other types of paints and coatings were identified. Because TCE is not present in paint thinners, only a single speciation factor for paints and coatings is used.			

6.1.2 (B) Summary and Discussion

Table 6-7 summarizes the TCE consumption estimates for the use categories discussed in this section. Note that the speciation factors are weighted by the populations of the states with and without TCE limits. These population weights are derived from the 2018 American Community Survey (U.S. Census Bureau 2019).

Some limitations of this approach include the following:

- The Freedonia 2020 solvent usage projections were made in 2016. While they may have attempted to account for foreseeable changes in the market for solvents, they likely could not have fully accounted for the regulatory and industry trends in the last five years. Their predictions therefore may not reflect the actual solvent market in 2020.

- This analysis relies on CARB's 2015 consumer and commercial product survey to estimate the market share of each use category. This necessitates several assumptions:

    - That the market share of products in California reflect those of the entire U.S.

    - That the market share of consumer and commercial products also reflects the market share of industrial products

    - That the sales volumes of products omitted from the survey data for confidentiality reasons are negligible

    - That the sales volumes of the overall products are proportional to the volumes of solvent used

- The analysis uses the speciation factors as a proxy for TCE's share of the solvent market, but this may be inaccurate to the extent that product categories are largely comprised of non-solvent alternatives (i.e. TCE may be a small share of total volatile emissions, but a larger share of solvent emissions/use)

Table 6-7: Non-Point Sources Annual Volume of TCE Consumed

Use Category	Total Use Category Demand (million lbs)	State TCE Limit		No State TCE Limit		Annual Volume of TCE Consumed (lbs)
		TCE Speciation Factor (Weight %)	State Population Weight	TCE Speciation Factor (Weight %)	State Population Weight	
	A	B	C	D	E	A x (0.01*B*C + 0.01*D*E) x 1,000,000
Aerosol Spray Cleaning/Degreasing	54	0.02	0.44	0.66	0.56	**203,522**
Adhesives and Sealants	643	0.04	0.44	0.01	0.56	**149,491**
Paint and Coatings	840	0.12	0.00	0.12	1.00	**1,008,000**
Spot Removers	18	0.08	0.44	10.98	0.56	**1,134,123**
Wipe/Liquid Spray Cold Cleaning	400	0.00	0.44	0.16	0.56	**360,408**

6.1.3 Summary of Consumption Volumes by Use Category

Table 6-8 summarizes the estimated consumption volume of TCE for each use category.

Table 6-8: Summary of TCE Consumption Volume Estimates, by Use Category

Use Category	Total Volume (lbs)	Source
Laboratory Use	Not Estimated	
Battery Manufacture	>53,175	(Descartes Datamyne 2022)
HFC Manufacturing	135,153,510	EPA 2017b; EPA 2020e
Vapor Degreasing	23,038,435	Table 6-2
HCl Production	Not Estimated	
Fluoroelastomer Production	Not Estimated	
Mold release	89,157	Table 6-2
Batch Cold Cleaning	162,666	Table 6-2
Liquid Cleaners and Degreasers	360,408	Table 6-7
Aerosol Spray Cleaning/Degreasing	203,522	Table 6-7
Lubricants and Greases	185,000	EPA 2020e
Adhesives, Sealants, Paints and Coatings (Adhesives and Sealants)	149,491	Table 6-7
Adhesives, Sealants, Paints and Coatings (Paint and Coatings)	1,008,000	Table 6-7
Spot Removers	1,134,123	Table 6-7
Disposal	Not estimated	-
Total	**161,484,312**	

EPA notes that the total TCE consumption volume estimated in Table 6-8 (161,484,312 lbs) is slightly lower than the total TCE production volume reported in the 2016 CDR (161,666,878 lbs). This may be due to several reasons. First, as described in Section 6.1.2, uses that may be associated with point and nonpoint sources are estimated using solvent usage projects for 2020, whereas volumes reported in CDR are based on 2015 production volumes. And as shown in Table 6-3, solvent usage is generally expected to increase over the period from 2015 to 2020. Second, the approach used to estimate TCE consumption volume is subject to various limitations and involve a degree of uncertainty, as discussed in the preceding sections. The difference in TCE consumption volume estimated by this analysis and that reported by CDR may reflect the errors and uncertainties related to this approach.

6.2 Number of Affected Facilities and Individuals Exposed in Occupational Settings

This section presents the number of firms and individuals exposed to TCE for each use category considered under the regulatory options. For most use categories EPA used two general approaches for estimating the number of firms using TCE and individuals employed at those firms that might be exposed to TCE. The first approach was applied for use categories where facilities could be identified in CDR, TRI, or NEI data (see 6.2.1). The second approach was generally applied for use categories defined as using a TCE containing product and uses various sources to estimate the numbers of facilities using TCE and OSHA enforcement data to estimate the percentage of employees per establishment with potential exposure to TCE (see 6.2.2, 6.2.6, 6.2.8, 6.2.9, 6.2.9, and 6.2.11). Use-specific approaches were used to develop the estimates for incorporation into formulation, mixture, or reaction product, vapor degreasing, spot removers, and waste handling, disposal, treatment, and recycling, described in sections 6.2.3, 6.2.5, 6.2.7, and 6.2.12, respectively. The estimates are summarized in section 6.2.13.

6.2.1 Number of Affected Facilities and Individuals in Facilities Identified in CDR, TRI, and NEI data

As shown in Table 6-9, EPA used CDR, TRI, and NEI data to identify facilities producing, importing, or releasing TCE and categorized them according to use category based on information provided in the data or other sources. When facilities fell into multiple use categories (e.g., an importer of TCE using the TCE as a processing aid in HFC manufacturing), they were accounted for once under the downstream use of TCE. With respect to fluoroelastomer production, 2 companies were identified as those reporting TCE on TRI or NEI reports and had a NAICS code that related to an industry where rubber-type products were potentially manufactured. However, it is not clear that these companies use TCE to manufacture fluoroelastomers. In its 2021 Multi-Industry Per- and Polyfluoroalkyl Substances (PFAS) Substances (PFAS) Study (Preliminary) EPA identified only 2 domestic manufacturers of fluoroelastomers and one processor none of which appeared in the 2020 TRI or NEI with reports for TCE, suggesting they are not using TCE in their process. While EPA does not believe that domestic manufacture of fluoroelastomers using TCE occurs, EPA conservatively used these companies to estimate impacts of the rule and to account for the uncertainty in knowing if this is an ongoing use however, has low confidence that they are using TCE as a process solvent in the manufacture of fluoroelastomers.

Table 6-9: Number of TCE Facilities for Select Use Categories

Use Category	TCE Facilities	Notes
Laboratory Use	10	Estimated using 2017 NEI data (EPA 2020a).
Manufacturers	2	Estimated using 2020 CDR data (EPA 2022a).
Import/Repackage	9	Estimated using 2020 CDR data (EPA 2022a).
Battery and Synthetic Paper Processing Aid	3	Estimated using 2017 NEI data (EPA 2020a) and information provided by affected facilities.
HFC Manufacturing	2	Estimated using 2020 CDR data (EPA 2022a).
Batch Cold Cleaning	52	Estimated using 2017 NEI data (EPA 2020a).
HCl Production	28	Estimated using 2020 TRI (EPA 2022b) and 2017 NEI data (EPA 2020a).
Fluoroelastomer Production	2	Estimated using 2017 NEI data (EPA 2020a).

Table 6-10 shows the numbers of workers and ONUs per facility, which were derived from the TCE Risk Evaluation, except for the laboratory use, which comes from the Perchloroethylene Risk Evaluation.

Table 6-10: Number of Workers and ONUs per Facility for Select Use Categories

Use Category	Workers	ONUs
Manufacturers	70	34
Import/Repackage	2	1
Battery Manufacture	17	8
HFC Manufacturing	19	9
Batch Cold Cleaning	51	31
HCl Production	19	9
Fluoroelastomer Production	17	8
Source: TCE Risk Evaluation (EPA 2020e)		

6.2.2 Estimated Number of Workers and ONUs

For some of the use categories, EPA uses OSHA enforcement data to estimate the percentage of employees per establishment with potential exposure to TCE. The data are updated daily and report 40 years of data on the approximately 100,000 inspections conducted annually. EPA utilizes two datasets to make this calculation:

- *Inspection dataset*. The inspection dataset records information on each establishment where OSHA performed an inspection (OSHA 2020a). OSHA may conduct inspections in response to imminent danger situations, severe injuries and illnesses, worker complaints, referrals, targeted inspections, or follow-up inspections (OSHA 2016c). EPA relies on the following variables from the inspection dataset:
    - Inspection ID
    - 4-digit NAICS
    - Number of employees in establishment

- *Violation dataset*. The violation dataset records information on each establishment where OSHA issued a citation due to a standard violation (OSHA 2020b). OSHA issues a citation to an establishment if there is a standard violation and if an employee has current, past, or potential exposure to the hazard in the previous six months (OSHA 2016a). EPA relies on the following variables from the violation dataset:

- Inspection ID
- Standard
- Number of employees exposed
- Citation issuance date

EPA restricts data to establishments in violation of one of the following standards, which pertain to exposure limits for TCE and other air contaminants:

- *1910.1000(b)*. Table Z-2. An employee's exposure to any substance listed in Table Z-2 shall not exceed the exposure limits specified as follows:

- *1910.1000(b)(1)*. 8-hour time weighted averages. An employee's exposure to any substance listed in Table Z-2, in any 8-hour work shift of a 40-hour work week, shall not exceed the 8-hour time weighted average limit given for that substance in Table Z-2.

- *1910.1000(b)(2)*. Acceptable ceiling concentrations. An employee's exposure to a substance listed in Table Z-2 shall not exceed at any time during an 8-hour shift the acceptable ceiling concentration limit given for the substance in the table, except for a time period, and up to a concentration not exceeding the maximum duration and concentration allowed in the column under "acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift."

- *1910.1000(e)*. To achieve compliance with paragraphs (a) through (d) of this section, administrative or engineering controls must first be determined and implemented whenever feasible. When such controls are not feasible to achieve full compliance, protective equipment or any other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in this section. Any equipment and/or technical measures used for this purpose must be approved for each particular use by a competent industrial hygienist or other technically qualified person.

Some establishments were cited for more than one of the above standards. To avoid double-counting these establishments, EPA kept only the citation entry with the highest number of workers potentially exposed. EPA also restricts the data to citations issued within the last ten years (2010-2020).

For each NAICS, EPA estimates the percentage of workers exposed to TCE by dividing the number of employees with TCE exposures by the total number of employees for each establishment. EPA then estimates the average percentage of workers exposed per establishment across the affected NAICS for each use category.

Unless otherwise stated in the sections below, for each use category EPA estimated the average number of employees exposed to TCE per firm by multiplying the number of firms using TCE by the estimated percentage of employees exposed to TCE per firm (see Section 6.2.2) and by the average number of employees per firm, estimated using 2017 CBP data for the relevant NAICS (U.S. Census Bureau 2020). The analysis uses estimates from the supplemental risk evaluation file for environmental releases and occupational exposures (EPA 2020f) for the percentage of exposed employees in each use category that are assumed to be ONUs, with the remaining percentages assumed to be exposed workers.

6.2.3 Processing: incorporation into a formulation, mixture or reaction product

Based on the list of manufacturers of products containing TCE compiled by EPA (see Chapter 4), 28 firms are estimated to process TCE for incorporation into formulation, mixture or reaction product. We assume there is one additional firm that reformulates a TCE-containing pepper spray. Based on EPA's TCE Risk Evaluation (EPA 2020e), there are 16 workers and 5 ONUs per facility exposed to TCE.

6.2.4 Laboratory Use

Using EPA's (2020a) NEI data, 10 laboratory facilities using TCE were identified. According American Association of State Highway and Transportation Officials (AASHTO), there are 241 laboratories in more than 40 states that maintain accreditation for AASHTO and ASTM test methods T-164 and D-2172, which are methods used in the testing process for asphalt pavement material (AASHTO 2023). Thus, EPA estimates that there are 251 facilities in total under the laboratory use category. Table 6-11 presents the estimated number of facilities for laboratory uses. Based on the Perchloroethylene Risk Evaluation (EPA 2020j), EPA estimates that there is 1 worker and 9 ONUs per affected laboratory facility.

Table 6-11: Number of TCE Facilities for Laboratory Uses

Use Category	TCE Facilities	Notes
Laboratory Use (except asphalt testing)	10	Estimated using 2017 NEI data (EPA 2020a).
Laboratory Use (asphalt testing)	241	AASHTO Public Comment (AASHTO 2023).
Laboratory Use (Total)	**251**	-

6.2.5 Vapor Degreasing

The Institute for Research and Technical Assistance (IRTA) (2016b) estimated that approximately 15 percent of Open Top Vapor Degreasers (OTVDs) are operated with trichloroethylene (TCE), methylene chloride (DCM), and PCE, with the other 85 percent being operated with 1-Bromopropane (1-BP). Applying this 85:15 ratio to the estimated 2,500 vapor degreasers using 1-BP according to the final risk evaluation for 1-BP (EPA 2020c), and assuming the mix of TCE, DCM, and PCE OTVDs is 80%, 1%, and 19%, respectively, EPA estimates approximately 350 OTVDs use TCE (= 2,500 x 15/85 x 80%). Using the ratio of OTVDs to enclosed vapor degreasers (EVDs) and conveyorized vapor degreasers (CVDs) as estimated in IRTA (2016b), EPA estimates approximately 9 CVDs and 7 EVD use TCE. Based on 2017 NEI data, there is one web vapor degreaser (WVD) that uses TCE. Table 6-12 presents the estimated number of OTVDs, EVDs, CVDs, and WVDs.

Table 6-12: Estimated Number of Vapor Degreasers Using TCE

Vapor Degreaser	Estimated Number of Vapor Degreasers Using 1-BP[1]	Ratio of OTVDs Using TCE to OTVDs Using 1-BP[2]	Ratio of OTVDs to EVDs and CVDs[3]	Estimated Number of Vapor Degreasers Using TCE
Open Top Vapor Degreasers (OTVD)	2,500	0.14	-	**350**
Enclosed Vapor Degreasers (EVD)		-	0.02	**7**
Conveyorized Vapor Degreasers (CVD)		-	0.025	**9**
Web Vapor Degreasers (WVD)[4]		-	-	**1**

Notes:
[1] EPA 2020c
[2] Based on an 85:15 ratio of OTVDs operated with 1-BP versus other solvents (TCE, PCE, and DCM), and 80% of these other solvents operated with TCE (14% = 0.15/0.85 x 0.8)
[3] IRTA (2016b)
[4] Based on 2017 NEI data, there is one web vapor degreaser that uses TCE.

The numbers of workers and ONUs per vapor degreaser were estimated based on an OECD (2021) report and are presented in Table 6-13.

Table 6-13: Number of Workers and ONUs per Vapor Degreaser Facility

Use Category	Workers	ONUs
OTVD	6	4
EVD		
CVD/WVD		
Source: OECD 2021		

6.2.6 Mold Release

A total of 17 firms are estimated to use TCE in mold release (predominantly tire and rubber companies) based on 2017 NEI data (EPA 2020a). Section 6.2.2 describes the approach used to estimate the number of workers and ONUs for this use category. This results in an estimated 371 workers and 44 ONUs exposed to TCE in in mold release applications (Table 6-14).

Table 6-14: Number of Mold Release Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms Using TCE[1]	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Employees that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C	D	A x B x C x (1-D)	A x B x C x D
326211	Tire Manufacturing (except Retreading)	0	562	7%	11%	16	2
326212	Tire Retreading	2	25	7%	11%	2	0
332919	Other Metal Valve and Pipe Fitting Manufacturing	1	60	7%	11%	4	0
335220	Major Household Appliance Manufacturing	1	334	6%	11%	13	2
336320	Motor Vehicle Electrical and Electronic Equipment Manufacturing	3	111	16%	11%	51	6
336390	Other Motor Vehicle Parts Manufacturing	7	117	16%	11%	121	14
812332	Industrial Launderers	2	168	49%	11%	163	19
Total Mold Release		**17**	132	19%	11%	**371**	**44**

Notes:
[1] Based on firms identified as using TCE for mold release use from the 2017 NEI (EPA 2020a). See Section 6.1.1 for a description of how this analysis mapped use categories to firms reporting emissions to NEI.
[2] U.S. Census Bureau 2020
[3] Estimated by dividing the number of employees with TCE exposures by the total number of employees for each establishment from OSHA enforcement data (OSHA 2020a; OSHA 2020b).See Section 6.2.2 for further description.
[4] Derived from Table 2-31 of EPA 2020f (11% = 1,690 ONUs/15,900 total exposed)

6.2.7 Spot Removers

The Economic Analysis of the Proposed Regulation of Perchloroethylene Under TSCA Section 6(a) (EPA 2023a) estimated that about 6,000 facilities currently using perchloroethylene dry cleaning machines. Since TCE spot removers would generally not be compatible with other dry cleaning machines, EPA estimates that 83% of dry cleaners with perchloroethylene dry cleaning machines use TCE spotting chemicals. This estimate is based on personal communications with the Dry Cleaning and Laundry Institute and the National Cleaners Association (Personal Communication with Dry Cleaning and

Laundry Institute 2015; Dry Cleaning and Laundry Institute (DLI) and National Cleaners Association (NCA) (2017)), who estimated that 50% of dry cleaners used TCE spotting chemicals and 60% of dry cleaning machines use perchloroethylene.

Following EPA's (2023a) estimates, there is one worker and one ONU per dry cleaner. Thus, EPA estimates that there are 4,980 facilities, workers, and ONUs using TCE spotting chemicals.

6.2.8 Lubricants and Greases

This use category includes penetrating lubricants and metalworking fluids. The number of firms and workers using TCE-containing penetrating lubricants is discussed in the following Section 6.2.9. Therefore, this section only addresses metalworking fluids. EPA identified the NAICS presented in Table 6-15 based on its judgement of industries likely to engage in metal shaping operations such as machining, grinding, deformation, and blasting.

EPA did not identify information to estimate the number of facilities using metalworking fluids containing TCE. However, the Trichloroethylene Market and Use Report (EPA 2017i) estimated that no more than 1.7% of the national TCE production volume is used for "miscellaneous" uses, which includes metalworking fluids. Therefore, EPA expects the number of sites using TCE-containing metalworking fluids to be small and assumes that 0.5% of firms in industries that may use metalworking fluids use metalworking fluids containing TCE. Multiplying the assumed 0.5% market share by the 69,050 total firms in the relevant NAICS from the 2017 CBP (U.S. Census Bureau 2020) results in an estimated 345 firms using TCE.

Section 6.2.2 describes the approach used to estimate the number of workers and ONUs for this use category. As shown in Table 6-15, 1,751 workers and 76 ONUs are estimated to be exposed to TCE from lubricants and greases uses.

Table 6-15: Number of Lubricants and Greases Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms[2]	Estimated Percentage of Firms Using TCE[1]	Total Number of Firms Using TCE	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Workers that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C = A x B	D	E	F	A x B x D x E x (1-F)	C x D x E x F

Table 6-15: Number of Lubricants and Greases Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms[2]	Estimated Percentage of Firms Using TCE[1]	Total Number of Firms Using TCE	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Workers that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C = A x B	D	E	F	A x B x D x E x (1-F)	C x D x E x F
332321	Metal Window and Door Manufacturing	875	0.5%	4.4	60	15%	4%	38.7	1.7
332322	Sheet Metal Work Manufacturing	3,752	0.5%	18.8	28	15%	4%	78.5	3.4
332323	Ornamental and Architectural Metal Work Manufacturing	2,322	0.5%	11.6	16	15%	4%	27.2	1.2
332410	Power Boiler and Heat Exchanger Manufacturing	268	0.5%	1.3	85	8%	4%	8.4	0.4
332420	Metal Tank (Heavy Gauge) Manufacturing	636	0.5%	3.2	53	8%	4%	12.4	0.5
332431	Metal Can Manufacturing	66	0.5%	0.3	252	8%	4%	6.1	0.3
332439	Other Metal Container Manufacturing	261	0.5%	1.3	41	8%	4%	4.0	0.2
332510	Hardware Manufacturing	568	0.5%	2.8	50	10%	4%	13.1	0.6
332613	Spring Manufacturing	312	0.5%	1.6	55	8%	4%	6.5	0.3
332618	Other Fabricated Wire Product Manufacturing	680	0.5%	3.4	32	8%	4%	8.2	0.4
332710	Machine Shops	17,829	0.5%	89.1	13	9%	4%	96.9	4.2
332721	Precision Turned Product Manufacturing	3,670	0.5%	18.4	28	9%	4%	43.8	1.9
332722	Bolt, Nut, Screw, Rivet, and Washer Manufacturing	650	0.5%	3.3	58	9%	4%	16.1	0.7
332911	Industrial Valve Manufacturing	385	0.5%	1.9	89	16%	4%	25.9	1.1
332912	Fluid Power Valve and Hose Fitting Manufacturing	294	0.5%	1.5	124	16%	4%	27.3	1.2
332913	Plumbing Fixture Fitting and Trim Manufacturing	94	0.5%	0.5	91	16%	4%	6.4	0.3
332919	Other Metal Valve and Pipe Fitting Manufacturing	217	0.5%	1.1	60	16%	4%	9.9	0.4
332991	Ball and Roller	104	0.5%	0.5	199	16%	4%	15.6	0.7

Table 6-15: Number of Lubricants and Greases Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms[2]	Estimated Percentage of Firms Using TCE[1]	Total Number of Firms Using TCE	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Workers that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C = A x B	D	E	F	A x B x D x E x (1-F)	C x D x E x F
	Bearing Manufacturing								
332992	Small Arms Ammunition Manufacturing	148	0.5%	0.7	89	16%	4%	10.0	0.4
332993	Ammunition (except Small Arms) Manufacturing	43	0.5%	0.2	266	16%	4%	8.6	0.4
332994	Small Arms, Ordnance, and Ordnance Accessories Manufacturing	388	0.5%	1.9	52	16%	4%	15.3	0.7
332996	Fabricated Pipe and Pipe Fitting Manufacturing	644	0.5%	3.2	42	16%	4%	20.4	0.9
332999	All Other Miscellaneous Fabricated Metal Product Manufacturing	3,514	0.5%	17.6	19	16%	4%	50.3	2.2
333111	Farm Machinery and Equipment Manufacturing	1,054	0.5%	5.3	57	25%	4%	71.5	3.1
333112	Lawn and Garden Tractor and Home Lawn and Garden Equipment Manufacturing	148	0.5%	0.7	127	25%	4%	22.1	1.0
333120	Construction Machinery Manufacturing	651	0.5%	3.3	92	25%	4%	70.5	3.1
333131	Mining Machinery and Equipment Manufacturing	224	0.5%	1.1	49	25%	4%	13.1	0.6
333132	Oil and Gas Field Machinery and Equipment Manufacturing	502	0.5%	2.5	66	25%	4%	39.1	1.7
333241	Food Product Machinery Manufacturing	432	0.5%	2.2	37	2%	4%	1.7	0.1
333242	Semiconductor Machinery Manufacturing	140	0.5%	0.7	124	2%	4%	1.9	0.1
333243	Sawmill,	337	0.5%	1.7	37	2%	4%	1.3	0.1

Table 6-15: Number of Lubricants and Greases Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms[2]	Estimated Percentage of Firms Using TCE[1]	Total Number of Firms Using TCE	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Workers that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C = A x B	D	E	F	A x B x D x E x (1-F)	C x D x E x F
	Woodworking, and Paper Machinery Manufacturing								
333244	Printing Machinery and Equipment Manufacturing	263	0.5%	1.3	27	2%	4%	0.8	0.0
333249	Other Industrial Machinery Manufacturing	1,811	0.5%	9.1	30	2%	4%	5.8	0.3
333314	Optical Instrument and Lens Manufacturing	390	0.5%	2.0	38	29%	4%	20.3	0.9
333316	Photographic and Photocopying Equipment Manufacturing	180	0.5%	0.9	21	29%	4%	5.2	0.2
333318	Other Commercial and Service Industry Machinery Manufacturing	1,231	0.5%	6.2	42	29%	4%	72.1	3.1
333413	Industrial and Commercial Fan and Blower and Air Purification Equipment Manufacturing	401	0.5%	2.0	58	3%	4%	3.0	0.1
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	362	0.5%	1.8	43	3%	4%	2.0	0.1
333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	705	0.5%	3.5	126	3%	4%	11.6	0.5
333511	Industrial Mold Manufacturing	1,392	0.5%	7.0	25	6%	4%	10.4	0.5
333514	Special Die and Tool, Die Set, Jig, and Fixture Manufacturing	2,293	0.5%	11.5	19	6%	4%	13.0	0.6
333517	Machine Tool Manufacturing	787	0.5%	3.9	35	6%	4%	8.0	0.3
333519	Rolling Mill and Other	390	0.5%	2.0	35	6%	4%	4.0	0.2

Table 6-15: Number of Lubricants and Greases Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms[2]	Estimated Percentage of Firms Using TCE[1]	Total Number of Firms Using TCE	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Workers that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C = A x B	D	E	F	A x B x D x E x (1-F)	C x D x E x F
	Metalworking Machinery Manufacturing								
333515	Cutting Tool and Machine Tool Accessory Manufacturing	1,285	0.5%	6.4	21	6%	4%	7.9	0.3
333611	Turbine and Turbine Generator Set Units Manufacturing	115	0.5%	0.6	310	1%	4%	2.6	0.1
333612	Speed Changer, Industrial High-Speed Drive, and Gear Manufacturing	194	0.5%	1.0	61	1%	4%	0.9	0.0
333613	Mechanical Power Transmission Equipment Manufacturing	200	0.5%	1.0	79	1%	4%	1.1	0.0
333618	Other Engine Equipment Manufacturing	261	0.5%	1.3	136	1%	4%	2.5	0.1
333912	Air and Gas Compressor Manufacturing	261	0.5%	1.3	70	12%	4%	10.4	0.5
333914	Measuring, Dispensing, and Other Pumping Equipment Manufacturing	457	0.5%	2.3	81	12%	4%	21.1	0.9
333921	Elevator and Moving Stairway Manufacturing	166	0.5%	0.8	51	12%	4%	4.8	0.2
333922	Conveyor and Conveying Equipment Manufacturing	718	0.5%	3.6	52	12%	4%	21.0	0.9
333923	Overhead Traveling Crane, Hoist, and Monorail System Manufacturing	268	0.5%	1.3	72	12%	4%	10.9	0.5
333924	Industrial Truck, Tractor, Trailer, and Stacker Machinery Manufacturing	311	0.5%	1.6	89	12%	4%	15.6	0.7
333991	Power-Driven	123	0.5%	0.6	59	12%	4%	4.1	0.2

Table 6-15: Number of Lubricants and Greases Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms[2]	Estimated Percentage of Firms Using TCE[1]	Total Number of Firms Using TCE	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Workers that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C = A x B	D	E	F	A x B x D x E x (1-F)	C x D x E x F
	Handtool Manufacturing								
333992	Welding and Soldering Equipment Manufacturing	341	0.5%	1.7	48	12%	4%	9.2	0.4
333993	Packaging Machinery Manufacturing	471	0.5%	2.4	44	12%	4%	11.8	0.5
333994	Industrial Process Furnace and Oven Manufacturing	317	0.5%	1.6	34	12%	4%	6.2	0.3
333995	Fluid Power Cylinder and Actuator Manufacturing	253	0.5%	1.3	89	12%	4%	12.8	0.6
333996	Fluid Power Pump and Motor Manufacturing	132	0.5%	0.7	79	12%	4%	5.9	0.3
333997	Scale and Balance Manufacturing	73	0.5%	0.4	51	12%	4%	2.1	0.1
333999	All Other Miscellaneous General Purpose Machinery Manufacturing	1,558	0.5%	7.8	36	12%	4%	31.5	1.4
336111	Automobile Manufacturing	162	0.5%	0.8	511	2%	4%	9.9	0.4
336112	Light Truck and Utility Vehicle Manufacturing	49	0.5%	0.2	2,022	2%	4%	11.8	0.5
336120	Heavy Duty Truck Manufacturing	74	0.5%	0.4	358	2%	4%	3.2	0.1
336211	Motor Vehicle Body Manufacturing	632	0.5%	3.2	76	12%	4%	27.2	1.2
336212	Truck Trailer Manufacturing	379	0.5%	1.9	98	12%	4%	21.1	0.9
336213	Motor Home Manufacturing	41	0.5%	0.2	291	12%	4%	6.8	0.3
336214	Travel Trailer and Camper Manufacturing	601	0.5%	3.0	90	12%	4%	30.8	1.3
336310	Motor Vehicle Gasoline Engine and Engine Parts Manufacturing	706	0.5%	3.5	82	16%	4%	43.3	1.9

Table 6-15: Number of Lubricants and Greases Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms[2]	Estimated Percentage of Firms Using TCE[1]	Total Number of Firms Using TCE	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Workers that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C = A x B	D	E	F	A x B x D x E x (1-F)	C x D x E x F
336320	Motor Vehicle Electrical and Electronic Equipment Manufacturing	565	0.5%	2.8	111	16%	4%	46.8	2.0
336330	Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing	220	0.5%	1.1	174	16%	4%	28.5	1.2
336340	Motor Vehicle Brake System Manufacturing	139	0.5%	0.7	168	16%	4%	17.4	0.8
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing	390	0.5%	2.0	188	16%	4%	54.6	2.4
336360	Motor Vehicle Seating and Interior Trim Manufacturing	307	0.5%	1.5	235	16%	4%	53.8	2.3
336370	Motor Vehicle Metal Stamping	597	0.5%	3.0	181	16%	4%	80.3	3.5
336390	Other Motor Vehicle Parts Manufacturing	1,268	0.5%	6.3	117	16%	4%	110.2	4.8
336411	Aircraft Manufacturing	262	0.5%	1.3	636	2%	4%	12.8	0.6
336412	Aircraft Engine and Engine Parts Manufacturing	319	0.5%	1.6	211	2%	4%	5.1	0.2
336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing	750	0.5%	3.8	138	2%	4%	7.9	0.3
336414	Guided Missile and Space Vehicle Manufacturing	22	0.5%	0.1	1,608	2%	4%	2.7	0.1
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	16	0.5%	0.1	1,040	2%	4%	1.3	0.1
336419	Other Guided Missile and Space Vehicle Parts and	33	0.5%	0.2	101	2%	4%	0.3	0.0

Table 6-15: Number of Lubricants and Greases Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms[2]	Estimated Percentage of Firms Using TCE[1]	Total Number of Firms Using TCE	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Workers that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C = A x B	D	E	F	A x B x D x E x (1-F)	C x D x E x F
	Auxiliary Equipment Manufacturing								
336510	Railroad Rolling Stock Manufacturing	153	0.5%	0.8	193	16%	4%	22.0	1.0
336611	Ship Building and Repairing	503	0.5%	2.5	199	6%	4%	27.5	1.2
336612	Boat Building	833	0.5%	4.2	45	6%	4%	10.3	0.4
336991	Motorcycle, Bicycle, and Parts Manufacturing	423	0.5%	2.1	23	1%	4%	0.5	0.0
336992	Military Armored Vehicle, Tank, and Tank Component Manufacturing	38	0.5%	0.2	244	1%	4%	0.5	0.0
336999	All Other Transportation Equipment Manufacturing	390	0.5%	2.0	35	1%	4%	0.7	0.0
337124	Metal Household Furniture Manufacturing	261	0.5%	1.3	37	10%	4%	4.7	0.2
Total Lubricants and Greases		69,050	0.5%	**345**	51	10%	4%	**1,751**	**76**

Notes:
[1] EPA judgement
[2] U.S. Census Bureau 2020
[3] Estimated by dividing the number of employees with TCE exposures by the total number of employees for each establishment from OSHA enforcement data (OSHA 2020a; OSHA 2020b).See Section 6.2.2 for further description.
[4] Derived from Section 2.11.3.2 of EPA 2020f (4% = 2 ONUs/48 total exposed)

6.2.9 Aerosol Spray Cleaning/Degreasing

Table 6-16 presents the NAICS that are expected to use aerosol degreasers. Based on a survey by the California Air Resources Board (CARB), approximately 73% of automotive maintenance and repair facilities use brake cleaning products, approximately 38% of these facilities use brake cleaning products containing chlorinated chemicals, and 5-6% of the facilities that use chlorinated products reported using TCE-based products (CARB 2000). Using the high-end value from the CARB data, an estimated 1.7% of facilities are estimated to use aerosol products containing TCE (1.7% = 6% x 38% x 73%). Multiplying this 1.7% market share by an estimated 256,850 establishments in the industry (U.S. Census Bureau 2015) results in an estimated 4,366 firms using TCE-based aerosol degreasing and aerosol lubricant products.

These data only relate to aerosol brake cleaning products used in the automotive repair industry; however, aerosol degreasing may be used in electronics repair, industrial equipment repair, home and garden equipment repair, or other similar industries. Market penetration data for these industries were not identified; therefore, in lieu of other information, EPA assumes a similar market penetration as for brake cleaning products. EPA estimates the number of facilities using TCE aerosols for energized electrical cleaners (EEC) are estimated as the number of TCE aerosol users in NAICS 811213 (Communication Equipment Repair and Maintenance), 811219 (Other Electronic and Precision Equipment Repair and Maintenance), and 811310 (Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance). Thus, as shown in Table 6-16, 668 of the 4,366 firms using TCE-based aerosol degreasing and aerosol lubricant products are assumed to be using EEC aerosols.

Section 6.2.2 describes the approach used to estimate the number of workers and ONUs for this use category. As shown in Table 6-16, 5,852 workers and 696 ONUs are estimated to be exposed to TCE in aerosol products.

Table 6-16: Number of Aerosol Spray Cleaning/Degreasing Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms Using TCE[1]	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Employees that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C	D	A x B x C x (1-D)	A x B x C x D
Aerosol Spray Cleaning/Degreasing, except EEC							
313230	Nonwoven Fabric Mills	4	89	10%	11%	28	3
333514	Special Die and Tool, Die Set, Jig and Fixture Manufacturing	42	19	6%	11%	45	5
334310	Audio and Video Equipment Manufacturing	9	19	67%	11%	98	12
4411	Automobile Dealers	753	33	5%	11%	1,087	129
451110	Sporting Goods Stores	300	15	3%	11%	133	16
811111	General Automotive Repair	1,461	5	26%	11%	1,537	183
811112	Automotive Exhaust System Repair	28	3	26%	11%	21	3
811113	Automotive Transmission Repair	78	4	26%	11%	70	8
811118	Other Automotive Mechanical and Electrical Repair and Maintenance	56	5	26%	11%	63	7
811121	Automotive Body, Paint and Interior Repair and Maintenance	604	7	26%	11%	1,041	124
811122	Automotive Glass Replacement Shops	88	6	26%	11%	128	15
811191	Automotive Oil Change and Lubrication Shops	83	14	26%	11%	263	31
811198	All Other Automotive Repair and Maintenance	67	5	26%	11%	76	9
811211	Consumer Electronics Repair and Maintenance	32	7	8%	11%	17	2
811212	Computer and Office Machine Repair and Maintenance	94	7	8%	11%	45	5
Non-EEC subtotal		***3,698***	***12***	***12%***	***11%***	***4,651***	***553***
EEC Aerosol Spray Cleaning/Degreasing							
811213	Communication Equipment Repair and Maintenance	32	10	8%	11%	24	3
811219	Other Electronic and Precision Equipment Repair and Maintenance	51	13	8%	11%	48	6
811310	Commercial and Industrial Machinery	369	10	29%	11%	958	114

Table 6-16: Number of Aerosol Spray Cleaning/Degreasing Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms Using TCE[1]	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Employees that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C	D	A x B x C x (1-D)	A x B x C x D
	and Equipment (except Automotive and Electronic) Repair and Maintenance						
811411	Home and Garden Equipment Repair and Maintenance	31	3	25%	11%	19	2
811490	Other Personal and Household Goods Repair and Maintenance	184	4	25%	11%	153	18
EEC subtotal		***668***	***8***	***25%***	***11%***	***1,201***	***143***
All Aerosol Spray Cleaning/Degreasing							
Total Aerosol Spray Cleaning/Degreasing		**4,366**	12	13%	11%	**5,852**	**696**

Notes:
[1] EPA 2017a
[2] U.S. Census Bureau 2020
[3] Estimated by dividing the number of employees with TCE exposures by the total number of employees for each establishment from OSHA enforcement data (OSHA 2020a; OSHA 2020b).See Section 6.2.2 for further description.
[4] Derived from Table 2-31 of EPA 2020f (11% = 1,690 ONUs/15,900 total exposed)

6.2.10 Adhesives, Sealants, Paints, and Coatings

Using the approach described in Section 6.1 to map use categories to the 2017 NEI data (EPA 2020a), this analysis identified nine firms in the NEI data that use TCE in adhesives and sealants and 31 firms that use TCE in paints and coatings. EPA expects that this may underestimate the number of firms in these use categories because many of these firms could be nonpoint sources of TCE and would not be identified in the NEI data. Therefore, EPA also includes an additional 25 firms identified in the risk evaluation (EPA 2020f) for a total of 65 firms. The risk evaluation derived its estimates for the number of firms from 2014 NEI, 2016 TRI, and 2016 DMR data. Note that for the NAICS that are reported in both the risk evaluation and the 2017 NEI data, this analysis uses the firm counts from the 2017 NEI data because they are more recent than the data used in the risk evaluation.

Section 6.2.2 describes the approach used to estimate the number of workers and ONUs for this use category. As shown in Table 6-17, 616 workers and 288 ONUs are estimated to be exposed to TCE in adhesives, sealants, paints, and coatings.

Table 6-17: Number of Adhesive, Sealants, Paints and Coatings Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms Using TCE[1]	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Employees that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C	D	A x B x C x (1-D)	A x B x C x D

Table 6-17: Number of Adhesive, Sealants, Paints and Coatings Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms Using TCE[1]	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Employees that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C	D	A x B x C x (1-D)	A x B x C x D
313210	Broadwoven Fabric Mills	1	63	10%	32%	4	2
313320	Fabric Coating Mills	1	46	53%	32%	17	8
321992	Prefabricated Wood Building Manufacturing	1	32	14%	32%	3	1
322220	Paper Bag and Coated and Treated Paper Manufacturing	2	84	8%	32%	9	4
324199	All Other Petroleum and Coal Products Manufacturing	1	46	17%	32%	5	2
325510	Paint and Coating Manufacturing	1	39	32%	32%	8	4
325520	Adhesive Manufacturing	1	60	32%	32%	13	6
325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing	2	35	19%	32%	9	4
32614	Polystyrene Foam Product Manufacturing	2	88	12%	32%	14	7
326150	Urethane and Other Foam Product (except Polystyrene) Manufacturing	1	73	12%	32%	6	3
326211	Tire Manufacturing (except Retreading)	2	562	7%	32%	52	24
326212	Tire Retreading	1	25	7%	32%	1	1
326220	Rubber and Plastics Hoses and Belting Manufacturing	2	101	7%	32%	9	4
326299	All Other Rubber Product Manufacturing	2	53	7%	32%	5	2
331523	Nonferrous Metal Die-Casting Foundries	1	96	9%	32%	6	3
332321	Metal Window and Door Manufacturing	2	60	15%	32%	13	6
332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	1	23	19%	32%	3	1
332813	Electroplating, Plating, Polishing, Anodizing and Coloring	9	25	19%	32%	30	14
332993	Ammunition (except Small Arms) Manufacturing	1	266	16%	32%	28	13
332994	Small Arms, Ordnance, and Ordnance Accessories Manufacturing	2	52	16%	32%	11	5
332999	All Other Miscellaneous Fabricated Metal Product Manufacturing	2	19	16%	32%	4	2
333515	Cutting Tool and Machine Tool Accessory Manufacturing	1	21	6%	32%	1	0
333914	Measuring, Dispensing, and Other Pumping Equipment Manufacturing	1	81	12%	32%	7	3
334417	Electronic Connector Manufacturing	1	118	7%	32%	5	2
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	1	301	1%	32%	2	1
335312	Motor and Generator Manufacturing	1	78	5%	32%	3	1

Table 6-17: Number of Adhesive, Sealants, Paints and Coatings Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms Using TCE[1]	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Employees that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C	D	A x B x C x (1-D)	A x B x C x D
335931	Current-Carrying Wiring Device Manufacturing	1	71	7%	32%	3	2
336211	Motor Vehicle Body Manufacturing	1	76	12%	32%	6	3
336213	Motor Home Manufacturing	1	291	12%	32%	24	11
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing	1	188	16%	32%	20	9
336360	Motor Vehicle Seating and Interior Trim Manufacturing	1	235	16%	32%	25	12
336390	Other Motor Vehicle Parts Manufacturing	2	117	16%	32%	25	12
336411	Aircraft Manufacturing	3	636	2%	32%	21	10
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	1	1,040	2%	32%	11	5
336611	Ship Building and Repairing	1	199	6%	32%	8	4
337110	Wood Kitchen Cabinet and Counter Top Manufacturing	1	15	10%	32%	1	0
337121	Upholstered Household Furniture Manufacturing	1	68	10%	32%	5	2
337122	Nonupholstered Wood Household Furniture Manufacturing	1	13	10%	32%	1	0
337211	Wood Office Furniture Manufacturing	1	43	3%	32%	1	0
339113	Surgical Appliance and Supplies Manufacturing	1	53	15%	32%	5	3
339920	Sporting and Athletic Goods Manufacturing	1	25	27%	32%	5	2
339991	Gasket, Packing, and Sealing Device Manufacturing	1	58	27%	32%	11	5
481111	Scheduled Passenger Air Transportation	1	1,376	19%	32%	175	82
928110	National Security	2	215	0%	32%	0	0
Total Adhesives, Sealants, Paints, and Coatings		**65**	**154**	**9%**	**32%**	**616**	**288**

Notes:
[1] Based on EPA 2017a and firms identified as using TCE for adhesive and sealant use from the 2017 NEI (EPA 2020a). See Section 6.1.1 for a description of how this analysis mapped use categories to firms reporting emissions to NEI.
[2] U.S. Census Bureau 2020
[3] Estimated by dividing the number of employees with TCE exposures by the total number of employees for each establishment from OSHA enforcement data (OSHA 2020a; OSHA 2020b).See Section 6.2.2 for further description.
[4] Derived from Table 2-36 of EPA 2020f (32% = 1,400 ONUs/4,400 total exposed)

6.2.11 Liquid Cleaners and Degreasers

EPA expects that wipe cleaning is primarily done in automobile, appliance, and electronics repair shops and assumes that the same NAICS may potentially be affected as those identified for the aerosol spray cleaning and degreasing use (see section 6.2.9) . EPA did not identify any information on the number or percentage of repair shops that use wipe cleaning products containing TCE. Therefore, this analysis assumes a 5% market share of TCE products in repair industries. Multiplying the assumed 5% market share by the 236,309 total firms in the relevant NAICS from the 2017 CBP (U.S. Census Bureau 2020) results in an estimated 11,815 firms using TCE.

Section 6.2.2 describes the approach used to estimate the number of workers and ONUs for this use category. As shown in Table 6-18, 16,053 workers and 1,667 ONUs are estimated to be exposed to TCE from liquid cleaners and degreasers use.

Table 6-18: Number of Liquid Cleaners and Degreasers Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms[2]	Estimated Percentage of Firms Using TCE[1]	Total Number of Firms Using TCE	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Employees that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C = A x B	D	E	F	A x B x D x E x (1-F)	C x D x E x F
313230	Nonwoven Fabric Mills	195	5%	10	89	10%	9%	76	8
333514	Special Die and Tool, Die Set, Jig and Fixture Manufacturing	2,293	5%	115	19	6%	9%	123	13
334310	Audio and Video Equipment Manufacturing	462	5%	23	19	67%	9%	269	28
4411	Automobile Dealers	40,769	5%	2,038	33	5%	9%	2,983	310
451110	Sporting Goods Stores	16,233	5%	812	15	3%	9%	364	38
811111	General Automotive Repair	79,072	5%	3,954	5	26%	9%	4,216	438
811112	Automotive Exhaust System Repair	1,521	5%	76	3	26%	9%	59	6

Table 6-18: Number of Liquid Cleaners and Degreasers Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms[2]	Estimated Percentage of Firms Using TCE[1]	Total Number of Firms Using TCE	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Employees that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C = A x B	D	E	F	A x B x D x E x (1-F)	C x D x E x F
811113	Automotive Transmission Repair	4,206	5%	210	4	26%	9%	191	20
811118	Other Automotive Mechanical and Electrical Repair and Maintenance	3,027	5%	151	5	26%	9%	172	18
811121	Automotive Body, Paint and Interior Repair and Maintenance	32,696	5%	1,635	7	26%	9%	2,855	296
811122	Automotive Glass Replacement Shops	4,764	5%	238	6	26%	9%	350	36
811191	Automotive Oil Change and Lubrication Shops	4,467	5%	223	14	26%	9%	722	75
811198	All Other Automotive Repair and Maintenance	3,637	5%	182	5	26%	9%	208	22
811211	Consumer Electronics Repair and Maintenance	1,746	5%	87	7	8%	9%	47	5
811212	Computer and Office Machine Repair and Maintenance	5,068	5%	253	7	8%	9%	124	13
811213	Communication Equipment Repair and Maintenance	1,738	5%	87	10	8%	9%	65	7
811219	Other Electronic and Precision Equipment Repair and Maintenance	2,787	5%	139	13	8%	9%	130	14
811310	Commercial and Industrial Machinery and Equipment (except	19,986	5%	999	10	29%	9%	2,628	273

Table 6-18: Number of Liquid Cleaners and Degreasers Firms and Individuals

NAICS[1]	NAICS Description	Total Number of Firms[2]	Estimated Percentage of Firms Using TCE[1]	Total Number of Firms Using TCE	Average Number of Total Employees per Firm[2]	Estimated Percentage of Employees Exposed to TCE[3]	Percentage of Employees that are ONUs[4]	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
		A	B	C = A x B	D	E	F	A x B x D x E x (1-F)	C x D x E x F
	Automotive and Electronic) Repair and Maintenance								
811411	Home and Garden Equipment Repair and Maintenance	1,704	5%	85	3	25%	9%	52	5
811490	Other Personal and Household Goods Repair and Maintenance	9,938	5%	497	4	25%	9%	419	43
Total Liquid Cleaners and Degreasers		236,309	5%	**11,815**	12	13%	9%	**16,053**	**1,667**

Notes:
[1] EPA judgement. Assumed to be the same as aerosol spray cleaning/degreasing use.
[2] U.S. Census Bureau 2020
[3] Estimated by dividing the number of employees with TCE exposures by the total number of employees for each establishment from OSHA enforcement data (OSHA 2020a; OSHA 2020b).See Section 6.2.2 for further description.
[4] Derived from Table 2-43 of EPA 2020f (9% = 25,300 ONUs/269,000 total exposed)

6.2.12 Disposal to Wastewater

TCE is a contaminant of concern in a significant number of cleanup sites that are managed under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund sites, as well as under The Resource Conservation and Recovery Act (RCRA). The remediation of these sites, including the removal and treatment of TCE-contaminated groundwater, is critical to EPA's mission to protect human health and the environment. Additionally, there are sites where TCE-contaminated groundwater is being addressed under the authority of other federal environmental laws or state and local government authorities. The disposal of wastewater that contains TCE to industrial pre-treatment, industrial treatment, or publicly owned treatment works is an important method used in these cleanup efforts. At many contaminated sites, TCE-contaminated wastewater is pumped out of the ground and either sent to offsite industrial treatment or publicly owned treatment works.

According to EPA's Superfund Enterprise Management System, (SEMS) there are 1,649 sites on the Superfund National Priorities List (including Superfund Alternative Approach (SAA)) sites. Of these sites, 736 (approximately 45%) have TCE in groundwater at a concentration where remediation is needed (EPA 2023b). EPA estimates that there are 739 POTWs potentially affected by the rule, accounting for an affected POTW for each clean-up site and 4 POTWs potentially receiving contaminated wastewater from 2 battery manufacturers and 1 synthetic paper manufacturer.

Section 6.2.2 describes the approach used to estimate the number of workers and ONUs for this use category. As shown inTable 6-19, 177 workers and 103 ONUs are estimated to be exposed to TCE from the disposal use category.

Table 6-19: Number of Disposal Firms and Individuals

Use Category	Number of Sites Using TCE	Workers	ONUs
Disposal to Wastewater	739	9,607	3,695

6.2.13 Summary of Number of Affected Firms and Employees

Table 6-20 presents a summary of the number of affected firms and employees, by COU.

Table 6-20: Summary of Affected Firms and Employees

Use Category	Number of Sites Using TCE	Number of Workers Exposed to TCE	Number of ONUs Exposed to TCE
Laboratory Use	251	251	2,259
Manufacturing	2	140	68
Import/Repackage	9	18	9
Processing Aid (Battery and Synthetic Paper)	3	51	24
HFC Manufacturing	2	38	18
Intermediate in HCl Production	28	532	252
Fluoroelastomer Manufacture	2	34	16
Open-Top Vapor Degreasing	350	2,100	1,400
Enclosed Vapor Degreasing	7	42	28
Conveyorized Vapor Degreasing	8	48	32
Web Vapor Degreasing	1	6	4
Batch Cold Cleaning	52	312	208
Disposal to Wastewater	739	9,607	3,695
Incorporation Into Formulation, Mixture, or Reaction Product	28	448	140
Mold Release	17	371	44
Liquid Cleaners and Degreasers	11,815	16,053	1,667
Aerosol Spray Cleaning/Degreasing	4,366	5,852	696
Lubricants and Greases	345	1,751	76
Adhesives, Sealants, Paints and Coatings	65	616	288
Spot Removers	4,980	14,940	3,735
Film Cleaner	-	-	-
Toner Aid	-	-	-
Polish	-	-	-
Pepper Spray	-	-	-
Total	**23,070**	**53,210**	**14,659**

6.3 Estimated Number of Exposed Consumers

Table 6-21 presents the estimated number of consumer users, which are estimated as a function of the estimated TCE consumption volumes presented above in Table 6-8. The percentage of total consumption assumed to be for consumer use for the calculations is an assumed value based on EPA judgement, and therefore these estimated numbers of exposed consumers should be considered highly uncertain.

Table 6-21: Estimated number of Consumer Users

Use Category	Annual Volume of TCE Consumed (lbs)[1]	Percentage Consumer Use[2]	Estimated Volume of Consumer TCE Use (oz)	TCE Product Concentration[3]	Estimated Volume of Consumer Product Use (oz)	Median Consumer Product Use (oz/year)[4]	Number of Annual Consumer Users	Notes
	A	B	C = (A x B) x 16 oz/lb	D	E = C / D	F	G = E / F	
Aerosol Spray Cleaning/Degreasing	203,522	5%	162,818	84%	193,430	16	12,089	(EPA 2011a) product category: Engine Degreasers. TCE product concentration based on average of midpoint % TCE in formulation for 24 aerosol cleaners/degreasers
Mold Release	89,157	0.05%	713	67%	1,069	16	67	(EPA 2011a) product category: Solvent-Type Cleaning Fluids or Degreasers. TCE product concentration based on average of midpoint % TCE in formulation for 13 mold release products
Lubricants and Greases	185,000	0.05%	1,480	21%	7,108	2.25	3,159	(EPA 2011a) product category: Other Lubricants (excluding automotive). TCE product concentration based on average of midpoint % TCE in formulation for 7 lubricant products (40-60, 5-10, 15.7-25.8, 5-10, 7-13, 7-13, 40-50).
Adhesives and Sealants	149,491	0.05%	1,196	55%	2,184	1	2,184	(EPA 2011a) product category: Adhesives. TCE product concentration based on average of midpoint % TCE in formulation for 14 adhesive products
Spot Removers	1,134,123	0.05%	9,073	57%	16,011	5.5	2,911	(EPA 2011a) product category: Spot removers. TCE product concentration based on average of midpoint % TCE in formulation for 3 dry cleaning products
Liquid Cleaners and Degreasers	360,408	0.05%	2,883	95%	3,035	16	190	(EPA 2011a) product category: Solvent-Type Cleaning Fluids or Degreasers. TCE product concentration based on average of midpoint % TCE in formulation for 3 liquid degreasers

[1]See Table 6-8.
[2]EPA assumption.
[3]See Notes Column.
[4]See Table 17-6 in EPA 2011a).

7. Cost Analysis

This chapter presents the estimated incremental costs of the options considered in this analysis across the regulated use categories. Section 7.1 summarizes the options considered for each use category. Section 7.2 addresses the timeframe of the analysis with respect to annualized costs. Section 7.3 presents a summary of the number of affected entities with incremental costs. Section 7.4 presents the fully loaded wage rates used in the economic analysis. Section 7.5 presents the estimated costs associated with rule familiarization and downstream notification. Section 7.6 presents estimated costs for the reformulation of products containing TCE. Section 7.7 presents estimated costs for switching to alternatives to TCE in vapor degreasing. Section 7.8 presents estimated costs for compliance with the dermal protection component of a Workplace Chemical Protection Program (WCPP). Section 7.9 presents estimated costs for compliance with the respiratory protection components of a WCPP. Section 7.10 summarizes the total costs for WCPP compliance. Section 7.11 presents the estimated costs for the interim prescriptive controls required for aerosol spray energized electrical cleaners. Section 7.12 presents a discussion of unquantified costs and other uncertainties underlying the cost estimates. Section 7.13 presents the total annualized costs under the options.

Figure 7-1, on the following page, presents an overview of the key elements of the cost analysis.

Figure 7-1: Overview of Key Quantified Elements of the Cost Analysis

Rule Familiarization (see section 7.5)	• Incremental cost impact incurred by entities affected by the rule • Estimated as an initial labor burden for the time needed to understand how the rule applies to them and what they need to do to comply with the rule's requirements
Downstream Notification (see section 7.5)	• For uses that are not prohibited, manufacturers are assumed to incur a labor burden for modifying their SDS in order to comply with the downstream notification requirements
Costs of the Prohibition of Products Containing TCE (see section 7.6)	• Each product containing TCE is assumed to be replaced by a product that was reformulated ($64,966 per product) • Since alternative products with similar costs and efficacy are available (see Chapter 5), incremental costs beyond rule familiarization for product users that must switch to alternatives are not estimated (see discussion of unquantified costs and uncertainties in section 7.11)
Costs of the Prohibition of TCE for Vapor Degreasing (see section 7.7)	• Substantial transition and capital costs may be necessary to switch to TCE vapor degreasing alternatives • Incremental additional ongoing costs are also estimated • Estimated annualized costs are $65k - $90k per vapor degreaser
Workplace Chemical Protection Program (see sections 7.8, 7.9, and 7.10)	• Costs include a labor burden for setting up and maintaining a workplace chemical protection program (WCPP), which includes dermal and respiratory exposure control • Non-labor costs include exposure monitoring and PPE costs (dermal and respiratory) • Note that exposures are required to be addressed using the hierarchy of controls, but because potential administrative and engineering control costs are unknown, costs of compliance are estimated assuming PPE is used to comply (this assumption is made for the purpose of cost estimation only and does not mean EPA expects compliance will be achieved only by using PPE)
Costs of Prohibition Estimated Using WCPP Costs (section 7.12)	• WCPP costs are used as a lower bound estimate for prohibition costs for the following use categories: manufacturing, battery separator manufacture, intermediate in HCl production, and fluoroelastomer manufacture
Uncertainties and Unquantified Costs (section 7.11)	Uncertainties and unquantified costs associated with the following are discussed: • Switching to alternative products • How TCE is being used in conditions of use (COUs) defined by the sector using TCE (e.g., oil and gas drilling) • COUs prohibited only under Option 3 • WCPP estimate uncertainties

7.1 Description of Options

Table 7-1 summarizes the regulatory options by use category. The options are described in more detail in section 1.2.

Table 7-1: Summary of Regulatory Options by Use Category

<table>
<tr><th>Use Category</th><th>Option 1 (ECEL of 0.2 ppm)</th><th>Option 2 (ECEL of 0.0011ppm)</th></tr>
<tr><td>Laboratory Use</td><td>WCPP followed by prohibition[1]

[1]Asphalt Testing: WCPP for 10 years followed by prohibition (10-year 6g exemption). Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.</td><td>Prohibition/WCPP followed by prohibition[2]

[2]Asphalt Testing: Prohibited. Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.</td></tr>
<tr><td>Manufacturing</td><td colspan="2" rowspan="2">WCPP for limited uses until prohibited[3]

[3]Interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.</td></tr>
<tr><td>Import/Repackage</td></tr>
<tr><td>Battery and Synthetic Paper Processing Aid</td><td>WCPP followed by prohibition[4]

[4]20-year exemption with WCPP 6 months after rule finalization for lead acid battery separators. 5-year exemption with WCPP 6 months after rule finalization for lithium battery separators.15-year exemption with WCPP 6 months after rule finalization for synthetic paper.</td><td>WCPP followed by prohibition[5]

[5]10-year exemption with WCPP 6 months after rule finalization for battery separator manufacture. Synthetic paper use prohibited.</td></tr>
<tr><td>HFC Manufacturing</td><td colspan="2">Long-Term Phase Out with WCPP followed by Prohibition[6]

[6]Long-term phase out to prohibition over 8.5 years, interim requirements of WCPP.</td></tr>
<tr><td>Intermediate in HCl Production</td><td>Not Subject to Rule</td><td>WCPP followed by prohibition[7]

[7]WCPP 6 months to 2 years after rule finalization followed by prohibition.</td></tr>
<tr><td>Fluoroelastomer Manufacture</td><td colspan="2">WCPP followed by Prohibition[8]

[8]WCPP 6 months to 2 years after rule finalization followed by prohibition.</td></tr>
<tr><td>Open-Top Vapor Degreasing</td><td colspan="2" rowspan="4">Prohibition with Interim WCPP for Exemptions[9]

[9]A 6(g) exemption for 7 years applies to OTVD for narrow tubes for aerospace or medical device use. A 6(g) exemption for 10 years applies to naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes for OTVDs. A 6(g) exemption for 7 years applies to human-rated rocket engine cleaning in EVDs by Federal agencies and their contractors. A 6(g) exemption for 10 years applies to rayon fabric scouring in EVDs for rocket booster nozzle production for Federal agencies and their contractors.</td></tr>
<tr><td>Enclosed Vapor Degreasing</td></tr>
<tr><td>Conveyorized/Web Vapor Degreasing</td></tr>
<tr><td>Batch Cold Cleaning</td></tr>
<tr><td>Disposal to Wastewater</td><td>Prohibition 1 year after rule finalization with WCPP requirements for POTWs exceeding a water screening level and worker protection requirements for cleanup sites and industrial treatment/pre-treatment. [10]

[10]For POTWs above the water screening level, WCPP would be required (with the interim occupational exposure limit (ECEL)). For cleanup site workers and industrial treatment/pre-treatment, use TSCA regulatory limit (new interim occupational exposure limit (ECEL)) within the framework of existing OSHA HAZWOPER requirements.</td><td>Prohibition[11]

[11]One year after rule finalization.</td></tr>
</table>

Table 7-1: Summary of Regulatory Options by Use Category

<table>
<tr><th>Use Category</th><th>Option 1 (ECEL of 0.2 ppm)</th><th>Option 2 (ECEL of 0.0011ppm)</th></tr>
<tr><td>Energized Electrical Cleaners</td><td>Prohibition with Interim APF50 Respirator Requirement[12]

[12]Prohibit 3 years after rule finalization with interim prescriptive respiratory protection requirements of APF 50 respirator use.</td><td>Prohibition[13]

[13]Six months after rule finalization.</td></tr>
<tr><td>Incorporation into Formulation, Mixture, or Reaction Product</td><td colspan="2" rowspan="14">Prohibition[14,15]

[14]Prohibition six months after rule finalization.

[15]Adhesives and Sealants for Aerospace uses have a 5-year exemption with interim WCPP. Since the numbers of workers affected by the exemption is unknown, the exemption is not accounted for in the analysis and the costs and benefits from prohibition are assumed for all affected users of adhesives, sealants, paints, and coatings.</td></tr>
<tr><td>Commercial Use Pepper Spray</td></tr>
<tr><td>Incorporation into Articles</td></tr>
<tr><td>Mold Release</td></tr>
<tr><td>Liquid Cleaners and Degreasers</td></tr>
<tr><td>Aerosol Spray Cleaning/Degreasing (except EEC)</td></tr>
<tr><td>Lubricants and Greases</td></tr>
<tr><td>Adhesives, Sealants, Paints and Coatings[3]</td></tr>
<tr><td>Functional Fluids</td></tr>
<tr><td>Spot Removers</td></tr>
<tr><td>Film Cleaner</td></tr>
<tr><td>Toner Aid</td></tr>
<tr><td>Polish</td></tr>
</table>

7.2 Timeline for the Analysis

In selecting the number of years of the regulatory options to consider in the cost-benefit analysis, it is important to select a timeframe sufficiently long enough to capture the important effects of the benefits and the costs without selecting a timeframe that is so long that it adds unnecessary uncertainty. In addition, EPA's (2014a) *Guidelines for Preparing Economic Analyses* suggests the following when selecting the time horizon:

> "That is, the time horizon should be long enough that the net benefits for all future years (beyond the time horizon) are expected to be negligible when discounted to the present. In practice, however, it is not always obvious when this will occur because it may be unclear whether or when the policy will be renewed or retired by policy makers, whether or when the policy will become obsolete or "non-binding" due to exogenous technological changes, how long the capital investments or displacements caused by the policy will persist, etc.
>
> As a practical matter, reasonable alternatives for the time span of the analysis may be based on assumptions regarding:
>
> - The expected life of capital investments required by or expected from the policy;
> - The point at which benefits and costs reach a steady state;

- Statutory or other requirements for the policy or the analysis; and/or
- The extent to which benefits and costs are separated by generations."

The recommendation in EPA's (2014a) guidance that "the time horizon should be long enough that the net benefits for all future years (beyond the time horizon) are expected to be negligible when discounted to the present" would imply that a fairly long time horizon would be appropriate. For example, if one assumes that the rule never becomes obsolete or non-binding, net benefits in the 100th year of the policy would still exceed $100,000 after discounting them back to present dollars using a 3% discount rate. However, the probability that the rule becomes obsolete increases over time. For example, newer chemicals or other technological advances could make TCE obsolete without any rule. Given this uncertainty, EPA selected a shorter time horizon of 20 years for the analysis. A time period of 20 years is short enough that the products that were reformulated to be TCE-free would probably not need to be reformulated again during that time period. In addition, the annualized costs and benefits of the rule start to level out at a 20-year time horizon. Thus, selecting a longer time horizon is unlikely to have a significant effect on the relative rankings of the options under consideration.

The present discounted value for the annualized value of the 20-year stream of costs is estimated using discount rates of 2, 3 and 7 percent. Costs are discounted (for the discount rate r = 3% and r = 7%) back to the beginning of the 20-year period, as follows:

$$Present\ Discounted\ Value = \sum_{t=0}^{20} \frac{(Undiscounted\ Value)_t}{(1+r)^t} \qquad (1)$$

The present discounted value costs are annualized as follows:

$$(Annualized\ Costs) = (PDV_{20\ year\ cost\ stream}) * \frac{r * (1+r)^{20}}{(1+r)^{21} - 1} \qquad (2)$$

7.2.1 Accounting for the timing of implementing phased-in requirements

With the exception of the prohibitions on manufacture and import for most conditions of use, most other requirements are effective between 6 to 12 months after the rule is finalized. To simplify the calculations, "time zero" for the analysis is 6-12 months after the rule is finalized. The timing of requirements that are phased in over time are accounted for by rounding to the nearest year. Thus, no distinction is made for implementation 6 to 12 months after rule finalization is made. For example, under Option 1 laboratories using TCE for asphalt testing must comply with a WCPP starting 6 months after the rule is finalized through 10 years after the rule is finalized. After 10 years TCE is prohibited for this use. The analysis accounts for this as 9 years of meeting WCPP requirements and 11 years of prohibition.

It is also worth noting that the prohibition on TCE for laboratory uses goes into effect more than 20 years after the rule is finalized, which is after the end of the analytical timeframe for our analysis. Whether alternatives for TCE in laboratory testing will be available in 25 or 30 years is unknown, and what their costs would be is also unknown. Therefore, this analysis does not extend its timeframe to 25 or 30 years because the costs and benefits that would be incurred that many years in the future are highly uncertain.

Table 7-2: Summary of Timing of Requirements under the Rule and the Analysis by Use Category

<table>
<tr><th>Use Category</th><th>Option 1 (ECEL of 0.2 ppm)</th><th>Option 2 (ECEL of 0.0011ppm)</th></tr>
<tr><td>Laboratory Use</td><td>Rule: Asphalt Testing: WCPP for 10 years followed by prohibition (10-year 6g exemption). Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization
Analysis: Asphalt Testing: WCPP for 9 years followed by prohibition (where WCPP costs are used as a proxy for the unknown costs of prohibition). Other lab uses: WCPP for 20 years</td><td>Rule: Asphalt Testing: Prohibited. Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization. Other lab uses: Exempt for 50 years, interim requirements of WCPP 6 months after rule finalization
Analysis: Asphalt Testing: 20 years of prohibition (where WCPP costs are used as a proxy for the unknown costs of prohibition). Other lab uses: WCPP for 20 years</td></tr>
<tr><td>Manufacturing</td><td rowspan="2">Rule: Limited to permitted uses with WCPP 6 months after rule finalization
Analysis: 20 years of WCPP for Manufacturing; other uses are discontinued.</td><td rowspan="2">Rule: Limited to permitted uses with WCPP 6 months after rule finalization
Analysis: 20 years of WCPP for Manufacturing; other uses are discontinued.</td></tr>
<tr><td>Import/Repackage</td></tr>
<tr><td>Battery and Synthetic Paper Processing Aid</td><td>Rule: 20-year exemption with WCPP 6 months after rule finalization for lead acid batteries. 5-year exemption with WCPP 6 months after rule finalization for lithium batteries.15-year exemption with WCPP 6 months after rule finalization for synthetic paper.
Analysis: 14 years of WCPP and 6 years of prohibition (where WCPP costs are used as a proxy for the unknown costs of prohibition). Note that the lithium ion separator manufacturer producers the lead-acid separator in the same facility.</td><td>Rule: 10-year exemption with WCPP 6 months after rule finalization for battery separator manufacture. 2-year exemption with WCPP 6 months after rule finalization for synthetic paper.
Analysis: 9 years of WCPP and 11 years of prohibition (where WCPP costs are used as a proxy for the unknown costs of prohibition) for battery separator manufacture. 20 years of prohibition (where WCPP costs are used as a proxy for the unknown costs of prohibition) for synthetic paper.</td></tr>
</table>

HFC Manufacturing	**Rule:** Long-term phase out to prohibition over 8.5 years, interim requirements of WCPP **Analysis:** 9 years of WCPP (no costs after year 9 since it is a baseline phase-out).	**Rule:** Long-term phase out to prohibition over 8.5 years, interim requirements of WCPP **Analysis:** 9 years of WCPP (no costs after year 9 since it is a baseline phase-out).
Intermediate in HCl Production	**Rule:** Not subject to the rule **Analysis:** Costs are zero because they are exempt.	**Rule:** Exempt for 2 years (with interim WCPP) **Analysis:** 1 year of WCPP and 19 years of prohibition (where WCPP costs are used as a proxy for the unknown costs of prohibition)
Fluoroelastomer Manufacture	**Rule:** Exempt for 2 years (with interim WCPP) **Analysis:** 1 year of WCPP and 19 years of prohibition (where WCPP costs are used as a proxy for the unknown costs of prohibition)	
Open-Top Vapor Degreasing	**Rule:** Prohibition 1 year after rule finalization except for 6g exemptions. A 6g exemption for 7 years applies to narrow tubes and medical device use. A 6g exemption for 10 years applies to naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes. **Analysis:** 5 OTVDs are assumed to have 6 years of WCPP and 14 years of prohibition. 1 OTVD is assumed to have 9 years of WCPP and 11 years of prohibition. Other OTVDs are assumed to have 20 years of prohibition.	**Rule:** Prohibition 1 year after rule finalization **Analysis:** Prohibition at "time zero"
Enclosed Vapor Degreasing	**Rule:** Prohibition 1 year after rule finalization, except for 6g exemptions. A 6g exemption for 7 years applies to human-rated rocket engine cleaning by Federal agencies and their contractors. A 6g exemption for 10 years applies to rayon fabric scouring for rocket booster nozzle production for Federal agencies and their contractors. **Analysis:** Prohibition at time zero, except for one vapor degreaser with 6 years of WCPP and 14 years of prohibition and one vapor degreaser with 9 years of WCPP and 11 years of prohibition.	
Conveyorized/Web Vapor Degreasing	**Rule:** Prohibition 1 year after rule finalization **Analysis:** Prohibition at "time zero"	
Batch Cold Cleaning		
Disposal to Wastewater	**Rule**: Prohibition 1 year after rule finalization[1,2] with WCPP requirements for POTWs exceeding a water screening level and worker protection requirements for cleanup sites and industrial treatment/pre-treatment. **Analysis:** Costs for clean-up sites are not estimated, as these facilities are likely to be in compliance under the baseline. Costs are estimated as the WCPP costs for the affected POTWs.	**Rule**: Prohibition 1 year after rule finalization[2] **Analysis:** Costs for clean-up sites are not estimated. Costs are estimated as the WCPP costs for the affected POTWs.

<table>
<tr><td>Energized Electrical Cleaners</td><td>Rule: Prohibit 3 years after rule finalization with interim prescriptive respiratory protection requirements[3]
Analysis: 2 years of APF 50 PPE and 19 years of prohibition.</td><td rowspan="15">Rule: Prohibit 6 months after rule finalization
Analysis: Prohibition at “time zero”</td></tr>
<tr><td>Incorporation into Formulation, Mixture, or Reaction Product</td><td rowspan="14">Rule: Prohibit 6 months after rule finalization[3]
Analysis: Prohibition at “time zero”</td></tr>
<tr><td>Commercial Use Pepper Spray</td></tr>
<tr><td>Incorporation into Articles</td></tr>
<tr><td>Mold Release</td></tr>
<tr><td>Liquid Cleaners and Degreasers</td></tr>
<tr><td>Aerosol Spray Cleaning/Degreasing (except EEC)</td></tr>
<tr><td>Lubricants and Greases</td></tr>
<tr><td>Adhesives, Sealants, Paints and Coatings[3]</td></tr>
<tr><td>Functional Fluids</td></tr>
<tr><td>Spot Removers</td></tr>
<tr><td>Film Cleaner</td></tr>
<tr><td>Toner Aid</td></tr>
<tr><td>Polish</td></tr>
<tr><td colspan="3">[1]For POTWs above the water screening level, WCPP would be required (with the interim occupational exposure limit (ECEL)).
[2]For cleanup site workers and industrial treatment/pre-treatment, use TSCA regulatory limit (new interim occupational exposure limit (ECEL)) within the framework of existing OSHA HAZWOPER requirements.
[3]Adhesives and Sealants for Aerospace uses have a 5-year exemption with interim WCPP. Since the numbers of workers affected by the exemption is unknown, the exemption is not accounted for in the cost analysis.</td></tr>
</table>

7.3 Summary of Number of Affected Entities

Table 7-3 presents the estimated numbers of sites and workers. Descriptions of how these estimates were derived are presented in section 6.2.

Table 7-3: Number of Sites, Workers, and ONUs Affected by TCE Risk Management

Use Category	Number of Facilities	Number of Workers	Number of ONUs
Laboratory Use	251	251	2,259
Manufacturing	2	140	68
Import/Repackage	9	18	9
Battery and Synthetic Paper Processing Aid	3	51	24
HFC Manufacturing	2	38	18
Intermediate in HCl Production	28	532	252
Fluoroelastomer Manufacture	2	34	16
Open-Top Vapor Degreasing	350	2,100	1,400
Enclosed Vapor Degreasing	7	42	28
Conveyorized Vapor Degreasing	8	48	32
Web Vapor Degreasing	1	6	4
Batch Cold Cleaning	52	312	208
Disposal to Wastewater	739	9,607	3,695
Energized Electrical Cleaners	668	1,201	143
Incorporation Into Formulation, Mixture, or Reaction Product	28	448	140
Mold Release	17	371	44
Liquid Cleaners and Degreasers	11,815	16,053	1,667
Aerosol Spray Cleaning/Degreasing	3,698	4,651	553
Lubricants and Greases	345	1,751	76
Adhesives, Sealants, Paints and Coatings	65	616	288
Spot Removers	4,980	14,940	3,735
Film Cleaner	-	-	-
Toner Aid	-	-	-
Polish	-	-	-
Pepper Spray	-	-	-
Total	**23,070**	**53,210**	**14,659**
Notes: See section 6.2 for a description of assumptions and sources used to develop the estimates.			

7.4 Industry Wage Rates

Wage and fringe benefit data for each labor category (e.g., managerial, professional/technical, clerical) are taken from the U.S. Bureau of Labor Statistics (BLS) Employer Costs for Employee Compensation (ECEC) Supplementary Tables (BLS 2023b). In the BLS report, wages are represented by the "wages and salaries" cost component and fringe benefits are represented by "total benefits."

Overhead costs are assumed to equal 20% of the sum of wages plus fringe benefits. This loading factor is described in *Handbook on Valuing Changes in Time Use Induced by Regulatory Requirements and Other U.S. EPA Actions* (EPA 2020g), and is reflective of multiplier values used in prior EPA economic analyses and information collection requests (ICRs) that are based on industry- and occupation-specific overhead rates affected by EPA regulations. This overhead loading factor is multiplied by the total compensation (wages plus fringe benefits). For example, the December 2022 fully loaded wage for production labor is (\$21.79 + \$11.63) * 1.2 = \$40.10. Table 7-4 presents the total hourly loaded wages used in this analysis.

Table 7-4: Industry Wage Rates (2022$)

Labor Category	Data Series	Date	Wage ($/hour)	Fringe Benefit	Total Compen-sation	Overhead as % of Total Compen-sation[1]	Overhead	Hourly Loaded Wages
			(a)	(b)	(c) =(b)+(a)	(d)	(e)=(c)*(d)	(f)=(c)+(e)
Manufacturing/ Managerial	BLS ECEC, Private Manufacturing industries, "Mgt, Business, and Financial"[2]	Dec-22	$54.29	$24.66	$78.95	20%	$15.79	$94.74
Manufacturing/ Production Worker	BLS ECEC, Private Manufacturing Industries, "Production occupations"[2]	Dec-22	$21.79	$11.63	$33.42	20%	$6.68	$40.10
Transportation and Public Utilities/ Managerial	BLS *ECEC*, Trade, Transportation, and Utilities Industries*,* "Mgt, Business, and Financial" [2]	Dec-22	$54.12	$21.82	$75.94	20%	$15.19	$91.13
Transportation and Public Utilities/ Maintenance and Repair Worker	BLS *ECEC*, Trade, Transportation, and Utilities Industries*,* "Installation, maintenance, and repair"[2]	Dec-22	$31.08	$15.29	$46.37	20%	$9.27	$55.64
Services/ Managerial	BLS ECEC, Service-providing Industries, Management, professional, and related occupations, "Mgt, Business, and Financial"	Dec-22	$54.77	$24.99	$79.76	20%	$15.95	$95.71
Services/ Maintenance and Repair Worker	BLS ECEC, Service-providing Industries, Natural resources, construction, and maintenance occupations, "Installation, maintenance, and repair"	Dec-22	$28.39	$13.15	$41.54	20%	$8.31	$49.85
Certified Industrial Hygienist	Wage*: BLS OEWS Occupational Health & Safety Specialists (19-5011)* Fringes as percent of wage: BLS ECEC, Private Manufacturing industries, "Professional and related occupations" [3,4]	May-22	$39.47	$19.96	$59.43	20%	$11.89	$71.32
Technical Specialist	Wage*: BLS OEWS Occupational Health & Safety Technicians (19-5012)* Fringes as percent of wage: BLS ECEC, Private Manufacturing industries, "Professional and related occupations" [3,4]	May-22	$30.40	$15.38	$45.78	20%	$9.16	$54.93
Vapor Degreasing Technician	Wage*: BLS OEWS Plant and Systems Operators (51-8000)* Fringes as percent of wage: BLS ECEC, Manufacturing industry [3,4]	May-22	$33.85	$17.12	$50.97	20%	$10.19	$61.16
Senior Engineer and Technical Advisor (vapor degreasing)	Wage*: BLS OEWS Architectural and Engineering Managers (11-9041)* Fringes as percent of wage: BLS ECEC, Manufacturing	May-22	$78.52	$39.71	$118.23	20%	$23.65	$141.88

Table 7-4: Industry Wage Rates (2022$)

Labor Category	Data Series	Date	Wage ($/hour)	Fringe Benefit	Total Compen-sation	Overhead as % of Total Compen-sation[1]	Overhead	Hourly Loaded Wages
			(a)	(b)	(c) =(b)+(a)	(d)	(e)=(c)*(d)	(f)=(c)+(e)
	industry [3,4]							

[1] An overhead rate of 20% is used based on assumptions in *Handbook on Valuing Changes in Time Use Induced by Regulatory Requirements and Other U.S. EPA Actions* (EPA 2020g).

[2] Source: *Employer Costs for Employee Compensation Historical Supplementary Tables, National Compensation Survey: December 2022* (BLS 2023b).

[3] Source: *Occupational Employment Statistics (Occupational Employment and Wage Statistics*) for May 2022 (BLS 2023c).

[4] Fringe benefits are not reported in the BLS OEWS (BLS 2023c). It is therefore assumed that fringes as a percentage of wages are 50.576%, based on the percentage for Private Manufacturing Industries, "Professional and related" in the BLS ECEC (BLS 2023b).

7.5 Rule Familiarization and Downstream Notification Costs

7.5.1 Rule Familiarization

Firms that are not subject to WCPP requirements are assumed to incur an initial managerial labor burden of one hour and firms that are subject to WCPP requirements are assumed to incur an initial industrial hygienist labor burden of three hours. The additional two hours of rule familiarization for firms subject to WCPP requirements are a result of the complexity of WCPP compliance when compared to firms subject to prohibition requirements. The wage rates used for the Disposal to Wastewater use category are the transportation and public utilities sector wages ($91.13). The wage rate for the Aerosol Spray Cleaning/Degreasing and Spot Removers use categories are the service sector wages ($95.71). The manufacturing sector wage was used for other use categories ($94.74).

Table 7-5: Total Rule Familiarization Costs (2022$)

Use Category	Number of Firms	Initial Costs
Rule Familiarization Costs for Firms Subject to Prescriptive Controls or WCPP Requirements		
Laboratory Use	251	$53,704
Manufacturing	2	$428
Battery and Synthetic Paper Processing Aid	3	$642
HFC Manufacturing	2	$428
Intermediate in HCL Production	28	$5,991
Fluoroelastomer Manufacture	2	$428
Open-Top Vapor Degreasing	350	$74,886
Enclosed Vapor Degreasing	7	$1,498
Disposal to Wastewater	739	$158,116
Energized Electrical Cleaners	668	$142,892
Rule Familiarization Costs for Entities Subject to Prohibition		
Import/Repackage	9	$853
Open-Top Vapor Degreasing	350	$33,159
Enclosed Vapor Degreasing	7	$663
Conveyorized Vapor Degreasing	8	$758
Web Vapor Degreasing	1	$95
Batch Cold Cleaning	52	$4,926
Disposal to Wastewater	739	$70,013
Energized Electrical Cleaners	668	$63,272
Incorporation Into Formulation, Mixture, or Reaction Product	28	$2,653
Mold Release	17	$1,611
Liquid Cleaners and Degreasers	11,815	$1,119,353
Aerosol Spray Cleaning/Degreasing	3,698	$353,950
Lubricants and Greases	345	$32,685
Adhesives, Sealants, Paints and Coatings	65	$6,158
Spot Removers	4,980	$476,636
Option 1 Total	**23,042**	**$2,391,092**
Option 2 Total	**23,070**	**$2,228,405**
Notes: Green shading indicates use categories expected to comply with WCPP requirements under Option 1 & 2. Blue shading indicates use categories expected to comply with WCPP requirements under Option 2 only. Note there is longer term compliance timeframe applicable to five Open-Top Vapor Degreasers using TCE for narrow tubes and medical device (7 years), one Open-Top Vapor Degreaser using TCE in naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes (10 years), one enclosed vapor degreasing application using TCE to scour rayon fabric for use in rocket booster engine nozzles (10 years). The analysis accounts for one enclosed vapor degreaser and one Open-Top Vapor Degreaser with 9 years of WCPP costs and prohibition costs in years 10-20, One enclosed vapor degreaser and five Open-Top Vapor Degreaser with 6 years of WCPP costs and prohibition costs in years 7-20. Other vapor degreasers have prohibition costs starting at "time zero".		

7.5.2 Downstream Notification

For conditions of use that are initially permitted to continue under this regulation, EPA is requiring that manufacturers (including importers), processors, and distributors, excluding retailers, of TCE and TCE-containing products provide downstream notification of the prohibitions through Safety Data Sheets

(SDSs). It is assumed that each of the 2 manufacturers and 9 importer/repackage firms spend 2 hours amending their SDSs to include this notification, resulting in a total initial cost of $189 per facility for downstream notification.

7.6 Reformulation Costs

This section describes the estimated costs for processors who currently formulate products containing TCE and are expected to reformulate their products in response to a risk management option. Reformulation involves changing the composition of a product or otherwise changing how it is produced, and can include activities such as research and development, laboratory testing, and product re-labeling. Reformulation may be necessary when a chemical use is prohibited (requiring manufacturers to produce alternative products that do not contain the banned chemical) or when a concentration or emission limit is imposed (requiring manufacturers to either produce alternative products that do not contain the banned chemical or to produce a version of the current product that complies with the rule).

Note that manufacturers may comply with a rulemaking by using alternative compliance strategies. For example, if a processor manufactures similar products that are already compliant with the rule, they may switch production away from the non-compliant product without needing to reformulate. On the other hand, if manufacturers only have one product and that product contains the regulated chemical, they will either need to reformulate that product or discontinue production altogether.

It is also important to note that downstream users of the products that are reformulated may also incur costs (or cost savings) when products are reformulated. These costs are not explicitly addressed in this section but are discussed above in Chapter 3. For example, when reformulation results in higher production costs, some of these costs may be passed on to downstream users. These costs are accounted for and attributed to the producer who reformulated and are not double-counted as a downstream user cost in such an instance (even though these costs may be ultimately incurred by users). Another example of when downstream users might have additional costs resulting from reformulation is when the reformulated product does not perform as well or is otherwise not a perfect drop-in substitute and they need to make changes in how they use the product. As discussed in section 7.11, the analysis is unable to quantify these additional potential costs.

Reformulation costs are dependent on factors such as formulation complexity, reformulation approach, and cost of alternative chemical inputs. Thus, the cost of product reformulation is highly variable. Because information on chemical formulation and production processes are proprietary for many firms, limited data also produce a high degree of uncertainty surrounding reformulation cost estimates.

The bullets below describe two of the potential strategies for reformulation: substitution and product discontinuation.

- **Substitution.** Substitution for another chemical input will vary in complexity. Products that can use drop-in chemical substitutes may not need extensive production and packaging changes. However, if the substitute is not as easily integrated into the existing product (e.g., if a solid powder is used to replace a liquid), manufacturers may have higher costs related to raw material, research and development, testing, labeling, packaging changes, and/or production changes. As the relative importance (in terms of functional or safety performance) of the regulated chemical increases, it is likely that the number and magnitude of cost components also increases (RTI 2002).

- **Product Discontinuation.** If manufacturers anticipate high costs associated with large-scale substitution and/or production changes, the analysis should consider whether those manufacturers will comply with the rule by discontinuing their product line. This economic analysis assumes that products will be reformulated.

7.6.1 Reformulation Cost Components

This analysis identified six reformulation cost components that manufacturers may incur, depending on the type of product and the reformulation approach. These cost components are synthesized from those described in RTI (2002) and CARB (2013).

1. **Research and product development**. This component involves a technical team identifying the reformulation strategy, developing a new product formula, and evaluating product prototypes. It may also include sourcing any new raw materials and specifying new packaging.

2. **Product performance testing**. Manufacturers may conduct several types of product testing.

    a. Stability testing. Ensures that the new formulation will maintain its composition under a variety of environmental conditions for a reasonable amount of time. This component is particularly applicable if the new formulation requires new packaging, a new chemical input, and/or a production change.

    b. Efficacy testing. Ensures the product performance meets any label claims and established consumer expectations.

    c. Safety testing. Ensures the new formulation is safe for employees to manufacture and transport and for consumers to use and store.

3. **Production and manufacturing changes**. Production changes may include re-tooling of production lines, new technology/equipment, and/or construction of new facilities. Reformulations for minor chemical inputs typically would not require major adjustments to the production process, but more substantial changes may be necessary for reformulations involving critical formulation components. This cost component may include a plant trial to ensure that production changes are feasible. For minor production changes, pilot plant testing (i.e., a small-scale version of the full production) may be sufficient and will not require as many resources as a plant trial. Costs may also be incurred to start-up production after the plant trial and to verify that necessary product and production specifications are being met.

4. **Packaging.** Packaging changes are only likely to be necessary if the regulated substance is a critical component.

5. **Labeling.** Labeling modifications may be necessary if product qualities or use instructions change.

6. **Marketing.** Marketing costs may include focus group testing, surveys, advertising, and new technical literature. Market group testing (e.g., focus groups and surveys) will likely not be conducted in most cases; it is likely only to be performed by large companies for high-profile products requiring a major reformulation. Similarly, advertising is likely only a relevant cost if a manufacturer will change its advertising campaign in response to the reformulation (e.g., to emphasize that the product no longer contains the regulated chemical). Updates to the technical literature may be necessary for major attribute changes of the reformulated product (e.g., new use or safety instructions).

Table 7-6 is adapted from a similar table in RTI (2002) and presents suggestions for the types of cost components incurred under each reformulation strategy.

Table 7-6: Example Cost Components, by Reformulation Approach

Cost Component	Substitution		Production Process Change
	Non-Critical Component[1]	Critical Component[2]	
Recurring Raw Material Cost	✓	✓	
Research and Product Development	✓	✓	✓
Stability Testing	✓	✓	✓
Efficacy Testing	✓	✓	✓
Safety Testing		✓	✓
Process Change			✓
Start-up and Verification	✓	✓	✓
Full-Scale Plant Trial		✓	✓
Pilot Plant Testing	✓		
Packaging		✓	✓
Labeling	✓	✓	✓
Marketing			
Market Group Testing			
Technical Literature		✓	

[1] Components that do not have functional or safety uses (e.g., preservatives, dyes/colorants)

[2] Components that have critical functional or safety uses

EPA has identified three sources that provide reformulation cost estimates. Each source and its limitations is described in the sections below.

7.6.1 (A) Cheminfo Services (2006)

Cheminfo Services (2006) estimated reformulation costs for 25 categories of automotive aftermarket chemical products for Environment Canada in support of a regulation implementing volatile organic compound (VOC) content limits. These products included adhesives, air fresheners, brake cleaners, engine degreasers, and paint removers. Cheminfo Services (2006) sent a questionnaire to 120 companies (55 responses) asking about costs associated with reformulation, with information ultimately provided for 39 products. The manufacturers responded with a wide range of estimated capital costs of reformulation ($0 to $78,000 in 2005 CAN$), with a mean value of $21,707 per product (2005 CAN$). Notably, capital costs for products using a dilution approach to reformulation were reported to be about half those for other reformulation approaches.

There are several limitations to this study. First, Cheminfo Services (2006) only reports a single range of reformulation capital costs, so EPA cannot determine how reported costs vary by reformulation approach or product category. For example, dilution was a reformulation method used for 16% of the products in the study, but reformulation costs for dilution cannot be distinguished from reformulation costs for more complex reformulations. Similarly, questionnaire respondents were only asked to provide an estimate for the total reformulation cost, such that EPA cannot determine which cost components the manufacturers considered in their estimates and the relative contribution of each of those components.

However, the mean reformulation value may be a reasonable estimate for reformulating the TCE-containing products that will be regulated under the rule. This mean value was used by both the Economic Analysis of the Proposed TSCA Section 6 Action on Trichloroethylene in Dry Cleaning Spot Removers and Aerosol Degreasers (EPA 2016a) and the Economic Analysis of the TSCA Section 6 Action on Methylene Chloride, Paint and Coating Remover (EPA 2019a).

7.6.1 (B) California Air Resources Board (2013)

The California Air Resources Board (CARB) developed a method to estimate reformulation costs, which it has used to estimate costs for products subject to several of its regulatory actions. These have included consumer products such as solvents, aerosol paint thinners, and aerosol coatings. Appendix J of CARB's Initial Statement of Reasons for Proposed Rulemaking for Proposed Amendments to the Antiperspirants and Deodorants Regulation, the Consumer Products Regulation, the Aerosol Coating Products Regulation, the Tables of MIR Values, Test Method 310, and Proposed Repeal of the Hairspray Credit Program details the methodology to estimate nonrecurring costs (CARB 2013). CARB identified eight phases that manufacturing facilities will implement to produce a compliant product (e.g., product development, labeling modification). For each phase, CARB then identified a set of cost components (e.g., material, personnel, prototype equipment) for which it developed a set of per-product costs. Costs and underlying assumptions were checked with stakeholders to verify reasonableness.

One limitation of CARB's methodology is that the estimated component costs for each phase were originally developed in 1991 and modified in 1999. These cost estimates were then adjusted to 2012$ using engineering plant cost indices. Production cost estimates from 20-30 years ago may not be representative of reformulation costs in current facilities. For example, "Computer Support" is a separate cost component for several reformulation phases and was potentially a more significant cost in 1991 than it would be presently. Another limitation is that while CARB provides estimated costs for each component, it does not provide the underlying calculations or methodology behind these estimates (e.g., burden hours, labor mix).

7.6.1 (C) RTI International (2002)

RTI International developed a food and cosmetics reformulation cost module for the U.S. Food and Drug Administration (FDA) (RTI 2002). RTI identified a series of cost components that manufacturing facilities may potentially incur when reformulating products to achieve compliance with FDA regulations. Cosmetics manufacturers, industry trade association representatives, and food industry consultants and laboratories were then interviewed to collect the information used to develop the cost estimates. Estimates were based on respondents' estimates of material costs, burden hours, and wage rates. RTI then built an Excel-based tool that can be used to model reformulation costs based on user inputs (e.g., product category, reformulation type).

To the extent that reformulating food and cosmetics differs from reformulating products subject to a Section 6 action, RTI's model may not reflect representative reformulation costs for the options being considered in this analysis. RTI's Excel-based tool only allows users to select products and NAICS codes associated with the food and cosmetics industries and does not allow users to view costs for individual reformulation components. However, RTI's cost estimates for individual reformulation components are presented in Table 7-7 and Table 7-8 based on their underlying data. As with the other sources, the underlying data do not disaggregate component cost estimates by burden hours, wage rates, or material costs.

7.6.2 Summary of Available Reformulation Unit Cost Estimates

Table 7-7 and Table 7-8 present a cross-walked summary of cost estimates from Cheminfo Services (2006), CARB (2013), and RTI (2002) for minor and major modifications, respectively. The cost component estimates for minor modifications in Table 7-7 approximately correspond to dilution and substitution of non-critical component reformulation approaches. The cost component estimates for major modifications in Table 7-8 approximately correspond to substitution of critical components (e.g., functional performance or safety uses) and production process changes. Note that EPA used best professional judgement to map estimates from the three sources to a set of consistent cost components and reformulation approaches, as each source differs in how it classifies these components and approaches. Given the degree of uncertainty in each source's reformulation cost estimates, a low-, high-, and mid- (for RTI (2002)) range estimate is presented for each cost component.

The RTI (2002) estimates are generally the largest cost estimates, followed by Cheminfo Services (2006) and CARB (2013). These differences may be the result of any number of differences in methodology or end user industry, as described in the preceding sections. For example, the food and cosmetics products evaluated by RTI (2002) may have more sophisticated formulations than the aerosol products evaluated by CARB (2013). Or, differences in regulatory requirements and/or consumer expectations for food and cosmetic products as compared to automotive products may incentivize food and cosmetic manufacturers to invest more in the research and development and marketing phases.

The total cost estimates presented in the tables do not include recurring costs associated with changes in a product's raw materials. Cost estimates for each source are inflated to 2022$ using the Consumer Price Index. Because EPA could not identify the dollar-year for the estimates presented in RTI (2002), it is assumed that estimates are presented in 2001$.

Table 7-7: Crosswalk of Per-Formula Component Cost Estimates (2022$) - Minor Modification[1]

Cost Component	ChemInfo[2]		CARB[3]		RTI[4]		
	Low	High	Low	High	Low	Mid	High
Research and Product Development	-	-	$206	$8,044	$12,473	$52,891	$106,246
Product Performance Testing							
-Stability Testing	-	-	-	$1,856	$1,063	$3,657	$8,842
-Efficacy Testing	-	-	-	$1,856	-	-	-
-Safety Testing	-	-	-	$4,331	-	-	-
Production and Manufacturing Changes							
-Process Change					-	-	-
-Start-up and Verification	-	-	-	$2,062	$1,841	$9,204	$20,294
-Plant Testing					-	-	-
Packaging	-	-	-	-	-	-	-
Labeling	-	-	-	$1,856	-	-	-
Marketing							
-Market Group Testing	-	-	-	$619	-	-	-
-Technical Literature	-	-	-	$412	-	-	-
TOTAL	**$0**	**$27,906**	**$206**	**$21,037**	**$15,376**	**$65,752**	**$135,383**

A dash "-" indicates that the source did not estimate costs for that component
[1] Corresponds to dilution and substitution of non-critical component strategies (e.g. dyes/colorants, preservatives).
[2] Low and high estimates correspond to minimum and mean capital cost estimates from Cheminfo Services (2006), respectively.
[3] Corresponds to the Low Cost estimates from CARB (2013) (Tables J-1 to J-3). The low estimate is the minimum Low Cost estimate of three product types (adhesive, aerosol multi-purpose solvent & paint thinner, aerosol coating), and the high estimate is the maximum Low Cost estimate of the three product types.
[4] Corresponds to estimates for minor non-critical ingredients from RTI (2002).

Table 7-8: Crosswalk of Per-Formula Component Cost Estimates (2022$) - Major Modification[1]

Cost Component	ChemInfo[2]		CARB[3]		RTI[4]		
	Low	High	Low	High	Low	Mid	High
Research and Product Development	-	-	$8,044	$27,225	$49,882	$211,561	$424,983
Product Performance Testing							
-Stability Testing	-	-	$1,856	$9,487	$4,247	$14,626	$35,370
-Efficacy Testing	-	-	$1,856	$7,837	-	-	-
-Safety Testing	-	-	$4,331	$14,025	$3,305	$9,419	$34,702
Production and Manufacturing Changes							
-Process Change	-	-	-	$2,062	$3,905	$12,916	$28,532
-Start-up and Verification					$7,363	$36,819	$180,324
-Plant Testing					$5,566	$20,294	$172,787
Packaging	-	-	-	-	$10,262	$27,307	$51,310
Labeling	-	-	$1,650	$1,856	-	-	-
Marketing							
-Market Group Testing	-	-	$619	$2,062	$66,099	$115,674	$190,036
-Technical Literature	-	-	-	$412	-	-	-
TOTAL	**$27,906**	**$100,276**	**$16,214**	**$57,386**	**$150,629**	**$448,616**	**$1,118,043**

A dash "-" indicates that the source did not estimate costs for that component
[1] Corresponds to substitution of critical component and manufacturing process change strategies.
[2] Low and high estimates correspond to mean and maximum capital cost estimates from Cheminfo Services (2006), respectively.
[3] Correspond to the High Cost estimates from CARB (2013) (Tables J-1 to J-3). The low estimate is the minimum High Cost estimate of three product types (adhesive, aerosol multi-purpose solvent & paint thinner, aerosol coating), and the high estimate is the maximum High Cost estimate of the three product types.
[4] Corresponds to estimates for major ingredients and production process changes from RTI (2002).

7.6.3 Reformulation Unit Costs Used in this Analysis

This analysis considered two different reformulation costs, which vary according to how complex the reformulation process is expected to be. The main source for the reformulation costs used in this analysis is CARB's (2013) analysis. EPA selected the CARB estimates as the primary basis for the reformulation costs because they were developed for the same types of products considered in this analysis. In addition, since the CARB estimates are disaggregated by type of cost, they can more easily accommodate adjustments to reflect more or less complex reformulations. While the Cheminfo Services (2006) estimates also pertain to similar types of products, there is no way to separate the costs for simpler dilution reformulations and those that are more complex. EPA believes that the RTI (2002) estimates, which were developed for reformulating food and cosmetics products, are likely to reflect higher reformulation costs than would be expected for the types of products considered in this analysis. However, EPA does use some of the RTI (2002) estimates' cost components to estimate reformulation costs for those products that are expected to require complex reformulations.

Table 7-9 presents the reformulation costs considered in this analysis. For each of the use categories where reformulation is expected to be necessary, this analysis uses the standard substitution reformulation cost. This estimate is based on CARB's highest reformulation cost estimate. The complex substitution reformulation cost estimate was considered and determined not to be applicable. It would be applicable for use categories that are expected to require the most complex reformulations. This cost is a combination of CARB's highest reformulation cost estimate and the RTI (2002) estimates (R&D, production and manufacturing, and package/labeling costs come from RTI (2002), and the other cost components are based on CARB's highest reformulation cost estimate).

Table 7-9: Reformulation Costs Used in this Analysis (2022$)

Cost Component	Standard Substitution Reformulation Cost
Research and Product Development	$27,225
• Stability Testing	$9,487
• Efficacy Testing	$7,837
• Safety Testing	$14,025
Production and Manufacturing	
• Process Change	$2,062
• Start-up and Verification	
• Plant Testing	
Packaging/Labeling	$1,856
Marketing	
• Market Group Testing	$2,062
• Technical Literature	$412
TOTAL	**$64,966**

Table 7-10 indicates which of the reformulation costs presented in Table 7-9 corresponds to each of the use categories considered in the analysis. As indicated, affected vapor degreasers and batch cold cleaning machine users are assumed to switch to different cleaning methods that use existing cleaning agents or a degreasing method using an existing degreasing fluid. For all other use categories, the analysis assumes that the standard substitution reformulation costs are incurred.

Table 7-10: Reformulation Costs by Use Category

Use Category	No reformulation	Standard Substitution Reformulation Cost	Notes
	($0)	($64,966)	
Vapor degreasing fluids Batch cold cleaning fluids	✓		EPA assumes that vapor degreasers and batch cold cleaning machine users will switch to vapor degreasing fluids that already exist, or switch to a different cleaning method.
All other product formulations		✓	Since alternatives already exist, EPA assumes the standard substitution reformulation costs for these products.
Sources: CARB (2013) and RTI (2002)			

7.6.4 Summary of Estimated Total Reformulations Costs by Use Category

Table 7-11 presents the estimated costs for the reformulation of products that would be necessary if TCE were prohibited for all use categories. Note that EPA assumes a prohibition of TCE use in vapor degreasing would result in switching to other cleaning methods and/or solvents that currently exist and therefore would not require any reformulation.

Table 7-11: Total Reformulation Costs by Use Category

Use Category	Products Reform-ulated	Reformulation Costs per Product	Total Initial Reformulation Costs
Mold Release	14	$64,966	$909,524
Liquid Cleaners and Degreasers	3	$64,966	$194,898
Aerosol Spray Cleaning/Degreasing	21	$64,966	$1,364,286
Energized Electronic Cleaner	4	$64,966	$259,864
Lubricants and Greases	7	$64,966	$454,762
Adhesives, Sealants, Paints and Coatings	16	$64,966	$1,039,456
Spot Removers	3	$64,966	$194,898
Pepper Spray	1	$64,966	$64,966
Total	**69**	**$64,966**	**$4,482,654**

7.7 Costs for Switching to Alternatives to TCE Vapor Degreasing (and TCE Batch Cold Cleaning)

EPA estimates there are 366 facilities nationwide that use TCE for vapor degreasing (and 52 facilities that use TCE in batch cold cleaning). This analysis also uses the estimated costs for switching to alternatives to TCE vapor degreasing as the estimated costs for switching to alternatives to batch cold cleaning machines. The estimated costs for switching to an alternative to TCE in vapor degreasing includes initial capital costs and other transition costs (see sections 7.7.2 and 7.7.3). The total costs for switching to alternatives to TCE in vapor degreasing are summarized in section 7.7.10).

EPA consulted with critical cleaning experts Barbara Kanegsberg and Ed Kanegsberg of BFK Solutions about the costs of switching to alternatives to methylene chloride in vapor degreasing. BFK Solutions helps manufacturers develop and/or optimize their cleaning processes. According to these experts, the alternatives that would be technologically and economically feasible would primarily depend on:

- the soils being removed,
- the level of cleanliness required,
- the characteristics of the components being cleaned,
- the volume of components being cleaned,
- and other factors.

Trial and error also add uncertainty to transition costs of an alternative cleaning process. Users may need to test multiple different cleaning processes before identifying a successful process.

BFK Solutions provided expert estimates of the costs of switching from the use of methylene chloride in different sized degreasers used in the different cleaning categories in the first two columns of Table 7-12 and the different cleaning methods presented the last column in Table 7-12 .

For this analysis, degreasers are defined as small, medium or large based on the cleaning chamber tank size. Dimensions for the size categories are small–12 in. x 12 in. x 10 in.; medium–36 in. x 36 in. x 22 in.; large–60 in. x 42 in. x 36 in.).

This economic analysis defines four "cleaning categories" that would need different processes and cleaning requirements for switching to an alternative cleaning method from vapor degreasing with methylene chloride. These terms are defined relative to the expected end-use of the product and consequences of inadequate or inappropriate cleaning.

- **General Cleaning** is defined as having relatively low process development and low cost of process verification. Primary costs will include equipment and performance testing.
- **High Precision Cleaning** covers the cleaning of high value parts where very small residue is acceptable, at best. Significant process development is needed; customer or other regulatory performance standards may be the driving force. Primary costs will include evaluation, initial and on-going performance testing and capital costs.
- **Safety Critical Cleaning** includes product processes where performance failure is not an acceptable option, because failure poses dire hazards for patient, public safety, or national security and/or because the cost of failure would be prohibitively high (e.g., space flight). This category will have higher costs for process verification and validation and may also cover situations with very high-cost consequences of failure. Primary costs will include evaluation, initial performance testing, cleanliness validation/verification, and capital costs.
- **Start-up/R&D Critical Cleaning** covers the development process of new high precision or high value products prior to production; these would typically not require large degreasers and would need adaptable cleaning systems and perhaps multiple cleaning systems.

The list of cleaning methods in Table 7-12 is not exclusive. There are additional cleaning methods using CO2, laser, and plasma that have not been included because they would be unlikely to be the primary method to replace a baseline method. They may become needed as additional methods in order to achieve required cleanliness specifications. Each method that is used will incur equipment and process development costs.

Table 7-12: Sizes, Cleaning Categories, and Cleaning Methods Considered in the Vapor Degreasing Cost Analysis

Size	Cleaning Category	Cleaning Method
Small	General	Baseline - OTVD with TCE
Medium	High Precision	Replace with Airless Degreaser with PCE
Large	Safety Critical	Convert OTVD to use Flashpoint inerted t-DCE
	Start-Up/R&D	Replace with OTVD using FlashPoint inerted t-DCE
		Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)
		OTVD for Low boiling point (<100C) Alcohol or other flammable
		OTVD for Very low flashpoint (<0C) solvent
		EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols
		Co-Solvent, Bi-Solvent
		High boiling, non-vacuum, non-rinse
		Semi-Aqueous
		Replace with Aqueous Cleaning
		Hybrid system (example: Inventec, HEMO)

Table 7-13 presents the descriptions of the baseline and alternative cleaning methods considered in this analysis.

ble 7-13: Cleaning Methods and Their Definitions

eaning Method	Definition
eline - OTVD with TCE	An OTVD uses heated solvent in the liquid and/or vapor phase. For this analysis, the baseline OTVD uses TCE as the solvent. A OTVD may or may not have a cover. It may be characterized by the equipment supplier using terms like "well-sealed" or havin "minimal solvent emissions." As defined here, OTVDs have an atmospheric air-solvent interface, which is why it is difficult to meet the low emissions required by the methylene chloride ECEL. Some but not all current OTVDs using methylene chloride m be the same as "National Emission Standards for Hazardous Air Pollutants (NESHAP) compliant" OTVDs, in that they may ha double-coils and a high freeboard ratio. An OTVD may include ultrasonic cleaning and/or a spray wand.
less Degreaser with PCE	An airless degreaser (sometimes referred to as an airless/airtight cleaning system) is equipment for which there is never an atmospheric air-solvent interface. Solvent does not enter the working chamber until the product to be cleaned has been placed i the chamber, the chamber has been sealed and air has been evacuated, usually to a level of one torr or less. Cleaning then can occur, usually by computer control, either by immersion (with or without ultrasonics), spray, or vapor degreasing. As with aqueous cleaning, solvent immersion cleaning could also include cyclic nucleation or cyclic cavitation, where the pressure is changed to provide boiling cycles. Following cleaning and rinsing cycles, the solvent is pumped back into sealed reservoirs, an the chamber is again pumped to a vacuum (sometimes through a carbon filter to capture residual traces of solvent vapors), thus providing vacuum drying. A closed-loop degreaser is not the same as an airless degreaser. While an OTVD that recirculates/redistills/reuses the solvent may be described as "closed loop", such systems have not been demonstrated to match low level of solvent loss achieved with an airless system.
nvert OTVD to use Flashpoint inerted t-E	An OTVD uses heated solvent in the liquid and/or vapor phase. For these cleaning methods, flashpoint inerted trans-dichloroethylene (trans-DCE) is the solvent. An OTVD may or may not have a cover. It may be characterized by the equipmen supplier using terms like "well-sealed" or having "minimal solvent emissions." Since flashpoint inerted trans DCE blends are more expensive, it may make sense for users to replace their OTVD if their existing machine is an older, more emissive model. Trans-DCE is currently undergoing Risk Evaluation by TSCA. The fluorinated inerting agents are also under scrutiny by the U EPA and other regulators because of concerns about PFAS.
place with OTVD using Flashpoint rted t-DCE	
stice® system (trans-1-chloro-,3,trifluoropropene)	An OTVD uses heated solvent in the liquid and/or vapor phase. For these cleaning methods, trans-1-chloro-3,3,3,trifluoroprope is the solvent. An OTVD may or may not have a cover. Because Solstice® has a low boiling point, the specifically designed OTVD may be characterized by the equipment supplier using terms like "well-sealed" or having "minimal solvent emissions." Since trans-1-chloro-3,3,3,trifluoropropene blends are volatile and more expensive, it is very unlikely to be used as a "drop-in" OTVDs currently in use for chlorinated or brominated solvents.
VD for Low boiling point (<100C) ohol or other flammable	These systems are vapor degreasers where engineering controls have been employed to eliminate ignition and oxidation source order to ensure that flammable liquids can be used. They are certified to meet fire protection standards. Examples of low flashpoint solvents include simple alcohols like methanol, ethanol, and propanol. An azeotrope of cyclohexane with isopropano has also been used. The most common very low flashpoint solvent is acetone. It should be noted that, with the exception of acetone, these other solvents are considered to be VOCs, and have restrictions in areas of poor air quality.
VD for Very low flashpoint (<0C) vent	
D for High Boiling Point Combustibles 00C) Hydrocarbons and Alcohols	These are systems containing combustible (flashpoint > 37.8C) solvents, with boiling points greater than 100C. The solvents in current use are either medium chain (~10-12 carbons) iso-paraffins or those that are called "modified alcohols", such as iso-propanol connected to a butane (4-carbon) chain. Because the primary concern is reducing flammability concerns rather than to exposure, these systems are likely to be the same as airless degreasers, but need not be designed to completely eliminate the emissions to the degree required from chlorinated and brominated solvents.
Solvent, Bi-Solvent	These are systems that use two organic solvents. For the purposes of this analysis, the terms Co-Solvent and Bi-Solvent are interchangeable. In some cases, the cleaning agent (sometimes referred to as the solvating agent) is in one chamber and the rins

ble 7-13: Cleaning Methods and Their Definitions

eaning Method	Definition
	agent (sometimes referred to as the displacement agent) is in a second tank and is used sequentially. In other designs, the washi step is a mixture of cleaning agent and displacement agent. **Rinsing/displacement with Flashpoint-inerted trans DCE** Typically, a plant-based ester (such as a soy methyl ester is used as the cleaning or solvating agent. Nearly all current co-solven or bi-solvent systems use flashpoint-inerted trans DCE as the displacement agent. The fluorinated inerting agents are also under scrutiny because of concerns about PFAS. **Rinsing/displacement with alcohol (cost estimates do not reflect this possibility)** If ingredients of flashpoint-inerted trans DCE were to become unavailable through regulatory actions or business decisions, co-solvent and bi-solvent systems are options. Barbara Kanegsberg conducted cleaning studies at Litton Guidance and Control Systems in the late 1980s- early 1990s for what we now term safety/critical military applications. Cleaning was demonstrated using cleaning agents such as d-limonene or high-boiling hydrocarbon blends followed by repeated rinsing with isopropyl alcol The processes were more readily and consistently accomplished using perfluorocarbons which could not be used today. These processes involved manual cleaning by highly-specialized technicians along with 100% inspection. Because current bi—solver and co-solvent processes involve flashpoint-inerted trans-DCE as the rinsing/displacement agent, additional process developme including testing, would be needed. Low flashpoint cleaning systems would be needed – this would add to equipment costs.

h boiling, non-vacuum, non-rinse	This method is limited to a few general cleaning applications where cleaning agent residue could be tolerated. Examples of solvents used in such systems include d-limonene and soy methyl esters. The FP is above 37.8 deg C (100 deg F), so they woul be considered not flammable by NFPA. Equipment would consist of a dip tank, most often but not necessarily heated. There co be ultrasonics or agitation. Depending on local regulations (notably those restricting VOC), there may or may not be a cover. Examples:
	• D-limonene (aliphatic hydrocarbon classified as a cyclic monoterpene, the major component in oils from citrus rinds)
	    • flashpoint 48 deg C
	    • boiling point 176 Deg C
	• Methyl Soyate (a mixture of long-chain, typically 16-18 carbons, fatty acid methyl esters)
	    • flashpoint 130C
	    • boiling point 200C

ni-Aqueous	A semi-aqueous cleaning process consists of a water-miscible blend, with high solvent concentration (including emulsions), use as an immersion or spray followed by an aqueous rinse (see the description of aqueous process). Some semi-aqueous processes are referred to as aqueous (by the supplier of cleaning agent, or cleaning equipment, or by the end-user, in part because there is not a clear demarcation of the line between an aqueous additive package and a water-rinseable solvent. Equipment costs are hig Carryover of solvent into the rinse tank can be a problem.
ueous Cleaning	Aqueous cleaning involves washing with a cleaning agent that could be water alone but that typically contains organic and inorganic chemistry. The quality of the water and the amount of water used is highly variable. Depending on the application, th water quality can range from tap water to purified water, for example, de-ionized or reverse osmosis.

ble 7-13: Cleaning Methods and Their Definitions

eaning Method	Definition
	Aqueous formulations vary in their composition (organic and inorganic additives), the pH, and the concentration at which they used. What is described as an aqueous process may actually be a semi-aqueous process, in large part because it has become mo acceptable to avoid the concept of using any organic solvent for cleaning. Heat and various types of cleaning action like ultrasonics, underwater agitation (like a jacuzzi or tubulation) may be used to enhance cleaning. In most instances there is significant amount of rinsing with water to displace the cleaning agent. In some instances, the rinse water may include chemicals (rust preventative (RP)) to forestall corrosion. Depending on the substrate to b cleaned and the end-use of the product, there is most often a drying step. In our model for cost comparison, we have used a was tank followed by rinse tanks followed by a drying chamber. While we have used immersion tanks as a model to describe the aqueous process to allow comparison among the cleaning processes, in fact there is an enormous variability in aqueous cleanin processes and aqueous cleaning equipment. The cost analyses generally consider aqueous systems to consist of one or two wash tanks followed by HOW MANY rinse tank and a dryer. Here are a few non-encompassing examples of aqueous cleaning equipment that are not a sequence of cleaning tan For general cleaning applications, cleaning agent may be applied to the part either by spray or immersion. Rinsing, if it occurs may be as simple as holding the part under a tap and rinsing all residue down the drain. In some metal cleaning, the part may be washed in a spray chamber, with or without rinsing. Where rinsing occurs, it may be accomplished by placing the part over a gr and spraying water on it. Drying may not be necessary. In-line aqueous cleaning equipment is widely used to remove "no-clean (low residue) flux from electronics assemblies, post-soldering. The cleaning action (washing and rinsing) typically involves spr in-air. There are wash, rinse, and drying chambers. In some applications such as in some hybrid cleaning water (and/or an aque cleaner) is introduced into a chamber containing the parts to be cleaned. Ultrasonic cleaning and/or in cyclic cavitation (cyclic nucleation) may be used to enhance cleaning.
rid system (e.g., Inventec, HEMO)	Hybrid systems use two or more cleaning methods in a single piece of cleaning equipment. Sometimes, the parts are cleaned in single chamber and cleaning solutions are introduced. Other systems use sequential chambers. One equipment manufacturer described the use of an aqueous cleaning step but with a solvent rinse. This would be distinguished from a semi-aqueous proces where the high-solvent cleaner is used for washing and water used for rinsing. As contrasted with co-solvent or bi-solvent systems, hybrid systems, in our definition, use an aqueous process as one of the methods, either sequentially or together as an emulsion.

The critical cleaning experts provided two sets of estimates that they described as “optimistic” and “realistic”. The “realistic” estimates accounted for additional trial and error in identifying and implementing the new cleaning processes and these are the estimates presented and used in this economic analysis.

The categories of costs presented in Table 7-14 were considered in the analysis.

Table 7-14: Categories of Costs Considered in the Vapor Degreasing Cost Analysis

Cost Categories Considered
Process Development for Identifying and Implementing the Alternative Cleaning Process (section 7.7.1)
Initial Capital Costs for New Machine (section 7.7.2)
Initial Capital Costs aside from New Machine (section 7.7.3)
Cleaning Agent Costs (section 7.7.4)
Waste Disposal Costs (section 7.7.5)
Annual Maintenance Costs (section 7.7.6)
Annual Labor Costs (section 7.7.7)
Electrical Costs (section 7.7.8)
Additional Floorspace (section 7.7.9)

EPA developed estimates of the baseline mix of cleaning categories by using the 366 sites using TCE for vapor degreasing in the identified in the National Emissions Inventory (EPA 2020a). EPA classified each of these facilities as performing high precision cleaning (20% of facilities), safety critical cleaning (30% of facilities), or general cleaning (45%). Since R&D cleaning facilities are unlikely to have releases that meet reporting thresholds, EPA assumed that they would be missing from the National Emissions Inventory data and assumed that R&D cleaning facilities represent 5% of the total. This suggests that the total fraction in each category is:

- Safety critical: 30%
- High precision: 20%
- General: 45%
- R&D: 5%

EPA also estimated the baseline mix of small, medium, and large facilities using the TCE emissions reported in National Emissions Inventory from vapor degreasers. Based on the estimates presented below in sections 7.7.4 and 7.7.5, liquid waste represents 47% of total solvent consumption. Thus, the NEI emissions were divided by 53% (53% = 1 - 47%) to estimate consumption and then mapped to the nearest size category according to the consumption estimates described in section 7.7.4, below. Based on these estimates the mix of small, medium, and large facilities is estimated to be 31%, 36%, and 32%, respectively. These baseline estimates are presented in Table 7-15.

Table 7-15: Estimated Baseline Mix for Size and Type

Size, Type, or Size/Type Combined	Estimated Baseline Percentage
Size	
Small	31%
Medium	36%
Large	32%
Type	
General Cleaning	45%
High Precision Cleaning	20%
Safety Critical Cleaning	30%
R&D Critical Cleaning	5%
Size/Type Combined	
Small/General Cleaning	14%
Medium/General Cleaning	16.4%
Large/General Cleaning	14.6%
Small/High Precision Cleaning	9.3%
Medium/High Precision Cleaning	11%
Large/High Precision Cleaning	9.7%
Small/Safety Critical Cleaning	6.2%
Medium/Safety Critical Cleaning	7.3%
Large/Safety Critical Cleaning	6.5%
Small/Start-Up/R&D Critical Cleaning	2.3%
Medium/Start-Up/R&D Critical Cleaning	2.7%

An estimate or assumption about the mix of alternative cleaning methods is also needed to estimate the costs for switching cleaning methods. EPA asked critical cleaning experts who help manufacturers develop and/or optimize their cleaning processes to estimate a percentage weight for each alternative cleaning method that indicates how likely affected vapor degreasers would be to adopt each method. They provided two sets of percentages, one under a scenario where trans-DCE was considered a viable alternative cleaning method and a second scenario where it is was not. Note that the estimated percentage weights intentionally sum to more than 100% to account for instances where a facility switches from using TCE vapor degreasing to multiple cleaning methods. These percentages are presented below in section 7.7.10.

7.7.1 Process Development for Identifying and Implementing the Alternative Cleaning Process

The process of identifying and implementing alternative cleaning processes is complex and includes the following types of activities:

- Consulting with customers
- Consulting with suppliers
- Researching cleaning options (web-search, talk to vendors, attend webinars, trade shows)
- Obtaining and reviewing equipment costs
- Selecting, obtaining and shipping representative hardware samples for test at vendor

- Consulting with insurance carrier and fire department
- Conducting, evaluating and reviewing cleanliness tests
- Management review
- Refining equipment and process design
- Making facilities changes
- Setting up and performance testing new equipment
- Process validation
- Employee training

EPA asked BFK Solutions to estimate these process development costs and two sets of costs were provided: (1) optimistic and (2) realistic. The realistic set of estimates are used in this economic analysis.

As presented in Table 7-16, the estimated initial costs associated with the development and implementation of alternative cleaning processes range from $100,000 to $1,540,000. The 25th, 50th, and 75th percentile for the estimated incremental costs are about $170,000, $340,000, and $1,100,000 respectively.

Table 7-16: Process Development for Identifying and Implementing the Alternative Cleaning Process

Size Cleaning Category; Alternative Cleaning Method	Estimated Initial Costs (2022$)
General Cleaning of All Sizes; convert to aqueous	$100,000
General Cleaning of All Sizes; convert to cleaning methods other than aqueous	$170,000
High Precision Cleaning of All Sizes; convert to aqueous	$290,000
High Precision Cleaning of All Sizes; convert to cleaning methods other than aqueous	$340,000
R&D Critical Cleaning of All Sizes; all cleaning methods	$410,000
Safety Critical of All Sizes; convert to aqueous	$1,100,000
Safety Critical of All Sizes; convert to cleaning methods other than aqueous	$1,540,000

7.7.2 Initial Capital Costs for New Machine

Machine costs were estimated by looking at currently available new machines on the market and/or used machines available for purchase. Table 7-17 presents the estimated initial costs associated with purchasing a new machine or upgrading an existing machine. When these initial costs are incurred, they range from $4,000 to $6.7 million.

Table 7-17: Initial Capital Costs for New Machine, by Size, Cleaning Category, and Alternative Cleaning Method

Size/Cleaning Category	Alternative Cleaning Method	Estimated Initial Costs (2022$)
Small/General Cleaning	Replace with Airless Degreaser with PCE	$280,000
	Convert OTVD to use Flashpoint inerted t-DCE	$0
	Replace with OTVD using FlashPoint inerted t-DCE	$60,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$90,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$160,000
	OTVD for Very low flashpoint (<0C) solvent	$160,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$280,000
	Co-Solvent, Bi-Solvent	$440,000
	High boiling, non-vacuum, non-rinse	$4,000
	Semi-Aqueous	$100,000
	Replace with Aqueous Cleaning	$240,000
	Hybrid system (e.g., Inventec, HEMO)	$392,000
Medium/General Cleaning	Replace with Airless Degreaser with PCE	$480,000
	Convert OTVD to use Flashpoint inerted t-DCE	$0
	Replace with OTVD using Flashpoint inerted t-DCE	$380,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$540,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$500,000
	OTVD for Very low flashpoint (<0C) solvent	$500,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$480,000
	Co-Solvent, Bi-Solvent	$500,000
	High boiling, non-vacuum, non-rinse	$16,000
	Semi-Aqueous	$400,000
	Replace with Aqueous Cleaning	$500,000
	Hybrid system (e.g., Inventec, HEMO)	$672,000
Large/General Cleaning	Replace with Airless Degreaser with PCE	$4,800,000
	Convert OTVD to use Flashpoint inerted t-DCE	$0
	Replace with OTVD using Flashpoint inerted t-DCE	$3,600,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$5,400,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$4,800,000
	OTVD for Very low flashpoint (<0C) solvent	$4,800,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$4,800,000
	Co-Solvent, Bi-Solvent	$288,000
	High boiling, non-vacuum, non-rinse	$32,000
	Semi-Aqueous	$160,000
	Replace with Aqueous Cleaning	$4,800,000

Table 7-17: Initial Capital Costs for New Machine, by Size, Cleaning Category, and Alternative Cleaning Method

Size/Cleaning Category	Alternative Cleaning Method	Estimated Initial Costs (2022$)
	Hybrid system (e.g., Inventec, HEMO)	$6,720,000
Small/High Precision Cleaning	Replace with Airless Degreaser with PCE	$280,000
	Convert OTVD to use Flashpoint inerted t-DCE	$0
	Replace with OTVD using Flashpoint inerted t-DCE	$60,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$90,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$160,000
	OTVD for Very low flashpoint (<0C) solvent	$160,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$280,000
	Co-Solvent, Bi-Solvent	$220,000
	Semi-Aqueous	$100,000
	Replace with Aqueous Cleaning	$260,000
	Hybrid system (e.g., Inventec, HEMO)	$292,000
Medium/High Precision Cleaning	Replace with Airless Degreaser with PCE	$480,000
	Convert OTVD to use Flashpoint inerted t-DCE	$0
	Replace with OTVD using Flashpoint inerted t-DCE	$360,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$540,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$500,000
	OTVD for Very low flashpoint (<0C) solvent	$50,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$480,000
	Co-Solvent, Bi-Solvent	$480,000
	Semi-Aqueous	$400,000
	Replace with Aqueous Cleaning	$500,000
	Hybrid system (e.g., Inventec, HEMO)	$672,000
Large/High Precision Cleaning	Replace with Airless Degreaser with PCE	$4,800,000
	Convert OTVD to use Flashpoint inerted t-DCE	$0
	Replace with OTVD using Flashpoint inerted t-DCE	$3,600,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$5,400,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$4,800,000
	OTVD for Very low flashpoint (<0C) solvent	$4,800,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$4,800,000
	Co-Solvent, Bi-Solvent	$3,200,000
	Semi-Aqueous	$160,000
	Replace with Aqueous Cleaning	$4,800,000
	Hybrid system (e.g., Inventec, HEMO)	$6,720,000
Small/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$280,000

Table 7-17: Initial Capital Costs for New Machine, by Size, Cleaning Category, and Alternative Cleaning Method

Size/Cleaning Category	Alternative Cleaning Method	Estimated Initial Costs (2022$)
	Convert OTVD to use Flashpoint inerted t-DCE	$12,000
	Replace with OTVD using Flashpoint inerted t-DCE	$60,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$90,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$160,000
	OTVD for Very low flashpoint (<0C) solvent	$160,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$280,000
	Co-Solvent, Bi-Solvent	$220,000
	Semi-Aqueous	$100,000
	Replace with Aqueous Cleaning	$60,000
	Hybrid system (e.g., Inventec, HEMO)	$392,000
Medium/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$480,000
	Convert OTVD to use Flashpoint inerted t-DCE	$144,000
	Replace with OTVD using Flashpoint inerted t-DCE	$360,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$540,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$500,000
	OTVD for Very low flashpoint (<0C) solvent	$500,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$480,000
	Co-Solvent, Bi-Solvent	$480,000
	Semi-Aqueous	$400,000
	Replace with Aqueous Cleaning	$500,000
	Hybrid system (e.g., Inventec, HEMO)	$672,000
Large/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$4,800,000
	Convert OTVD to use Flashpoint inerted t-DCE	$720,000
	Replace with OTVD using Flashpoint inerted t-DCE	$3,600,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$5,400,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$4,800,000
	OTVD for Very low flashpoint (<0C) solvent	$4,800,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$4,800,000
	Co-Solvent, Bi-Solvent	$4,800,000
	Semi-Aqueous	$1,600,000
	Replace with Aqueous Cleaning	$4,800,000
	Hybrid system (e.g., Inventec, HEMO)	$6,700,000
Small/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	$280,000
	Convert OTVD to use Flashpoint inerted t-DCE	$0
	Replace with OTVD using Flashpoint inerted t-DCE	$60,000

Table 7-17: Initial Capital Costs for New Machine, by Size, Cleaning Category, and Alternative Cleaning Method

Size/Cleaning Category	Alternative Cleaning Method	Estimated Initial Costs (2022$)
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$90,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$160,000
	OTVD for Very low flashpoint (<0C) solvent	$160,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$280,000
	Co-Solvent, Bi-Solvent	$220,000
	Semi-Aqueous	$100,000
	Replace with Aqueous Cleaning	$60,000
Medium/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	$480,000
	Convert OTVD to use Flashpoint inerted t-DCE	$0
	Replace with OTVD using Flashpoint inerted t-DCE	$720,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$540,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$500,000
	OTVD for Very low flashpoint (<0C) solvent	$500,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$480,000
	Co-Solvent, Bi-Solvent	$480,000
	Semi-Aqueous	$400,000
	Replace with Aqueous Cleaning	$500,000

7.7.3 Other Initial Capital Costs

Non-machine initial costs may include costs for fire equipment. The cost was estimated as 25% of the machine cost in most cases.

Table 7-18 presents the estimated initial capital costs other than the costs of purchasing a new machine or upgrading an existing machine. When these initial costs are incurred, they range from $400 to $1.2 million.

Table 7-18: Other Initial Capital Costs by Size, Cleaning Category, and Alternative Cleaning Method

Size/Cleaning Category	Alternative Cleaning Method	Estimated Initial Costs (2022$)
Small/General Cleaning	Replace with Airless Degreaser with PCE	$28,000
	Convert OTVD to use Flashpoint inerted t-DCE	$18,000
	Replace with OTVD using Flashpoint inerted t-DCE	$9,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$18,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$32,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$70,000
	Co-Solvent, Bi-Solvent	$22,000
	High boiling, non-vacuum, non-rinse	$800
	Semi-Aqueous	$10,000
	Replace with Aqueous Cleaning	$3,333
	Hybrid system (e.g., Inventec, HEMO)	$39,200
Medium/General Cleaning	Replace with Airless Degreaser with PCE	$28,000
	Convert OTVD to use Flashpoint inerted t-DCE	$54,000
	Replace with OTVD using Flashpoint inerted t-DCE	$0
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$0
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$0
	OTVD for Very low flashpoint (<0C) solvent	$0
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$120,000
	Co-Solvent, Bi-Solvent	$0
	High boiling, non-vacuum, non-rinse	$0
	Semi-Aqueous	$10,000
	Replace with Aqueous Cleaning	$10,000
	Hybrid system (e.g., Inventec, HEMO)	$39,200
Large/General Cleaning	Replace with Airless Degreaser with PCE	$28,000
	Convert OTVD to use Flashpoint inerted t-DCE	$6,000
	Replace with OTVD using Flashpoint inerted t-DCE	$9,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$0
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$16,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$1,200,000
	Co-Solvent, Bi-Solvent	$22,000
	High boiling, non-vacuum, non-rinse	$400
	Semi-Aqueous	$10,000
	Replace with Aqueous Cleaning	$180,000

Table 7-18: Other Initial Capital Costs by Size, Cleaning Category, and Alternative Cleaning Method

Size/Cleaning Category	Alternative Cleaning Method	Estimated Initial Costs (2022$)
	Hybrid system (e.g., Inventec, HEMO)	$39,200
Small/High Precision Cleaning	Replace with Airless Degreaser with PCE	$28,000
	Convert OTVD to use Flashpoint inerted t-DCE	$18,000
	Replace with OTVD using Flashpoint inerted t-DCE	$0
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$0
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$16,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$70,000
	Co-Solvent, Bi-Solvent	$22,000
	Semi-Aqueous	$10,000
	Replace with Aqueous Cleaning	$3,333
	Hybrid system (e.g., Inventec, HEMO)	$39,200
Medium/High Precision Cleaning	Replace with Airless Degreaser with PCE	$28,000
	Convert OTVD to use Flashpoint inerted t-DCE	$18,000
	Replace with OTVD using Flashpoint inerted t-DCE	$9,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$0
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$36,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$35,000
	Co-Solvent, Bi-Solvent	$22,000
	Semi-Aqueous	$10,000
	Replace with Aqueous Cleaning	$3,333
	Hybrid system (e.g., Inventec, HEMO)	$39,200
Large/High Precision Cleaning	Replace with Airless Degreaser with PCE	$28,000
	Convert OTVD to use Flashpoint inerted t-DCE	$9,000
	Replace with OTVD using Flashpoint inerted t-DCE	$9,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$0
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$16,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$35,000
	Co-Solvent, Bi-Solvent	$22,000
	Semi-Aqueous	$10,000
	Replace with Aqueous Cleaning	$3,333
	Hybrid system (e.g., Inventec, HEMO)	$39,200
Small/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$28,000

Table 7-18: Other Initial Capital Costs by Size, Cleaning Category, and Alternative Cleaning Method

Size/Cleaning Category	Alternative Cleaning Method	Estimated Initial Costs (2022$)
	Convert OTVD to use Flashpoint inerted t-DCE	$9,000
	Replace with OTVD using Flashpoint inerted t-DCE	$9,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$0
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$16,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$35,000
	Co-Solvent, Bi-Solvent	$22,000
	Semi-Aqueous	$10,000
	Replace with Aqueous Cleaning	$3,333
	Hybrid system (e.g., Inventec, HEMO)	$39,200
Medium/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$28,000
	Convert OTVD to use Flashpoint inerted t-DCE	$9,000
	Replace with OTVD using Flashpoint inerted t-DCE	$9,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$0
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$16,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$35,000
	Co-Solvent, Bi-Solvent	$22,000
	Semi-Aqueous	$10,000
	Replace with Aqueous Cleaning	$3,333
	Hybrid system (e.g., Inventec, HEMO)	$39,200
Large/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$28,000
	Convert OTVD to use Flashpoint inerted t-DCE	$9,000
	Replace with OTVD using Flashpoint inerted t-DCE	$9,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$0
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$16,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$35,000
	Co-Solvent, Bi-Solvent	$22,000
	Semi-Aqueous	$10,000
	Replace with Aqueous Cleaning	$3,333
	Hybrid system (e.g., Inventec, HEMO)	$39,200
Small/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	$28,000
	Convert OTVD to use Flashpoint inerted t-DCE	$18,000
	Replace with OTVD using Flashpoint inerted t-DCE	$9,000

Table 7-18: Other Initial Capital Costs by Size, Cleaning Category, and Alternative Cleaning Method

Size/Cleaning Category	Alternative Cleaning Method	Estimated Initial Costs (2022$)
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$0
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$16,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$35,000
	Co-Solvent, Bi-Solvent	$22,000
	Semi-Aqueous	$10,000
	Replace with Aqueous Cleaning	$3,333
Medium/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	$28,000
	Convert OTVD to use Flashpoint inerted t-DCE	$18,000
	Replace with OTVD using Flashpoint inerted t-DCE	$9,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$0
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$16,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$35,000
	Co-Solvent, Bi-Solvent	$22,000
	Semi-Aqueous	$10,000
	Replace with Aqueous Cleaning	$3,333

7.7.4 Cleaning Agent Costs

The initial fill for the cleaning agent matches the volume of the tank, which is the correct volume if full immersion cleaning is used. This may overstate the initial fill if the entire chamber is not filled. Some vapor degreasers, including airless, may clean only in vapor zone, or by spray wand, and will only be filled to a fraction of the chamber size. This will reduce the amount of solvent needed to be purchased. General cleaning applications are more likely to need full immersion due to higher soil loading.

Annual fill cleaning agent estimates account for several different factors, including the type of soil, cleanliness requirements, loss of cleaning agent, and soil loading. Aqueous tanks need to be changed more frequently than solvent and thus will have a high annual replacement; general cleaning will have a higher soil load and will need even more frequent changes. BFK Solutions' estimates for the annual fill volumes of solvents were informed by various sources of real-world application and SAFECHEM estimates.

Table 7-19 presents the estimated initial fill costs for cleaning agent. These initial costs range from $120 to $240,000.

Table 7-19: Cleaning Agent Costs: Initial Fill by Size, Cleaning Category, and Alternative Cleaning Method

Size/Cleaning Category	Alternative Cleaning Method	Estimated Initial Costs (2022$)
Small/General Cleaning	Replace with Airless Degreaser with PCE	$900
	Convert OTVD to use Flashpoint inerted t-DCE	$1,800
	Replace with OTVD using Flashpoint inerted t-DCE	$1,800
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$1,800
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$240
	OTVD for Very low flashpoint (<0C) solvent	$300
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$180
	Co-Solvent, Bi-Solvent	$1,911
	High boiling, non-vacuum, non-rinse	$360
	Semi-Aqueous	$348
	Replace with Aqueous Cleaning	$120
	Hybrid system (e.g., Inventec, HEMO)	$3,600
Medium/General Cleaning	Replace with Airless Degreaser with PCE	$18,750
	Convert OTVD to use Flashpoint inerted t-DCE	$37,500
	Replace with OTVD using Flashpoint inerted t-DCE	$37,500
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$37,500
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$5,000
	OTVD for Very low flashpoint (<0C) solvent	$6,250
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$3,750
	Co-Solvent, Bi-Solvent	$39,813
	High boiling, non-vacuum, non-rinse	$7,500
	Semi-Aqueous	$7,250
	Replace with Aqueous Cleaning	$2,500
	Hybrid system (example: Inventec, HEMO)	$75,000
Large/General Cleaning	Replace with Airless Degreaser with PCE	$60,000
	Convert OTVD to use Flashpoint inerted t-DCE	$120,000
	Replace with OTVD using FlashPoint inerted t-DCE	$120,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$120,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$20,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$12,000
	Co-Solvent, Bi-Solvent	$127,400
	High boiling, non-vacuum, non-rinse	$24,000
	Semi-Aqueous	$23,200
	Replace with Aqueous Cleaning	$8,000

Table 7-19: Cleaning Agent Costs: Initial Fill by Size, Cleaning Category, and Alternative Cleaning Method

Size/Cleaning Category	Alternative Cleaning Method	Estimated Initial Costs (2022$)
	Hybrid system (example: Inventec, HEMO)	$240,000
Small/High Precision Cleaning	Replace with Airless Degreaser with PCE	$900
	Convert OTVD to use Flashpoint inerted t-DCE	$1,800
	Replace with OTVD using FlashPoint inerted t-DCE	$1,800
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$1,800
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$240
	OTVD for Very low flashpoint (<0C) solvent	$300
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$180
	Co-Solvent, Bi-Solvent	$1,911
	Semi-Aqueous	$348
	Replace with Aqueous Cleaning	$120
	Hybrid system (example: Inventec, HEMO)	$3,600
Medium/High Precision Cleaning	Replace with Airless Degreaser with PCE	$18,750
	Convert OTVD to use Flashpoint inerted t-DCE	$37,500
	Replace with OTVD using FlashPoint inerted t-DCE	$37,500
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$37,500
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$5,000
	OTVD for Very low flashpoint (<0C) solvent	$6,250
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$3,750
	Co-Solvent, Bi-Solvent	$39,813
	Semi-Aqueous	$7,250
	Replace with Aqueous Cleaning	$2,500
	Hybrid system (example: Inventec, HEMO)	$75,000
Large/High Precision Cleaning	Replace with Airless Degreaser with PCE	$60,000
	Convert OTVD to use Flashpoint inerted t-DCE	$120,000
	Replace with OTVD using FlashPoint inerted t-DCE	$120,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$120,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$20,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$12,000
	Co-Solvent, Bi-Solvent	$127,400
	Semi-Aqueous	$23,200
	Replace with Aqueous Cleaning	$8,000
	Hybrid system (example: Inventec, HEMO)	$240,000
Small/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$900

Table 7-19: Cleaning Agent Costs: Initial Fill by Size, Cleaning Category, and Alternative Cleaning Method

Size/Cleaning Category	Alternative Cleaning Method	Estimated Initial Costs (2022$)
	Convert OTVD to use Flashpoint inerted t-DCE	$1,800
	Replace with OTVD using FlashPoint inerted t-DCE	$1,800
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$1,800
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$240
	OTVD for Very low flashpoint (<0C) solvent	$300
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$180
	Co-Solvent, Bi-Solvent	$1,911
	Semi-Aqueous	$348
	Replace with Aqueous Cleaning	$120
	Hybrid system (example: Inventec, HEMO)	$3,600
Medium/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$18,750
	Convert OTVD to use Flashpoint inerted t-DCE	$37,500
	Replace with OTVD using FlashPoint inerted t-DCE	$37,500
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$37,500
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$5,000
	OTVD for Very low flashpoint (<0C) solvent	$6,250
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$3,750
	Co-Solvent, Bi-Solvent	$39,813
	Semi-Aqueous	$7,250
	Replace with Aqueous Cleaning	$2,500
	Hybrid system (example: Inventec, HEMO)	$75,000
Large/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$60,000
	Convert OTVD to use Flashpoint inerted t-DCE	$120,000
	Replace with OTVD using FlashPoint inerted t-DCE	$120,000
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$120,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$16,000
	OTVD for Very low flashpoint (<0C) solvent	$20,000
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$12,000
	Co-Solvent, Bi-Solvent	$127,400
	Semi-Aqueous	$23,200
	Replace with Aqueous Cleaning	$8,000
	Hybrid system (example: Inventec, HEMO)	$240,000
Small/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	$900
	Convert OTVD to use Flashpoint inerted t-DCE	$1,800
	Replace with OTVD using FlashPoint inerted t-DCE	$1,800

Table 7-19: Cleaning Agent Costs: Initial Fill by Size, Cleaning Category, and Alternative Cleaning Method

Size/Cleaning Category	Alternative Cleaning Method	Estimated Initial Costs (2022$)
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$1,800
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$240
	OTVD for Very low flashpoint (<0C) solvent	$300
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$180
	Co-Solvent, Bi-Solvent	$1,911
	Semi-Aqueous	$348
	Replace with Aqueous Cleaning	$120
Medium/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	$18,750
	Convert OTVD to use Flashpoint inerted t-DCE	$37,500
	Replace with OTVD using FlashPoint inerted t-DCE	$37,500
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$37,500
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$5,000
	OTVD for Very low flashpoint (<0C) solvent	$6,250
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$3,750
	Co-Solvent, Bi-Solvent	$39,813
	Semi-Aqueous	$7,250
	Replace with Aqueous Cleaning	$2,500

Table 7-20 presents the cleaning estimated baseline annual replacement cleaning agent costs.

Table 7-20: Cleaning Agent Costs: Cleaning Agent Costs: Baseline Annual Replacement (2022$)

Size/Cleaning Category	Cleaning Chamber Tank Size in Inches (Approx)	Cleaning Agent; Annual Replacement (gal)	Cleaning Agent Price ($/gal)	Baseline Cost
Small/General Cleaning	12 x 12 x 10	36	$150	$5,400
Medium/General Cleaning	36 x 36 x 22	726	$150	$108,900
Large/General Cleaning	60 x 42 x 36	1,162	$300	$348,450
Small/High Precision Cleaning	12 x 12 x 10	16	$300	$4,860
Medium/High Precision Cleaning	36 x 36 x 22	330	$300	$99,000
Large/High Precision Cleaning	60 x 42 x 36	8,711	$40	$348,450
Small/Safety Critical Cleaning	12 x 12 x 10	97	$50	$4,860
Medium/Safety Critical Cleaning	36 x 36 x 22	3,300	$30	$99,000
Large/Safety Critical Cleaning	60 x 42 x 36	2,188	$159	$348,450
Small/Start-Up/R&D Critical Cleaning	12 x 12 x 10	81	$60	$4,860
Medium/Start-Up/R&D Critical Cleaning	36 x 36 x 22	28	$58	$1,620

Table 7-21 presents the incremental annual cleaning agent replacement costs, which range from a cost savings of about $350,000 (indicated as a negative incremental cost) to an increased cost of about $1 million annually.

Table 7-21: Cleaning Agent Costs by Size, Cleaning Category, and Alternative Cleaning Method: Annual Replacement (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Cleaning Agent; Annual Replacement (gal)	Cleaning Agent Price ($/gal)	Baseline Cost	Post-Conversion Cost	Incremental Cost
Small/General Cleaning	Replace with Airless Degreaser with PCE	12	$150	$5,400	$1,800	($3,600)
	Convert OTVD to use Flashpoint inerted t-DCE	45	$300	$5,400	$13,500	$8,100
	Replace with OTVD using FlashPoint inerted t-DCE	45	$300	$5,400	$13,500	$8,100
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	36	$300	$5,400	$10,800	$5,400
	OTVD for Low boiling point (<100C) Alcohol or other flammable	45	$40	$5,400	$1,800	($3,600)
	OTVD for Very low flashpoint (<0C) solvent	45	$50	$5,400	$2,250	($3,150)
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	12	$30	$5,400	$360	($5,040)
	Co-Solvent, Bi-Solvent	48	$159	$5,400	$7,644	$2,244
	High boiling, non-vacuum, non-rinse	45	$60	$5,400	$2,700	($2,700)
	Semi-Aqueous	12	$58	$5,400	$696	($4,704)
	Replace with Aqueous Cleaning	144	$20	$5,400	$2,880	($2,520)
	Hybrid system (example: Inventec, HEMO)	12	$300	$5,400	$3,600	($1,800)
Medium/General Cleaning	Replace with Airless Degreaser with PCE	55	$150	$108,900	$8,250	($100,650)
	Convert OTVD to use Flashpoint inerted t-DCE	908	$300	$108,900	$272,400	$163,500
	Replace with OTVD using FlashPoint inerted t-DCE	908	$300	$108,900	$272,250	$163,350
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	726	$300	$108,900	$217,800	$108,900
	OTVD for Low boiling point (<100C) Alcohol or other flammable	908	$40	$108,900	$36,320	($72,580)
	OTVD for Very low flashpoint (<0C) solvent	908	$50	$108,900	$45,400	($63,500)
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	330	$30	$108,900	$9,900	($99,000)
	Co-Solvent, Bi-Solvent	750	$159	$108,900	$119,438	$10,538
	High boiling, non-vacuum, non-rinse	908	$60	$108,900	$54,480	($54,420)
	Semi-Aqueous	908	$58	$108,900	$52,664	($56,236)
	Replace with Aqueous Cleaning	1,500	$20	$108,900	$30,000	($78,900)
	Hybrid system (example: Inventec, HEMO)	660	$300	$108,900	$198,000	$89,100

Table 7-21: Cleaning Agent Costs by Size, Cleaning Category, and Alternative Cleaning Method: Annual Replacement (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Cleaning Agent; Annual Replacement (gal)	Cleaning Agent Price ($/gal)	Baseline Cost	Post-Conversion Cost	Incremental Cost
Large/General Cleaning	Replace with Airless Degreaser with PCE	300	$150	$348,450	$45,000	($303,450)
	Convert OTVD to use Flashpoint inerted t-DCE	2,323	$300	$348,450	$696,900	$348,450
	Replace with OTVD using FlashPoint inerted t-DCE	2,904	$300	$348,450	$871,125	$522,675
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	2,323	$300	$348,450	$696,900	$348,450
	OTVD for Low boiling point (<100C) Alcohol or other flammable	2,323	$40	$348,450	$92,920	($255,530)
	OTVD for Very low flashpoint (<0C) solvent	2,323	$50	$348,450	$116,150	($232,300)
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	100	$30	$348,450	$3,000	($345,450)
	Co-Solvent, Bi-Solvent	2,400	$159	$348,450	$382,200	$33,750
	High boiling, non-vacuum, non-rinse	2,323	$60	$348,450	$139,380	($209,070)
	Semi-Aqueous	2,323	$58	$348,450	$134,734	($213,716)
	Replace with Aqueous Cleaning	4,800	$20	$348,450	$96,000	($252,450)
	Hybrid system (example: Inventec, HEMO)	200	$300	$348,450	$60,000	($288,450)
Small/High Precision Cleaning	Replace with Airless Degreaser with PCE	11	$150	$4,860	$1,620	($3,240)
	Convert OTVD to use Flashpoint inerted t-DCE	41	$300	$4,860	$12,150	$7,290
	Replace with OTVD using FlashPoint inerted t-DCE	41	$300	$4,860	$12,150	$7,290
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	32	$300	$4,860	$9,720	$4,860
	OTVD for Low boiling point (<100C) Alcohol or other flammable	41	$40	$4,860	$1,620	($3,240)
	OTVD for Very low flashpoint (<0C) solvent	41	$50	$4,860	$2,025	($2,835)
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	11	$30	$4,860	$324	($4,536)
	Co-Solvent, Bi-Solvent	43	$159	$4,860	$6,880	$2,020
	Semi-Aqueous	11	$58	$4,860	$626	($4,234)
	Replace with Aqueous Cleaning	130	$20	$4,860	$2,592	($2,268)
	Hybrid system (example: Inventec, HEMO)	11	$300	$4,860	$3,240	($1,620)
Medium/High Precision Cleaning	Replace with Airless Degreaser with PCE	55	$150	$99,000	$8,250	($90,750)

Table 7-21: Cleaning Agent Costs by Size, Cleaning Category, and Alternative Cleaning Method: Annual Replacement (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Cleaning Agent; Annual Replacement (gal)	Cleaning Agent Price ($/gal)	Baseline Cost	Post-Conversion Cost	Incremental Cost
	Convert OTVD to use Flashpoint inerted t-DCE	825	$300	$99,000	$247,500	$148,500
	Replace with OTVD using FlashPoint inerted t-DCE	825	$300	$99,000	$247,500	$148,500
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	660	$300	$99,000	$198,000	$99,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	825	$40	$99,000	$33,000	($66,000)
	OTVD for Very low flashpoint (<0C) solvent	825	$50	$99,000	$41,250	($57,750)
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	55	$30	$99,000	$1,650	($97,350)
	Co-Solvent, Bi-Solvent	825	$159	$99,000	$131,381	$32,381
	Semi-Aqueous	825	$58	$99,000	$47,850	($51,150)
	Replace with Aqueous Cleaning	375	$20	$99,000	$7,500	($91,500)
	Hybrid system (example: Inventec, HEMO)	660	$300	$99,000	$198,000	$99,000
Large/High Precision Cleaning	Replace with Airless Degreaser with PCE	300	$150	$348,450	$45,000	($303,450)
	Convert OTVD to use Flashpoint inerted t-DCE	2,323	$300	$348,450	$696,900	$348,450
	Replace with OTVD using FlashPoint inerted t-DCE	2,323	$300	$348,450	$696,900	$348,450
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	2,323	$300	$348,450	$696,900	$348,450
	OTVD for Low boiling point (<100C) Alcohol or other flammable	2,323	$40	$348,450	$92,920	($255,530)
	OTVD for Very low flashpoint (<0C) solvent	2,323	$50	$348,450	$116,150	($232,300)
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	2,323	$30	$348,450	$69,690	($278,760)
	Co-Solvent, Bi-Solvent	100	$159	$348,450	$15,925	($332,525)
	Semi-Aqueous	2,323	$58	$348,450	$134,734	($213,716)
	Replace with Aqueous Cleaning	2,323	$20	$348,450	$46,460	($301,990)
	Hybrid system (example: Inventec, HEMO)	4,800	$300	$348,450	$1,440,000	$1,091,550
Small/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	11	$150	$4,860	$1,620	($3,240)
	Convert OTVD to use Flashpoint inerted t-DCE	41	$300	$4,860	$12,150	$7,290
	Replace with OTVD using FlashPoint inerted t-	41	$300	$4,860	$12,150	$7,290

Table 7-21: Cleaning Agent Costs by Size, Cleaning Category, and Alternative Cleaning Method: Annual Replacement (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Cleaning Agent; Annual Replacement (gal)	Cleaning Agent Price ($/gal)	Baseline Cost	Post-Conversion Cost	Incremental Cost
	DCE					
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	32	$300	$4,860	$9,720	$4,860
	OTVD for Low boiling point (<100C) Alcohol or other flammable	41	$40	$4,860	$1,620	($3,240)
	OTVD for Very low flashpoint (<0C) solvent	41	$50	$4,860	$2,025	($2,835)
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	11	$30	$4,860	$324	($4,536)
	Co-Solvent, Bi-Solvent	43	$159	$4,860	$6,880	$2,020
	Semi-Aqueous	11	$58	$4,860	$626	($4,234)
	Replace with Aqueous Cleaning	130	$20	$4,860	$2,592	($2,268)
	Hybrid system (example: Inventec, HEMO)	11	$300	$4,860	$3,240	($1,620)
Medium/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	55	$150	$99,000	$8,250	($90,750)
	Convert OTVD to use Flashpoint inerted t-DCE	55	$300	$99,000	$16,500	($82,500)
	Replace with OTVD using FlashPoint inerted t-DCE	825	$300	$99,000	$247,500	$148,500
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	660	$300	$99,000	$198,000	$99,000
	OTVD for Low boiling point (<100C) Alcohol or other flammable	825	$40	$99,000	$33,000	($66,000)
	OTVD for Very low flashpoint (<0C) solvent	825	$50	$99,000	$41,250	($57,750)
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	825	$30	$99,000	$24,750	($74,250)
	Co-Solvent, Bi-Solvent	55	$159	$99,000	$8,759	($90,241)
	Semi-Aqueous	825	$58	$99,000	$47,850	($51,150)
	Replace with Aqueous Cleaning	825	$20	$99,000	$16,500	($82,500)
	Hybrid system (e.g., Inventec, HEMO)	375	$300	$99,000	$112,500	$13,500
Large/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	300	$150	$348,450	$45,000	($303,450)
	Convert OTVD to use Flashpoint inerted t-DCE	2,323	$300	$348,450	$696,900	$348,450
	Replace with OTVD using Flashpoint inerted t-DCE	2,323	$300	$348,450	$696,900	$348,450
	Replace with Solstice system (trans-1-chloro-	2,323	$300	$348,450	$696,900	$348,450

Table 7-21: Cleaning Agent Costs by Size, Cleaning Category, and Alternative Cleaning Method: Annual Replacement (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Cleaning Agent; Annual Replacement (gal)	Cleaning Agent Price ($/gal)	Baseline Cost	Post-Conversion Cost	Incremental Cost
	3,3,3,trifluoropropene)					
	OTVD for Low boiling point (<100C) Alcohol or other flammable	2,323	$40	$348,450	$92,920	($255,530)
	OTVD for Very low flashpoint (<0C) solvent	2,323	$50	$348,450	$116,150	($232,300)
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	2,323	$30	$348,450	$69,690	($278,760)
	Co-Solvent, Bi-Solvent	100	$159	$348,450	$15,925	($332,525)
	Semi-Aqueous	2,323	$58	$348,450	$134,734	($213,716)
	Replace with Aqueous Cleaning	2,323	$20	$348,450	$46,460	($301,990)
	Hybrid system (e.g., Inventec, HEMO)	4,800	$300	$348,450	$1,440,000	$1,091,550
Small/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	11	$150	$4,860	$1,620	($3,240)
	Convert OTVD to use Flashpoint inerted t-DCE	41	$300	$4,860	$12,150	$7,290
	Replace with OTVD using Flashpoint inerted t-DCE	41	$300	$4,860	$12,150	$7,290
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	32	$300	$4,860	$9,720	$4,860
	OTVD for Low boiling point (<100C) Alcohol or other flammable	41	$40	$4,860	$1,620	($3,240)
	OTVD for Very low flashpoint (<0C) solvent	41	$50	$4,860	$2,025	($2,835)
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	11	$30	$4,860	$324	($4,536)
	Co-Solvent, Bi-Solvent	43	$159	$4,860	$6,880	$2,020
	Semi-Aqueous	11	$58	$4,860	$626	($4,234)
	Replace with Aqueous Cleaning	130	$20	$4,860	$2,592	($2,268)
Medium/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	55	$150	$1,620	$8,250	$6,630
	Convert OTVD to use Flashpoint inerted t-DCE	55	$300	$1,620	$16,500	$14,880
	Replace with OTVD using Flashpoint inerted t-DCE	825	$300	$1,620	$247,500	$245,880
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	11	$300	$1,620	$3,240	$1,620
	OTVD for Low boiling point (<100C) Alcohol or other flammable	825	$40	$1,620	$33,000	$31,380

Table 7-21: Cleaning Agent Costs by Size, Cleaning Category, and Alternative Cleaning Method: Annual Replacement (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Cleaning Agent; Annual Replacement (gal)	Cleaning Agent Price ($/gal)	Baseline Cost	Post-Conversion Cost	Incremental Cost
	OTVD for Very low flashpoint (<0C) solvent	825	$50	$1,620	$41,250	$39,630
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	825	$30	$1,620	$24,750	$23,130
	Co-Solvent, Bi-Solvent	55	$159	$1,620	$8,759	$7,139
	Semi-Aqueous	825	$58	$1,620	$47,850	$46,230
	Replace with Aqueous Cleaning	825	$20	$1,620	$16,500	$14,880

7.7.5 Waste Disposal Costs

Disposal costs were estimated based on TCE disposal costs and adjusted based on cleaning agent and method. For example, there is an estimated 20 percent upcharge for fluorinated solvents compared to TCE. Additionally, if the cleaning agent is combustible than it would be 80 percent of the TCE cost.

Table 7-22 presents the baseline waste disposal costs for TCE vapor degreasing.

Table 7-23 presents the estimated annual waste disposal costs under the baseline, under the new cleaning method, and the incremental change in the annual waste disposal costs. These costs range from a savings of about $4,000 (indicated as a negative incremental cost) to $16,000 in additional waste disposal costs.

Table 7-22: Baseline Waste Disposal Costs by Size and Cleaning Category (2022$)

Size/Cleaning Category	Cleaning Agent; Annual Replacement (gal)	Cleaning Agent Price ($/gal)	Baseline Cost
Small/General Cleaning	17	$18.20	$309
Medium/General Cleaning	330		$6,006
Large/General Cleaning	1,056		$19,219
Small/High Precision Cleaning	6		$100
Medium/High Precision Cleaning	110		$2,002
Large/High Precision Cleaning	352		$6,406
Small/Safety Critical Cleaning	6		$100
Medium/Safety Critical Cleaning	110		$2,002
Large/Safety Critical Cleaning	352		$6,406
Small/Start-Up/R&D Critical Cleaning	6		$100
Medium/Start-Up/R&D Critical Cleaning	110		$2,002

Table 7-23: Annual Waste Disposal Costs, by Size, Cleaning Category and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Liquid Waste (gal)	Disposal Cost ($/gal)	Baseline Cost	Post-Conversion Cost	In
Small/General Cleaning	Replace with Airless Degreaser with PCE	17	$18.20	$309	$309	
	Convert OTVD to use Flashpoint inerted t-DCE	17	$21.80	$309	$371	
	Replace with OTVD using Flashpoint inerted t-DCE	17	$21.80	$309	$371	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	17	$21.80	$309	$371	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	17	$14.50	$309	$247	
	OTVD for Very low flashpoint (<0C) solvent	17	$14.50	$309	$247	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	17	$14.50	$309	$247	
	Co-Solvent, Bi-Solvent	17	$14.50	$309	$247	
	High boiling, non-vacuum, non-rinse	17	$14.50	$309	$247	
	Semi-Aqueous	17	$14.50	$309	$247	
	Replace with Aqueous Cleaning	72	$4.00	$309	$288	
	Hybrid system (e.g., Inventec, HEMO)	17	$14.50	$309	$247	
Medium/General Cleaning	Replace with Airless Degreaser with PCE	330	$18.20	$6,006	$6,006	
	Convert OTVD to use Flashpoint inerted t-DCE	330	$21.80	$6,006	$7,194	
	Replace with OTVD using Flashpoint inerted t-DCE	330	$21.80	$6,006	$7,194	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	330	$21.80	$6,006	$7,194	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	330	$14.50	$6,006	$4,785	
	OTVD for Very low flashpoint (<0C) solvent	330	$14.50	$6,006	$4,785	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	330	$14.50	$6,006	$4,785	
	Co-Solvent, Bi-Solvent	330	$14.50	$6,006	$4,785	
	High boiling, non-vacuum, non-rinse	330	$14.50	$6,006	$4,785	
	Semi-Aqueous	330	$14.50	$6,006	$4,785	
	Replace with Aqueous Cleaning	1,500	$4.00	$6,006	$6,000	
	Hybrid system (e.g., Inventec, HEMO)	330	$14.50	$6,006	$4,785	
Large/General Cleaning	Replace with Airless Degreaser with PCE	1,056	$18.20	$19,219	$19,219	
	Convert OTVD to use Flashpoint inerted t-DCE	1,056	$21.80	$19,219	$23,021	

Table 7-23: Annual Waste Disposal Costs, by Size, Cleaning Category and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Liquid Waste (gal)	Disposal Cost ($/gal)	Baseline Cost	Post-Conversion Cost	In
	Replace with OTVD using Flashpoint inerted t-DCE	1,056	$21.80	$19,219	$23,021	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	1,056	$21.80	$19,219	$23,021	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	1,056	$14.50	$19,219	$15,312	
	OTVD for Very low flashpoint (<0C) solvent	1,056	$14.50	$19,219	$15,312	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	1,056	$14.50	$19,219	$15,312	
	Co-Solvent, Bi-Solvent	1,056	$14.50	$19,219	$15,312	
	High boiling, non-vacuum, non-rinse	1,056	$14.50	$19,219	$15,312	
	Semi-Aqueous	1,056	$14.50	$19,219	$15,312	
	Replace with Aqueous Cleaning	4,800	$4.00	$19,219	$19,200	
	Hybrid system (e.g., Inventec, HEMO)	2,112	$14.50	$19,219	$30,624	
Small/High Precision Cleaning	Replace with Airless Degreaser with PCE	3	$18.20	$100	$55	
	Convert OTVD to use Flashpoint inerted t-DCE	8	$21.80	$100	$174	
	Replace with OTVD using Flashpoint inerted t-DCE	8	$21.80	$100	$174	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	6	$21.80	$100	$120	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	8	$14.50	$100	$116	
	OTVD for Very low flashpoint (<0C) solvent	8	$14.50	$100	$116	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	3	$14.50	$100	$44	
	Co-Solvent, Bi-Solvent	8	$14.50	$100	$116	
	Semi-Aqueous	8	$14.50	$100	$116	
	Replace with Aqueous Cleaning	18	$4.00	$100	$72	
	Hybrid system (e.g., Inventec, HEMO)	17	$8.20	$100	$139	
Medium/High Precision Cleaning	Replace with Airless Degreaser with PCE	110	$18.20	$2,002	$2,002	
	Convert OTVD to use Flashpoint inerted t-DCE	110	$21.80	$2,002	$2,398	
	Replace with OTVD using Flashpoint inerted t-DCE	110	$21.80	$2,002	$2,398	
	Replace with Solstice system (trans-1-chloro-	110	$21.80	$2,002	$2,398	

Table 7-23: Annual Waste Disposal Costs, by Size, Cleaning Category and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Liquid Waste (gal)	Disposal Cost ($/gal)	Baseline Cost	Post-Conversion Cost	In
	3,3,3,trifluoropropene)					
	OTVD for Low boiling point (<100C) Alcohol or other flammable	110	$14.50	$2,002	$1,595	
	OTVD for Very low flashpoint (<0C) solvent	110	$14.50	$2,002	$1,595	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	110	$14.50	$2,002	$1,595	
	Co-Solvent, Bi-Solvent	110	$14.50	$2,002	$1,595	
	Semi-Aqueous	110	$14.50	$2,002	$1,595	
	Replace with Aqueous Cleaning	940	$4.00	$2,002	$3,760	
	Hybrid system (e.g., Inventec, HEMO)	330	$14.50	$2,002	$4,785	
Large/High Precision Cleaning	Replace with Airless Degreaser with PCE	400	$18.20	$6,406	$7,280	
	Convert OTVD to use Flashpoint inerted t-DCE	352	$21.80	$6,406	$7,674	
	Replace with OTVD using Flashpoint inerted t-DCE	352	$21.80	$6,406	$7,674	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	352	$21.80	$6,406	$7,674	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	352	$14.50	$6,406	$5,104	
	OTVD for Very low flashpoint (<0C) solvent	352	$14.50	$6,406	$5,104	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	400	$14.50	$6,406	$5,800	
	Co-Solvent, Bi-Solvent	352	$14.50	$6,406	$5,104	
	Semi-Aqueous	352	$14.50	$6,406	$5,104	
	Replace with Aqueous Cleaning	5,500	$4.00	$6,406	$22,000	
	Hybrid system (e.g., Inventec, HEMO)	2,112	$8.20	$6,406	$17,318	
Small/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	3	$18.20	$100	$55	
	Convert OTVD to use Flashpoint inerted t-DCE	6	$21.80	$100	$120	
	Replace with OTVD using Flashpoint inerted t-DCE	8	$21.80	$100	$174	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	6	$21.80	$100	$120	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	6	$14.50	$100	$80	
	OTVD for Very low flashpoint (<0C) solvent	6	$14.50	$100	$80	

Table 7-23: Annual Waste Disposal Costs, by Size, Cleaning Category and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Liquid Waste (gal)	Disposal Cost ($/gal)	Baseline Cost	Post-Conversion Cost	In
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	3	$14.50	$100	$44	
	Co-Solvent, Bi-Solvent	6	$14.50	$100	$80	
	Semi-Aqueous	6	$14.50	$100	$80	
	Replace with Aqueous Cleaning	18	$4.00	$100	$72	
	Hybrid system (e.g., Inventec, HEMO)	17	$8.20	$100	$139	
Medium/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	110	$18.20	$2,002	$2,002	
	Convert OTVD to use Flashpoint inerted t-DCE	110	$21.80	$2,002	$2,398	
	Replace with OTVD using Flashpoint inerted t-DCE	110	$21.80	$2,002	$2,398	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	110	$21.80	$2,002	$2,398	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	110	$14.50	$2,002	$1,595	
	OTVD for Very low flashpoint (<0C) solvent	110	$14.50	$2,002	$1,595	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	110	$14.50	$2,002	$1,595	
	Co-Solvent, Bi-Solvent	110	$14.50	$2,002	$1,595	
	Semi-Aqueous	110	$14.50	$2,002	$1,595	
	Replace with Aqueous Cleaning	940	$4.00	$2,002	$3,760	
	Hybrid system (e.g., Inventec, HEMO)	330	$8.20	$2,002	$2,706	
Large/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	400	$18.20	$6,406	$7,280	
	Convert OTVD to use Flashpoint inerted t-DCE	352	$21.80	$6,406	$7,674	
	Replace with OTVD using Flashpoint inerted t-DCE	352	$21.80	$6,406	$7,674	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	352	$21.80	$6,406	$7,674	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	352	$14.50	$6,406	$5,104	
	OTVD for Very low flashpoint (<0C) solvent	352	$14.50	$6,406	$5,104	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	400	$14.50	$6,406	$5,800	
	Co-Solvent, Bi-Solvent	352	$14.50	$6,406	$5,104	
	Semi-Aqueous	352	$14.50	$6,406	$5,104	

Table 7-23: Annual Waste Disposal Costs, by Size, Cleaning Category and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Liquid Waste (gal)	Disposal Cost ($/gal)	Baseline Cost	Post-Conversion Cost	In
	Replace with Aqueous Cleaning	5,500	$4.00	$6,406	$22,000	
	Hybrid system (e.g., Inventec, HEMO)	2,112	$8.20	$6,406	$17,318	
Small/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	3	$18.20	$100	$55	
	Convert OTVD to use Flashpoint inerted t-DCE	6	$21.80	$100	$120	
	Replace with OTVD using Flashpoint inerted t-DCE	8	$21.80	$100	$174	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	6	$21.80	$100	$120	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	6	$14.50	$100	$80	
	OTVD for Very low flashpoint (<0C) solvent	6	$14.50	$100	$80	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	3	$14.50	$100	$44	
	Co-Solvent, Bi-Solvent	6	$14.50	$100	$80	
	Semi-Aqueous	6	$14.50	$100	$80	
	Replace with Aqueous Cleaning	18	$4.00	$100	$72	
Medium/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	110	$18.20	$2,002	$2,002	
	Convert OTVD to use Flashpoint inerted t-DCE	110	$21.80	$2,002	$2,398	
	Replace with OTVD using Flashpoint inerted t-DCE	110	$21.80	$2,002	$2,398	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	110	$21.80	$2,002	$2,398	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	110	$14.50	$2,002	$1,595	
	OTVD for Very low flashpoint (<0C) solvent	110	$14.50	$2,002	$1,595	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	110	$14.50	$2,002	$1,595	
	Co-Solvent, Bi-Solvent	110	$14.50	$2,002	$1,595	
	Semi-Aqueous	110	$14.50	$2,002	$1,595	
	Replace with Aqueous Cleaning	940	$4.00	$2,002	$3,760	

7.7.6 Annual Maintenance Costs

Maintenance costs are highly dependent on the type and age of the cleaning system. There is an estimated 20-year life for most systems and maintenance costs will be needed for items like filters, process monitoring, annual employee check-ups, monitoring for soil or water contamination. There is a 25 percent additional markup for extra items.

Table 7-24 presents the estimated annual maintenance costs under the baseline, under the new cleaning method, and the incremental change in the annual maintenance costs. These costs range from a savings of about $200,000 (indicated as a negative incremental cost) to $200,000 in additional waste disposal costs.

Table 7-24: Annual Maintenance Costs, by Size, Cleaning Category, and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Baseline Cost	Post-Conversion Cost	In
Small/General Cleaning	Replace with Airless Degreaser with PCE	$3,750	$19,250	
	Convert OTVD to use Flashpoint inerted t-DCE	$3,750	$4,313	
	Replace with OTVD using FlashPoint inerted t-DCE	$3,750	$4,313	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$3,750	$6,750	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$3,750	$11,000	
	OTVD for Very low flashpoint (<0C) solvent	$3,750	$12,000	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$3,750	$21,875	
	Co-Solvent, Bi-Solvent	$3,750	$28,875	
	High boiling, non-vacuum, non-rinse	$3,750	$300	
	Semi-Aqueous	$3,750	$6,875	
	Replace with Aqueous Cleaning	$3,750	$15,208	
	Hybrid system (e.g., Inventec, HEMO)	$3,750	$26,950	
Medium/General Cleaning	Replace with Airless Degreaser with PCE	$22,500	$31,750	
	Convert OTVD to use Flashpoint inerted t-DCE	$22,500	$11,250	
	Replace with OTVD using Flashpoint inerted t-DCE	$22,500	$23,750	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$22,500	$33,750	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$22,500	$31,250	
	OTVD for Very low flashpoint (<0C) solvent	$22,500	$31,250	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$22,500	$37,500	
	Co-Solvent, Bi-Solvent	$22,500	$31,250	
	High boiling, non-vacuum, non-rinse	$22,500	$1,000	
	Semi-Aqueous	$22,500	$25,625	
	Replace with Aqueous Cleaning	$22,500	$31,875	
	Hybrid system (e.g., Inventec, HEMO)	$22,500	$44,450	
Large/General Cleaning	Replace with Airless Degreaser with PCE	$225,000	$301,750	
	Convert OTVD to use Flashpoint inerted t-DCE	$225,000	$225,563	
	Replace with OTVD using Flashpoint inerted t-DCE	$225,000	$225,563	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$225,000	$337,500	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$225,000	$301,000	
	OTVD for Very low flashpoint (<0C) solvent	$225,000	$301,000	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$225,000	$375,000	
	Co-Solvent, Bi-Solvent	$225,000	$19,375	

Table 7-24: Annual Maintenance Costs, by Size, Cleaning Category, and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Baseline Cost	Post-Conversion Cost	In
	High boiling, non-vacuum, non-rinse	$225,000	$2,025	
	Semi-Aqueous	$225,000	$10,625	
	Replace with Aqueous Cleaning	$225,000	$311,250	
	Hybrid system (e.g., Inventec, HEMO)	$225,000	$422,450	
Small/High Precision Cleaning	Replace with Airless Degreaser with PCE	$3,750	$19,250	
	Convert OTVD to use Flashpoint inerted t-DCE	$3,750	$3,750	
	Replace with OTVD using Flashpoint inerted t-DCE	$3,750	$3,750	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$3,750	$5,625	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$3,750	$11,000	
	OTVD for Very low flashpoint (<0C) solvent	$3,750	$11,000	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$3,750	$21,875	
	Co-Solvent, Bi-Solvent	$3,750	$15,125	
	Semi-Aqueous	$3,750	$6,875	
	Replace with Aqueous Cleaning	$3,750	$16,458	
	Hybrid system (e.g., Inventec, HEMO)	$3,750	$20,700	
Medium/High Precision Cleaning	Replace with Airless Degreaser with PCE	$22,500	$31,750	
	Convert OTVD to use Flashpoint inerted t-DCE	$22,500	$23,063	
	Replace with OTVD using Flashpoint inerted t-DCE	$22,500	$23,063	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$22,500	$33,750	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$22,500	$32,250	
	OTVD for Very low flashpoint (<0C) solvent	$22,500	$5,375	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$22,500	$32,188	
	Co-Solvent, Bi-Solvent	$22,500	$31,375	
	Semi-Aqueous	$22,500	$25,625	
	Replace with Aqueous Cleaning	$22,500	$31,458	
	Hybrid system (e.g., Inventec, HEMO)	$22,500	$44,450	
Large/High Precision Cleaning	Replace with Airless Degreaser with PCE	$225,000	$301,750	
	Convert OTVD to use Flashpoint inerted t-DCE	$225,000	$225,563	
	Replace with OTVD using Flashpoint inerted t-DCE	$225,000	$225,563	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$225,000	$337,500	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$225,000	$301,000	
	OTVD for Very low flashpoint (<0C) solvent	$225,000	$301,000	

Table 7-24: Annual Maintenance Costs, by Size, Cleaning Category, and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Baseline Cost	Post-Conversion Cost	In
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$225,000	$302,188	
	Co-Solvent, Bi-Solvent	$225,000	$1,875	
	Semi-Aqueous	$225,000	$10,625	
	Replace with Aqueous Cleaning	$225,000	$300,208	
	Hybrid system (e.g., Inventec, HEMO)	$225,000	$422,450	
	Replace with Airless Degreaser with PCE	$3,750	$19,250	
	Convert OTVD to use Flashpoint inerted t-DCE	$3,750	$4,313	
	Replace with OTVD using Flashpoint inerted t-DCE	$3,750	$4,313	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$3,750	$5,625	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$3,750	$11,000	
Small/Safety Critical Cleaning	OTVD for Very low flashpoint (<0C) solvent	$3,750	$11,000	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$3,750	$19,688	
	Co-Solvent, Bi-Solvent	$3,750	$15,125	
	Semi-Aqueous	$3,750	$6,875	
	Replace with Aqueous Cleaning	$3,750	$3,958	
	Hybrid system (e.g., Inventec, HEMO)	$3,750	$26,950	
	Replace with Airless Degreaser with PCE	$22,500	$31,750	
	Convert OTVD to use Flashpoint inerted t-DCE	$22,500	$9,563	
	Replace with OTVD using Flashpoint inerted t-DCE	$22,500	$23,063	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$22,500	$33,750	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$22,500	$32,250	
Medium/Safety Critical Cleaning	OTVD for Very low flashpoint (<0C) solvent	$22,500	$32,250	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$22,500	$32,188	
	Co-Solvent, Bi-Solvent	$22,500	$31,375	
	Semi-Aqueous	$22,500	$25,625	
	Replace with Aqueous Cleaning	$22,500	$31,458	
	Hybrid system (e.g., Inventec, HEMO)	$22,500	$44,450	
	Replace with Airless Degreaser with PCE	$225,000	$301,750	
	Convert OTVD to use Flashpoint inerted t-DCE	$225,000	$45,563	
Large/Safety Critical Cleaning	Replace with OTVD using Flashpoint inerted t-DCE	$225,000	$225,563	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$225,000	$337,500	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$225,000	$301,000	

Table 7-24: Annual Maintenance Costs, by Size, Cleaning Category, and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Baseline Cost	Post-Conversion Cost	In
	OTVD for Very low flashpoint (<0C) solvent	$225,000	$301,000	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$225,000	$302,188	
	Co-Solvent, Bi-Solvent	$225,000	$301,375	
	Semi-Aqueous	$225,000	$100,625	
	Replace with Aqueous Cleaning	$225,000	$300,208	
	Hybrid system (example: Inventec, HEMO)	$225,000	$421,200	
Small/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	$3,750	$19,250	
	Convert OTVD to use Flashpoint inerted t-DCE	$3,750	$4,313	
	Replace with OTVD using FlashPoint inerted t-DCE	$3,750	$4,313	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$3,750	$5,625	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$3,750	$11,000	
	OTVD for Very low flashpoint (<0C) solvent	$3,750	$11,000	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$3,750	$19,688	
	Co-Solvent, Bi-Solvent	$3,750	$15,125	
	Semi-Aqueous	$3,750	$6,875	
	Replace with Aqueous Cleaning	$3,750	$3,958	
Medium/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	$22,500	$31,750	
	Convert OTVD to use Flashpoint inerted t-DCE	$22,500	$45,563	
	Replace with OTVD using Flashpoint inerted t-DCE	$22,500	$45,563	
	Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	$22,500	$33,750	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	$22,500	$32,250	
	OTVD for Very low flashpoint (<0C) solvent	$22,500	$32,250	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$22,500	$32,188	
	Co-Solvent, Bi-Solvent	$22,500	$31,375	
	Semi-Aqueous	$22,500	$25,625	
	Replace with Aqueous Cleaning	$22,500	$31,458	

7.7.7 Annual Labor Costs

Labor costs are dependent on the type of machine, degree of automation and number of runs. Table 7-25 presents the estimated baseline labor costs for operating a vapor degreasing machine.

Table 7-25: Baseline Labor Costs (2022$) Size and Cleaning Category

Size/Cleaning Category	Annual Labor (hours)	Baseline Labor Cost
Small/General Cleaning	979	$59,876
Medium/General Cleaning	850	$51,986
Large/General Cleaning	790	$48,316
Small/High Precision Cleaning	880	$53,821
Medium/High Precision Cleaning	750	$45,870
Large/High Precision Cleaning	640	$39,142
Small/Safety Critical Cleaning	879	$53,760
Medium/Safety Critical Cleaning	750	$45,870
Large/Safety Critical Cleaning	640	$39,142
Small/Start-Up/R&D Critical Cleaning	720	$44,035
Medium/Start-Up/R&D Critical Cleaning	720	$44,035

For the cleaning types and methods estimated to have incremental differences in labor costs, Table 7-26 presents the estimated annual labor costs under the baseline, under the new cleaning method, and the incremental change in the annual labor costs. Among those facilities with incremental cost changes, the costs range from a savings of about $30,000 (indicated as a negative incremental cost) to $15,000 in additional labor costs.

Table 7-26: Annual Labor Costs (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Baseline Cost	Post-Conversion Cost
Small/General Cleaning	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$59,876	$32,598
	Replace with Aqueous Cleaning	$59,876	$62,995
Medium/General Cleaning	Replace with Airless Degreaser with PCE	$51,986	$32,598
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$51,986	$32,598
	Replace with Aqueous Cleaning	$51,986	$59,019
Large/General Cleaning	Replace with Airless Degreaser with PCE	$48,316	$32,598
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$48,316	$32,598
	Replace with Aqueous Cleaning	$48,316	$59,019
Small/High Precision Cleaning	Replace with Airless Degreaser with PCE	$53,821	$32,598
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$53,821	$32,598
Medium/High Precision Cleaning	Replace with Airless Degreaser with PCE	$45,870	$32,598
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$45,870	$32,598
	Replace with Aqueous Cleaning	$45,870	$49,845
Large/High Precision Cleaning	Replace with Airless Degreaser with PCE	$39,142	$32,598
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$39,142	$32,598
	Replace with Aqueous Cleaning	$39,142	$47,093
Small/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$53,760	$32,598
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$53,760	$32,598
	Replace with Aqueous Cleaning	$53,760	$59,019
Medium/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$45,870	$32,598
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$45,870	$32,598
	Replace with Aqueous Cleaning	$45,870	$49,845
Large/Safety Critical Cleaning	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$39,142	$32,598
	Replace with Aqueous Cleaning	$39,142	$47,093
Small/Start-Up/R&D Critical Cleaning	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$44,035	$32,598
	Replace with Aqueous Cleaning	$44,035	$59,019
Medium/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	$44,035	$32,598
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$44,035	$32,598
	Replace with Aqueous Cleaning	$44,035	$49,845
Small/Start-Up/R&D Critical Cleaning	Replace with Aqueous Cleaning	$44,035	$59,019
Medium/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	$44,035	$32,598
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$44,035	$32,598

Table 7-26: Annual Labor Costs (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Baseline Cost	Post-Conversion Cost
	Replace with Aqueous Cleaning	$44,035	$49,845

7.7.8 Annual Electricity Costs

Electrical costs are assuming 2,000 hours per work year (40hr/wk*50wks). It is also assumed that this cost is dependent on the size of the cleaning system and is not dependent on the type of cleaning.

For the cleaning types and methods estimated to have incremental differences in electricity costs, Table 7-27 presents the estimated annual electricity costs under the baseline, under the new cleaning method, and the incremental change in the annual costs. Among those facilities with incremental cost changes, the costs range from a savings of about $100 (indicated as a negative incremental cost) to about $19,000 in additional electricity costs.

e 7-27: Annual Electricity Costs by Size, Cleaning Category, and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Baseline Cost	Post-Conversion Cost	Incre al C
/General Cleaning	Replace with Airless Degreaser with PCE	$21	$33	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$21	$41	
	High boiling, non-vacuum, non-rinse	$21	$41	
	Replace with Aqueous Cleaning	$21	$483	
	Hybrid system (e.g., Inventec, HEMO)	$21	$162	
um/General Cleaning	Replace with Airless Degreaser with PCE	$259	$419	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$259	$518	
	Co-Solvent, Bi-Solvent	$259	$144	(
	Semi-Aqueous	$259	$1,723	$
	Replace with Aqueous Cleaning	$259	$6,041	$
	Hybrid system (e.g., Inventec, HEMO)	$259	$2,028	$
/General Cleaning	Replace with Airless Degreaser with PCE	$828	$1,339	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$828	$1,657	
	Replace with Aqueous Cleaning	$828	$19,331	$1
	Hybrid system (e.g., Inventec, HEMO)	$828	$6,490	$
/High Precision Cleaning	Replace with Airless Degreaser with PCE	$21	$33	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$21	$41	
	Replace with Aqueous Cleaning	$21	$483	
	Hybrid system (e.g., Inventec, HEMO)	$21	$162	
um/High Precision Cleaning	Replace with Airless Degreaser with PCE	$259	$419	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$259	$518	
	Co-Solvent, Bi-Solvent	$259	$144	(
	Semi-Aqueous	$259	$1,723	$
	Replace with Aqueous Cleaning	$259	$6,041	$
	Hybrid system (e.g., Inventec, HEMO)	$259	$2,028	$
/High Precision Cleaning	Replace with Airless Degreaser with PCE	$828	$1,339	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$828	$1,657	
	Replace with Aqueous Cleaning	$828	$19,331	$1
	Hybrid system (e.g., Inventec, HEMO)	$828	$6,490	$
/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$21	$33	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$21	$41	
	Replace with Aqueous Cleaning	$21	$483	

e 7-27: Annual Electricity Costs by Size, Cleaning Category, and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Baseline Cost	Post-Conversion Cost	Increr al Co
	Hybrid system (e.g., Inventec, HEMO)	$21	$162	
um/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$259	$419	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$259	$518	
	Co-Solvent, Bi-Solvent	$259	$144	(
	Semi-Aqueous	$259	$1,723	$
	Replace with Aqueous Cleaning	$259	$6,041	$
	Hybrid system (e.g., Inventec, HEMO)	$259	$2,028	$
/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	$828	$1,339	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$828	$1,657	
	Replace with Aqueous Cleaning	$828	$19,331	$1
	Hybrid system (e.g., Inventec, HEMO)	$828	$6,490	$
/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	$21	$33	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$21	$41	
	Replace with Aqueous Cleaning	$21	$483	
um/Start-Up/R&D Critical Cleaning	Replace with Airless Degreaser with PCE	$259	$419	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	$259	$518	
	Co-Solvent, Bi-Solvent	$259	$144	(
	Semi-Aqueous	$259	$1,723	$
	Replace with Aqueous Cleaning	$259	$6,041	$

7.7.9 Additional Floorspace Costs

The estimates for additional floorspace needed are based on a study done in 1999 with BFK Solutions and the Toxics Use Reduction Institute (Kanegsberg and LeBlanc 1999, Kanegsberg 2001). Estimated costs are added if multiple pieces of the cleaning systems are needed (examples include the cleaning system, rinsing tank and dryer). Floorspace costs are estimated to be $7.03 per square foot, the average national cost for in-place rents in December 2022 according to the CommercialEdge National Industrial Report (CommercialEdge 2023).

For the cleaning types and methods estimated to require additional floorspace, Table 7-28 presents the estimated annual incremental costs. Among those facilities with incremental costs, the costs range from about $100 to about $9,000 in additional floorspace.

e 7-28: Annual Additional Floorspace Costs, by Size, Cleaning Category, and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Additional Floorspace Required (square feet)	Incremental ($7.03/sq
/General Cleaning	Replace with Airless Degreaser with PCE	20	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	20	
	OTVD for Very low flashpoint (<0C) solvent	20	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	20	
	Co-Solvent, Bi-Solvent	40	
	Replace with Aqueous Cleaning	65	
	Hybrid system (e.g., Inventec, HEMO)	30	
um/General Cleaning	Replace with Airless Degreaser with PCE	200	$
	OTVD for Low boiling point (<100C) Alcohol or other flammable	200	$
	OTVD for Very low flashpoint (<0C) solvent	200	$
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	200	$
	Co-Solvent, Bi-Solvent	400	$
	Replace with Aqueous Cleaning	650	$
	Hybrid system (e.g., Inventec, HEMO)	280	$
/General Cleaning	Replace with Airless Degreaser with PCE	400	$
	OTVD for Low boiling point (<100C) Alcohol or other flammable	400	$
	OTVD for Very low flashpoint (<0C) solvent	400	$
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	400	$
	Co-Solvent, Bi-Solvent	800	$
	Replace with Aqueous Cleaning	1,300	$
/High Precision Cleaning	Replace with Airless Degreaser with PCE	20	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	20	
	OTVD for Very low flashpoint (<0C) solvent	20	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	20	
	Co-Solvent, Bi-Solvent	40	
	Replace with Aqueous Cleaning	65	
	Hybrid system (e.g., Inventec, HEMO)	30	
um/High Precision Cleaning	Replace with Airless Degreaser with PCE	200	$
	OTVD for Low boiling point (<100C) Alcohol or other flammable	200	$
	OTVD for Very low flashpoint (<0C) solvent	200	$
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	200	$
	Co-Solvent, Bi-Solvent	400	$
	Replace with Aqueous Cleaning	650	$

e 7-28: Annual Additional Floorspace Costs, by Size, Cleaning Category, and Alternative Cleaning Method (2022$)

Size/Cleaning Category	Alternative Cleaning Method	Additional Floorspace Required (square feet)	Incremental ($7.03/sq
	Hybrid system (e.g., Inventec, HEMO)	280	$
/High Precision Cleaning	Replace with Airless Degreaser with PCE	400	$
	OTVD for Low boiling point (<100C) Alcohol or other flammable	400	$
	OTVD for Very low flashpoint (<0C) solvent	400	$
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	400	$
	Co-Solvent, Bi-Solvent	800	$
	Replace with Aqueous Cleaning	1,300	$
/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	20	
	OTVD for Low boiling point (<100C) Alcohol or other flammable	20	
	OTVD for Very low flashpoint (<0C) solvent	20	
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	20	
	Co-Solvent, Bi-Solvent	40	
	Replace with Aqueous Cleaning	65	
	Hybrid system (e.g., Inventec, HEMO)	30	
um/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	200	$
	OTVD for Low boiling point (<100C) Alcohol or other flammable	200	$
	OTVD for Very low flashpoint (<0C) solvent	200	$
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	200	$
	Co-Solvent, Bi-Solvent	400	$
	Replace with Aqueous Cleaning	650	$
	Hybrid system (e.g., Inventec, HEMO)	280	$
/Safety Critical Cleaning	Replace with Airless Degreaser with PCE	400	$
	OTVD for Low boiling point (<100C) Alcohol or other flammable	400	$
	OTVD for Very low flashpoint (<0C) solvent	400	$
	EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	400	$
	Co-Solvent, Bi-Solvent	800	$
	Replace with Aqueous Cleaning	1,300	$

7.7.10 Incremental Costs for Vapor Degreasing Facilities Switching to TCE Alternatives

Table 7-29 through Table 7-39 present the initial and recurring costs for each size, cleaning category, and alternative cleaning method combination considered. EPA asked BFK Solutions to estimate a percentage weight for each alternative cleaning method that indicates how likely affected vapor degreasers would be to adopt each method. They provided two sets of percentages, one under a scenario where trans-DCE was considered a viable alternative cleaning method and a second scenario where it was not. Note that the estimated percentage weights intentionally sum to more than 100 percent to account for instances where a facility switches from using TCE vapor degreasing to multiple cleaning methods.

Table 7-29: Initial and Recurring Costs by Alternative Cleaning Method: Small/General Cleaning (2022$)

Alternative Cleaning Method	Weight[1]		Initial Costs	Annual Recurring Costs
	with trans-DCE	without trans-DCE		
Replace with Airless Degreaser with PCE	10%	15%	$484,925	($13,309)
Convert OTVD to use Flashpoint inerted t-DCE	10%	0%	$191,800	$8,724
Replace with OTVD using Flashpoint inerted t-DCE	9%	0%	$242,800	$8,724
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	8%	10%	$281,800	$8,461
OTVD for Low boiling point (<100C) Alcohol or other flammable	1%	1%	$348,240	$3,728
OTVD for Very low flashpoint (<0C) solvent	0%	0%	$364,300	$5,178
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	20%	30%	$522,180	($14,094)
Co-Solvent, Bi-Solvent	5%	8%	$635,911	$27,587
High boiling, non-vacuum, non-rinse	15%	20%	$177,160	($6,192)
Semi-Aqueous	15%	20%	$282,348	($1,642)
Replace with Aqueous Cleaning	20%	25%	$340,597	$12,956
Hybrid system (e.g., Inventec, HEMO)	7%	10%	$606,800	$21,690
Weighted Average Across Methods (Including trans-DCE)			**$431,304**	**$2,536**
Weighted Average Across Methods (Excluding trans-DCE)			**$549,659**	**$707**
[1]Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods				

Table 7-30: Initial and Recurring Costs by Alternative Cleaning Method: Medium/General Cleaning (2022$)

Cleaning method	Weight[1]		Initial Costs	Annual Recurring Costs
	with trans-DCE	without trans-DCE		
Replace with Airless Degreaser with PCE	12%	15%	$702,775	($107,307)
Convert OTVD to use Flashpoint inerted t-DCE	10%	0%	$263,500	$153,438
Replace with OTVD using Flashpoint inerted t-DCE	9%	0%	$589,500	$165,788
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	8%	10%	$749,500	$121,338
OTVD for Low boiling point (<100C) Alcohol or other flammable	1%	1%	$677,000	($63,645)
OTVD for Very low flashpoint (<0C) solvent	0%	0%	$678,250	($54,565)
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	25%	35%	$775,750	($102,944)
Co-Solvent, Bi-Solvent	5%	8%	$711,813	$20,763
High boiling, non-vacuum, non-rinse	15%	20%	$195,500	($77,141)
Semi-Aqueous	15%	20%	$589,250	($52,868)
Replace with Aqueous Cleaning	20%	25%	$609,644	($52,146)
Hybrid system (e.g., Inventec, HEMO)	7%	10%	$958,200	$113,567
Weighted Average Across Methods (Including trans-DCE)			**$766,711**	**($20,220)**
Weighted Average Across Methods (Excluding trans-DCE)			**$920,775**	**($66,650)**
[1]Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods				

Table 7-31: Initial and Recurring Costs by Alternative Cleaning Method: Large/General Cleaning (2022$)

Cleaning method	Weight[1]		Initial Costs	Annual Recurring Costs
	with trans-DCE	without trans-DCE		
Replace with Airless Degreaser with PCE	12%	15%	$5,064,025	($237,180)
Convert OTVD to use Flashpoint inerted t-DCE	10%	0%	$298,000	$352,814
Replace with OTVD using Flashpoint inerted t-DCE	9%	0%	$3,901,000	$527,039
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	8%	10%	$5,692,000	$464,752
OTVD for Low boiling point (<100C) Alcohol or other flammable	1%	1%	$5,004,000	($180,625)
OTVD for Very low flashpoint (<0C) solvent	0%	0%	$5,008,000	($157,395)
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	30%	40%	$6,184,000	($211,435)
Co-Solvent, Bi-Solvent	5%	8%	$609,400	($170,158)
High boiling, non-vacuum, non-rinse	15%	20%	$228,400	($435,952)
Semi-Aqueous	18%	22%	$365,200	($431,998)
Replace with Aqueous Cleaning	20%	25%	$5,085,144	($127,874)
Hybrid system (e.g., Inventec, HEMO)	7%	10%	$7,171,200	($73,934)
Weighted Average Across Methods (Including trans-DCE)			**$4,998,652**	**($156,214)**
Weighted Average Across Methods (Excluding trans-DCE)			**$6,015,626**	**($310,687)**
[1]Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods				

Table 7-32: Initial and Recurring Costs by Alternative Cleaning Method: Small/High Precision (2022$)

Cleaning method	Weight[1]		Initial Costs	Annual Recurring Costs
	with trans-DCE	Without trans-DCE		
Replace with Airless Degreaser with PCE	15%	25%	$648,706	($6,939)
Convert OTVD to use Flashpoint inerted t-DCE	20%	0%	$355,581	$7,364
Replace with OTVD using Flashpoint inerted t-DCE	20%	0%	$397,581	$7,364
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	12%	15%	$427,581	$6,755
OTVD for Low boiling point (<100C) Alcohol or other flammable	5%	8%	$512,021	$4,167
OTVD for Very low flashpoint (<0C) solvent	1%	2%	$512,081	$4,572
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	20%	33%	$685,961	($7,529)
Co-Solvent, Bi-Solvent	5%	15%	$579,692	$13,692
Semi-Aqueous	2%	5%	$446,129	($1,093)
Replace with Aqueous Cleaning	15%	20%	$551,453	$11,332
Hybrid system (e.g., Inventec, HEMO)	10%	18%	$670,581	$15,722
Weighted Average Across Methods (Including trans-DCE)			**$654,845**	**$5,398**
Weighted Average Across Methods (Excluding trans-DCE)			**$844,139**	**$4,314**
[1]Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods				

Table 7-33: Initial and Recurring Costs by Alternative Cleaning Method: Medium/High Precision (2022$)

Cleaning method	Weight[1]		Initial Costs	Annual Recurring Costs
	With trans-DCE	Without trans-DCE		
Replace with Airless Degreaser with PCE	15%	25%	$866,556	($91,291)
Convert OTVD to use Flashpoint inerted t-DCE	20%	0%	$391,281	$149,459
Replace with OTVD using Flashpoint inerted t-DCE	20%	0%	$742,281	$149,459
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	12%	15%	$913,281	$110,646
OTVD for Low boiling point (<100C) Alcohol or other flammable	5%	8%	$856,781	($55,251)
OTVD for Very low flashpoint (<0C) solvent	1%	2%	$428,031	($73,876)
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	20%	33%	$854,531	($99,676)
Co-Solvent, Bi-Solvent	5%	15%	$877,594	$43,546
Semi-Aqueous	2%	5%	$753,031	($46,968)
Replace with Aqueous Cleaning	15%	20%	$793,833	($66,457)
Hybrid system (e.g., Inventec, HEMO)	10%	18%	$1,121,981	$127,471
Weighted Average Across Methods (Including trans-DCE)			**$974,528**	**$39,947**
Weighted Average Across Methods (Excluding trans-DCE)			**$1,242,743**	**($31,180)**
[1]Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods				

Table 7-34: Initial and Recurring Costs by Alternative Cleaning Method: Large/High Precision (2022$)

Cleaning method	Weight[1]		Initial Costs	Annual Recurring Costs
	with trans-DCE	without trans-DCE		
Replace with Airless Degreaser with PCE	15%	25%	$5,227,806	($227,132)
Convert OTVD to use Flashpoint inerted t-DCE	20%	0%	$464,781	$350,280
Replace with OTVD using Flashpoint inerted t-DCE	20%	0%	$4,064,781	$350,280
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	12%	15%	$5,855,781	$462,217
OTVD for Low boiling point (<100C) Alcohol or other flammable	5%	8%	$5,167,781	($178,020)
OTVD for Very low flashpoint (<0C) solvent	1%	2%	$5,171,781	($154,790)
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	20%	33%	$5,182,781	($205,083)
Co-Solvent, Bi-Solvent	5%	15%	$3,685,181	($551,328)
Semi-Aqueous	2%	5%	$528,981	($429,393)
Replace with Aqueous Cleaning	15%	20%	$5,099,333	($175,596)
Hybrid system (e.g., Inventec, HEMO)	10%	18%	$7,334,981	$1,305,573
Weighted Average Across Methods (Including trans-DCE)			**$5,432,677**	**$178,106**
Weighted Average Across Methods (Excluding trans-DCE)			**$7,331,884**	**$23,250**

[1]Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods

Table 7-35: Initial and Recurring Costs by Alternative Cleaning Method: Small/Safety Critical (2022$)

Cleaning method	Weight[1]		Initial Costs	Annual Recurring Costs
	With trans-DCE	Without trans-DCE		
Replace with Airless Degreaser with PCE	20%	30%	$1,849,913	($6,878)
Convert OTVD to use Flashpoint inerted t-DCE	20%	0%	$1,559,788	$7,872
Replace with OTVD using Flashpoint inerted t-DCE	20%	0%	$1,607,788	$7,927
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	15%	18%	$1,628,788	$6,755
OTVD for Low boiling point (<100C) Alcohol or other flammable	12%	15%	$1,713,228	$4,130
OTVD for Very low flashpoint (<0C) solvent	2%	2%	$1,713,288	$4,535
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	25%	33%	$1,852,168	($9,655)
Co-Solvent, Bi-Solvent	8%	15%	$1,780,899	$13,655
Semi-Aqueous	2%	5%	$1,647,336	($1,129)
Replace with Aqueous Cleaning	15%	20%	$1,163,453	$4,092
Hybrid system (e.g., Inventec, HEMO)	10%	18%	$1,971,788	$21,972
Weighted Average Across Methods (Including trans-DCE)			**$2,497,826**	**$4,851**
Weighted Average Across Methods (Excluding trans-DCE)			**$2,687,735**	**$3,442**

[1]Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods

Table 7-36: Initial and Recurring Costs by Alternative Cleaning Method: Medium/Safety Critical (2022$)

Cleaning method	Weight[1]		Initial Costs	Annual Recurring Costs
	with trans-DCE	without trans-DCE		
Replace with Airless Degreaser with PCE	20%	30%	$2,067,763	($91,291)
Convert OTVD to use Flashpoint inerted t-DCE	20%	0%	$1,727,488	($95,042)
Replace with OTVD using Flashpoint inerted t-DCE	20%	0%	$1,943,488	$149,459
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	15%	18%	$2,114,488	$110,646
OTVD for Low boiling point (<100C) Alcohol or other flammable	12%	15%	$2,057,988	($55,251)
OTVD for Very low flashpoint (<0C) solvent	2%	2%	$2,059,238	($47,001)
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	25%	33%	$2,055,738	($76,576)
Co-Solvent, Bi-Solvent	8%	15%	$2,078,801	($79,077)
Semi-Aqueous	2%	5%	$1,954,238	($46,968)
Replace with Aqueous Cleaning	15%	20%	$1,605,833	($57,457)
Hybrid system (e.g., Inventec, HEMO)	10%	18%	$2,323,188	$39,892
Weighted Average Across Methods (Including trans-DCE)			**$2,945,581**	**($29,387)**
Weighted Average Across Methods (Excluding trans-DCE)			**$3,178,086**	**($60,490)**
[1]Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods				

Table 7-37: Initial and Recurring Costs by Alternative Cleaning Method: Large/Safety Critical (2022$)

Cleaning method	Weight[1]		Initial Costs	Annual Recurring Costs
	with trans-DCE	without trans-DCE		
Replace with Airless Degreaser with PCE	20%	30%	$6,429,013	($220,588)
Convert OTVD to use Flashpoint inerted t-DCE	20%	0%	$2,385,988	$170,280
Replace with OTVD using Flashpoint inerted t-DCE	20%	0%	$5,265,988	$350,280
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	15%	18%	$7,056,988	$462,217
OTVD for Low boiling point (<100C) Alcohol or other flammable	12%	15%	$6,368,988	($178,020)
OTVD for Very low flashpoint (<0C) solvent	2%	2%	$6,372,988	($154,790)
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	25%	33%	$6,383,988	($205,083)
Co-Solvent, Bi-Solvent	8%	15%	$6,486,388	($251,828)
Semi-Aqueous	2%	5%	$3,170,188	($339,393)
Replace with Aqueous Cleaning	15%	20%	$5,911,333	($175,596)
Hybrid system (e.g., Inventec, HEMO)	10%	18%	$8,516,188	$1,304,323
Weighted Average Across Methods (Including trans-DCE)			**$8,683,115**	**$130,757**
Weighted Average Across Methods (Excluding trans-DCE)			**$10,235,134**	**$64,462**
[1]Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods				

Table 7-38: Initial and Recurring Costs by Alternative Cleaning Method: Small/R&D Safety Critical (2022$)

Cleaning method	Weight[1]		Initial Costs	Annual Recurring Costs
	with trans-DCE	without trans-DCE		
Replace with Airless Degreaser with PCE	15%	35%	$727,900	$14,143
Convert OTVD to use Flashpoint inerted t-DCE	17%	0%	$434,775	$7,872
Replace with OTVD using Flashpoint inerted t-DCE	17%	0%	$485,775	$7,927
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	25%	32%	$506,775	$6,755
OTVD for Low boiling point (<100C) Alcohol or other flammable	12%	18%	$591,215	$3,990
OTVD for Very low flashpoint (<0C) solvent	1%	1%	$591,275	$4,395
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	17%	30%	$730,155	($71)
Co-Solvent, Bi-Solvent	10%	16%	$658,886	$13,374
Semi-Aqueous	7%	10%	$525,323	($1,129)
Replace with Aqueous Cleaning	15%	20%	$478,428	$13,359
Weighted Average Across Methods (Including trans-DCE)			**$767,783**	**$10,269**
Weighted Average Across Methods (Excluding trans-DCE)			**$1,001,951**	**$12,551**
[1]Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods				

Table 7-39: Initial and Recurring Costs by Alternative Cleaning Method: Medium/R&D Safety Critical (2022$)

Cleaning method	Weight[1]		Initial Costs	Annual Recurring Costs
	with trans-DCE	without trans-DCE		
Replace with Airless Degreaser with PCE	15%	35%	$945,750	$6,518
Convert OTVD to use Flashpoint inerted t-DCE	17%	0%	$470,475	$38,339
Replace with OTVD using Flashpoint inerted t-DCE	17%	0%	$1,181,475	$269,339
Replace with Solstice system (trans-1-chloro-3,3,3,trifluoropropene)	25%	32%	$992,475	$13,266
OTVD for Low boiling point (<100C) Alcohol or other flammable	12%	18%	$935,975	$40,723
OTVD for Very low flashpoint (<0C) solvent	1%	1%	$937,225	$48,973
EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols	17%	30%	$933,725	$21,232
Co-Solvent, Bi-Solvent	10%	16%	$956,788	$15,491
Semi-Aqueous	7%	10%	$832,225	$50,412
Replace with Aqueous Cleaning	15%	20%	$920,808	$37,189
Weighted Average Across Methods (Including trans-DCE)			**$1,243,291**	**$76,242**
Weighted Average Across Methods (Excluding trans-DCE)			**$1,527,040**	**$35,674**
[1]Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods				

Table 7-40 and Table 7-41 present a summary of the incremental costs for facilities using TCE for vapor degreasing that switch to an alternative cleaning method. The primary estimates used in the analysis are presented in Table 7-41 (assuming trans-DCE cleaning methods are not a viable option).

Table 7-40: Summary of Incremental Costs for Vapor Degreasing: Including Trans-DCE (2022$)

Size/Type	Size/Type Percentage Weight	Initial Costs	Recurring Annual Costs
Small/General Cleaning	14.00%	$431,304	$2,536
Medium/General Cleaning	16.4%	$766,711	($20,220)
Large/General Cleaning	14.6%	$4,998,652	($156,214)
Small/High Precision Cleaning	9.3%	$654,845	$5,398
Medium/High Precision Cleaning	11.00%	$974,528	$39,947
Large/High Precision Cleaning	9.7%	$5,432,677	$178,106
Small/Safety Critical Cleaning	6.2%	$2,497,826	$4,851
Medium/Safety Critical Cleaning	7.3%	$2,945,581	($29,387)
Large/Safety Critical Cleaning	6.5%	$8,683,115	$130,757
Small/Start-Up/R&D Critical Cleaning	2.3%	$767,783	$10,269
Medium/Start-Up/R&D Critical Cleaning	2.7%	$1,243,291	$76,242
All Types Combined	-	**$2,596,909**	**$5,380**

Table 7-41: Summary of Incremental Costs for Vapor Degreasing: Excluding Trans-DCE (2022$)

Size/Type	Size/Type Percentage Weight	Initial Costs	Recurring Annual Costs
Small/General Cleaning	14.00%	$549,659	$707
Medium/General Cleaning	16.4%	$920,775	($66,650)
Large/General Cleaning	14.6%	$6,015,626	($310,687)
Small/High Precision Cleaning	9.3%	$844,139	$4,314
Medium/High Precision Cleaning	11.00%	$1,242,743	($31,180)
Large/High Precision Cleaning	9.7%	$7,331,884	$23,250
Small/Safety Critical Cleaning	6.2%	$2,687,735	$3,442
Medium/Safety Critical Cleaning	7.3%	$3,178,086	($60,490)
Large/Safety Critical Cleaning	6.5%	$10,235,134	$64,462
Small/Start-Up/R&D Critical Cleaning	2.3%	$1,001,951	$12,551
Medium/Start-Up/R&D Critical Cleaning	2.7%	$1,527,040	$35,674
All Types Combined	-	**$3,161,475**	**($55,694)**

7.8 Costs of the Dermal Protection Component of the WCPP

The estimated costs associated with developing and implementing a dermal protection program is presented in section 7.8.1 and the dermal protection costs for gloves are presented in section 7.8.2.

7.8.1 Dermal Exposure Control Program Costs

Dermal exposure control program costs include planning how to implement dermal exposure controls and training employees on dermal exposure control:

- **Developing a dermal exposure control program –** Identify each person reasonably likely to be exposed, identify appropriate gloves to use for dermal protection, and set up training program. EPA assumes an average of 5 hours per facility by an industrial hygienist to develop a dermal exposure control program.

- **Training** – EPA assumes potentially exposed workers will have an hour of training on dermal protection annually. The training is assumed to be performed by an industrial hygienist, who is assumed to perform the training for four workers at a time.

Table 7-42 and Table 7-43 present the unit costs for developing a dermal exposure control program and dermal protection training.

Table 7-42: Develop Dermal Exposure Control Program (per facility)

Labor Burden	Units	Labor Rate (2022$)	Initial Cost
5	hrs	$71.32	$356.60

Table 7-43: Conduct Dermal Protection Training (per worker)

Annual Labor Burden[1]	Units	Labor Rate[1] (2022$)	Annual Cost per Facility
0.3125	hrs	$46.34	$14.48

[1]Each worker is assumed to require an hour of training annually and an industrial hygienist is assumed to deliver the training to four workers at a time, so the total labor burden is 1.25 hours per worker (1 hour of the worker's time and 0.25 hours of the industrial hygienist's time). Thus, the labor rate is a blended rate of the worker and industrial hygienist's wage.

7.8.2 Estimated Costs for Dermal PPE

Estimating the costs for dermal PPE involves identifying the types of gloves expected to be used in order to achieve compliance, obtaining the glove unit costs, estimating annual per-employee glove costs, accounting for the gloves' useful life, and applying the annual per-employee glove costs to the estimated number of employees required to have dermal protection.

1.1.1 (A) Gloves Selected for Cost Analysis

Gloves are manufactured to meet the needs of a range of industries and hazards, and thus vary in properties such as material and thickness. For protection against hazardous chemicals, the appropriateness of any given glove will depend on the type of chemical, the type of exposure (e.g., splash protection, immersion), the length of exposure, dexterity requirements, thermal protection, and comfort. There are several commonly used materials to protect against chemical hazards (OSHA 2004; Grainger 2019):

Butyl – a synthetic rubber that protects against a wide variety of chemicals and are resistant to oxidation and abrasion. Does not perform well with aliphatic and aromatic hydrocarbons and halogenated solvents.

Natural rubber (latex) – often used as a general-purpose glove that is resistant to temperature and abrasion, with good elasticity and comfort. Protects against most water solutions of acids, alkalis, salts, and ketones.

Neoprene – a synthetic rubber that protects against petroleum products, alcohols, organic acids, and alkalis. Provides good dexterity and wear resistance.

Nitrile – often used as a general-purpose glove that provides protection against chlorinated solvents, as well as oils, greases, petroleum products, acids, caustics, and alcohols. Does not perform well with strong oxidizing agents, aromatic solvents, ketones, and acetates.

Viton® - provides protection against chlorinated and aromatic solvents. Has low resistance to abrasion.

Polyvinyl chloride (PVC) – provides protection against most acids, fats, and petroleum hydrocarbons. Resistant to abrasion.

Polyvinyl alcohol (PVA) – a water-soluble material that provides protection against aromatic and chlorinated solvents. Cannot be used in water or water-based solutions.

PVA gloves provide the best protection against chlorinated solvents like TCE, so EPA assumes PVA gloves will be the most common choice for compliance with dermal protection requirements. Table 7-44 presents the unit cost per pair for the gloves used in the cost analysis.

Table 7-44: Unit Cost per Pair of Gloves (2022$)

Brand	Model	Material	Price	Price per Pair
Ansell	PVA 15-554	cotton lined PVA	$44.93/dozen pairs	$3.74
Source: Autumn Supply (2022)				

1.1.1 (B) Dermal PPE Unit Cost Per-Employee

To cost this option, the assumption is that firms adopt appropriate procedures for glove changing. EPA assumes a useful life of 1 week for the supported PVA gloves. Table 7-45 presents the annual cost per-worker for gloves.

Table 7-45: Annual Per-Worker Cost for Dermal PPE (2022$)

Glove Type	Unit Cost	Useful Life (yrs)*	Pairs per Year per Worker	Annual Costs
Supported/Lined PVA	$3.74	0.02	50	$187
*1 pair per week/50 work weeks per year Source: Autumn Supply (2022)				

7.8.3 Total Dermal Exposure Control Costs

Table 7-46 summarizes the total initial and annual dermal protection costs. Since the number of years of compliance with dermal exposure controls varies by option and whether or not TSCA section 6(g) exemptions apply, estimates are presented for all applicable durations for dermal exposure control under the regulatory options.

Table 7-46: Total Dermal Protection Costs, by Use Category (2022$)

Use Category	Number of Affected Facilities	Per Facility Costs (Initial)	Workers	Per Worker Costs (annual)	Total Costs	
					Initial	Annual
Laboratory Use	251	$356.60	251	$201.69	$89,506.60	$50,624
Manufacturing	2	$356.60	140	$201.69	$713.20	$28,237
Import/Repackage	9	$356.60	18	$201.69	$3,209.40	$3,630
Battery and Synthetic Paper Processing Aid	3	$356.60	51	$201.69	$1,069.80	$10,286
HFC Manufacturing	2	$356.60	38	$201.69	$713.20	$7,664
Intermediate in HCL Production	28	$356.60	532	$201.69	$9,984.80	$107,299
Fluoroelastomer Manufacture	2	$356.60	34	$201.69	$713.20	$6,857
Open-Top Vapor Degreasing	350	$356.60	2,100	$201.69	$124,810.00	$423,548
Enclosed Vapor Degreasing	7	$356.60	42	$201.69	$2,496.20	$8,471
Conveyorized Vapor Degreasing	8	$356.60	48	$201.69	$2,852.80	$9,681
Web Vapor Degreasing	1	$356.60	6	$201.69	$356.60	$1,210
Batch Cold Cleaning	52	$356.60	312	$201.69	$18,543.20	$62,927
Disposal to Wastewater	739	$356.60	9,607	$201.69	$263,527.40	$1,937,632
Incorporation Into Formulation, Mixture, or Reaction Product	28	$356.60	448	$201.69	$9,984.80	$90,357

7.9 Costs of the Respiratory Protection Component of the WCPP

This section presents preliminary cost estimates for a WCPP with an Existing Chemical Exposure Limit (ECEL) of 0.20 ppm under Option 1 and 0.0011 ppm under Option 2 as an 8-hour time-weighted average for TCE and an action level (AL) at half the limits (i.e., 0.10 ppm and 0.0005 ppm, respectively). The requirements under a WCPP vary according to how far above the action level or limit the exposure levels found during monitoring are. The different requirements for monitoring results are presented in Table 7-47.

Table 7-47: Monitoring Threshold Requirements

Exposure Threshold	Monitoring Requirements	Personal Protective Equipment (PPE) Requirements	Notification and Recordkeeping Requirements
Less than the action limit	Initial exposure monitoring	No respiratory protection	Notify employee of exposure monitoring results within 15 days of receipt of results Retain compliance records for 5 years
Between the action limit and the ECEL	Initial exposure monitoring Periodic exposure monitoring every six months	No respiratory protection	Notify employee of exposure monitoring results within 15 days of receipt of results Retain compliance records for 5 years
ECEL to less than 10 times the ECEL	Initial exposure monitoring Periodic exposure monitoring every three months	APF 10	Notify employee of exposure monitoring results within 15 days of receipt of results Retain compliance records for 5 years
10 times the ECEL to less than 25 times the ECEL	Initial exposure monitoring Periodic exposure monitoring every three months	APF 25	Notify employee of exposure monitoring results within 15 days of receipt of results Retain compliance records for 5 years
25 times the ECEL to less than 50 times the ECEL	Initial exposure monitoring Periodic exposure monitoring every three months	APF 50	Notify employee of exposure monitoring results within 15 days of receipt of results Retain compliance records for 5 years
50 times the ECEL to less than 1,000 times the ECEL	Initial exposure monitoring Periodic exposure monitoring every three months	APF 1,000	Notify employee of exposure monitoring results within 15 days of receipt of results Retain compliance records for 5 years
1,000 times the ECEL to less than 10,000 times the ECEL	Initial exposure monitoring Periodic exposure monitoring every three months	APF 10,000	Notify employee of exposure monitoring results within 15 days of receipt of results Retain compliance records for 5 years

Note that before resorting to compliance through using PPE, engineering or administrative controls should be used to lower exposure to below the action level. Using robotics and/or some type of barrier that separates the employee and the exposure area is an example of engineering controls. Ventilation/carbon adsorption systems are another example of engineering controls. Engineering controls are very site-specific and their costs would also depend on what controls are already in place, which is unknown. An example of an administrative control would be having certain employees vacate the work area when a high exposure activity is taking place. This could be infrequent and have minimal impacts on productivity or large impacts on productivity.

Thus, for the purpose of estimating costs (and benefits), EPA assumes that PPE is used. Note that is an assumption made for the purpose of estimating costs only, not an assumption about how facilities will actually comply with WCPP requirements. As noted in section 7.12.5, the WCPP requires that feasible engineering and administrative controls are implemented before resorting to PPE use. These controls would need to be implemented even if they are more expensive than achieving compliance through a PPE program. However, since PPE programs are costly, achieving compliance through engineering and/or administrative controls may be less expensive than the estimated PPE costs.

The costs for compliance with a WCPP include initial exposure monitoring, required PPE for the different thresholds outlined in the ECEL, periodic exposure monitoring, as appropriate, and notifications and recordkeeping.

To determine the number of entities with exposure monitoring results at the different thresholds, EPA used the median and 95th percentile exposure levels presented in the final risk evaluation (EPA 2020e)[11] and estimated the distribution assuming the exposures were distributed across facilities according to a lognormal distribution.[12] EPA estimated the 8-hour TWA exposure distribution to estimate which threshold monitoring category an entity fell under.

Table 7-48 presents an example for how the exposure monitoring threshold category was determined for the use categories where data for the 8-hour TWA exposure was available.

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[11] Also, see https://www.epa.gov/sites/default/files/2020-11/21._tce_supplemental_information_file_risk_calculator_for_occupational_exposures.xlsx.

[12]See https://www.epa.gov/sites/default/files/2020-11/21._tce_supplemental_information_file_risk_calculator_for_occupational_exposures.xlsx for the exposure values included in the risk evaluation.

Measured concentrations of various contaminants are very often found to have frequency distributions that are log-normal, including indoor-air contaminants (Ott 1990). Ott (1990) also provides a physical explanation for why some common processes in nature, including processes relevant to indoor air pollutant concentrations, can explain why lognormal distributions arise naturally. Therefore, EPA believes assuming exposure levels follow a log-normal distribution is a reasonable approach.

Table 7-48. Example for Determining the Distribution of Exposure Threshold Categories Across Entities with 8-hour and 15-minute TWA Exposure Data

Percentile	Long Term TWA exposure threshold category	Threshold Category for Costs and Benefits
1	< Action Level	14% of entities < Action Level
2	< Action Level	
3	< Action Level	
4	< Action Level	
5	< Action Level	
6	< Action Level	
7	< Action Level	
8	< Action Level	
9	< Action Level	
10	< Action Level	
11	< Action Level	
12	< Action Level	
13	< Action Level	
14	< Action Level	
15	Between Action Level and Limit	10% of entities Between Action Level and Limit
16	Between Action Level and Limit	
17	Between Action Level and Limit	
18	Between Action Level and Limit	
19	Between Action Level and Limit	
20	Between Action Level and Limit	
21	Between Action Level and Limit	
22	Between Action Level and Limit	
23	Between Action Level and Limit	
24	Between Action Level and Limit	
25	1 to <10 times the limit	44% of entities 1 to < 10 times the limit
26	1 to <10 times the limit	
27	1 to <10 times the limit	
28	1 to <10 times the limit	
29	1 to <10 times the limit	
30	1 to <10 times the limit	
31	1 to <10 times the limit	
32	1 to <10 times the limit	
33	1 to <10 times the limit	
34	1 to <10 times the limit	
35	1 to <10 times the limit	
36	1 to <10 times the limit	
37	1 to <10 times the limit	
38	1 to <10 times the limit	
39	1 to <10 times the limit	
40	1 to <10 times the limit	
41	1 to <10 times the limit	
42	1 to <10 times the limit	
43	1 to <10 times the limit	
44	1 to <10 times the limit	
45	1 to <10 times the limit	
46	1 to <10 times the limit	

Table 7-48. Example for Determining the Distribution of Exposure Threshold Categories Across Entities with 8-hour and 15-minute TWA Exposure Data

Percentile	Long Term TWA exposure threshold category	Threshold Category for Costs and Benefits
47	1 to <10 times the limit	
48	1 to <10 times the limit	
49	1 to <10 times the limit	
50	1 to <10 times the limit	
51	1 to <10 times the limit	
52	1 to <10 times the limit	
53	1 to <10 times the limit	
54	1 to <10 times the limit	
55	1 to <10 times the limit	
56	1 to <10 times the limit	
57	1 to <10 times the limit	
58	1 to <10 times the limit	
59	1 to <10 times the limit	
60	1 to <10 times the limit	
61	1 to <10 times the limit	
62	1 to <10 times the limit	
63	1 to <10 times the limit	
64	1 to <10 times the limit	
65	1 to <10 times the limit	
66	1 to <10 times the limit	
67	1 to <10 times the limit	
68	1 to <10 times the limit	
69	10 to < 25 times the limit	14% of Entities 10 to < 25 times the limit
70	10 to < 25 times the limit	
71	10 to < 25 times the limit	
72	10 to < 25 times the limit	
73	10 to < 25 times the limit	
74	10 to < 25 times the limit	
75	10 to < 25 times the limit	
76	10 to < 25 times the limit	
77	10 to < 25 times the limit	
78	10 to < 25 times the limit	
79	10 to < 25 times the limit	
80	10 to < 25 times the limit	
81	10 to < 25 times the limit	
82	10 to < 25 times the limit	
83	25 to < 50 times the limit	8% of Entities 25 to < 50 times the limit
84	25 to < 50 times the limit	
85	25 to < 50 times the limit	
86	25 to < 50 times the limit	
87	25 to < 50 times the limit	
88	25 to < 50 times the limit	
89	25 to < 50 times the limit	
90	25 to < 50 times the limit	
91	50 to < 1,000 times the limit	10% of Entities 50 to < 1,000 times the limit
92	50 to < 1,000 times the limit	

Table 7-48. Example for Determining the Distribution of Exposure Threshold Categories Across Entities with 8-hour and 15-minute TWA Exposure Data

Percentile	Long Term TWA exposure threshold category	Threshold Category for Costs and Benefits
93	50 to < 1,000 times the limit	
94	50 to < 1,000 times the limit	
95	50 to < 1,000 times the limit	
96	50 to < 1,000 times the limit	
97	50 to < 1,000 times the limit	
98	50 to < 1,000 times the limit	
99	50 to < 1,000 times the limit	
100	50 to < 1,000 times the limit	

In order to estimate costs (and benefits), EPA assumed that the variation in exposure is reflected across the entities rather than the workers. Table 7-49 and Table 7-50 present the respective estimated numbers of entities and workers in each ECEL threshold category.

Table 7-49: Count of Entities, by Use Category and Exposure Threshold

Use Category	<Action Level	Between Action Level and Limit	1 to <10 times the ECEL	10 to <25 times the ECEL	25 to <50 times the ECEL	50 to <1,000 times the ECEL	1,000+ times the ECEL	Total
Option 1 (ECEL Threshold 0.20 ppm)								
Manufacturing	0.94	0.28	0.64	0.08	0.04	0.02	-	2
Battery and Synthetic Paper Processing Aid	-	-	0.12	0.93	1.17	0.78	-	3
HFC Manufacturing	0.94	0.28	0.64	0.08	0.04	0.02	-	2
Fluoroelastomer Manufacture	-	-	0.08	0.62	0.78	0.52	-	2
Open-Top Vapor Degreasing	-	-	10.50	45.50	73.50	220.50	-	350
Enclosed Vapor Degreasing	0.07	0.70	6.16	0.07	-	-	-	7
Disposal to Wastewater	642.93	14.78	51.73	7.39	7.39	14.78	-	739
Incorporation Into Formulation, Mixture, or Reaction Product	24.36	0.56	1.96	0.28	0.28	0.56	-	28
Aerosol Spray Cleaning/Degreasing	-	-	43.66	1,091.50	1,964.70	1,266.14	-	4,366
Adhesives, Sealants, Paints and Coatings	-	-	16.25	17.55	13.00	18.20	-	65
Option 2 (ECEL Threshold 0.0011 ppm)								
Manufacturing	-	-	0.20	0.24	0.24	1.08	0.24	2
Battery and Synthetic Paper Processing Aid	-	-	-	-	-	-	3.00	3
HFC Manufacturing	-	-	0.20	0.24	0.24	1.08	0.24	2
Intermediate in HCL Production	-	-	2.80	3.36	3.36	15.12	3.36	28
Fluoroelastomer Manufacture	-	-	-	-	-	-	2.00	2
Open-Top Vapor Degreasing	-	-	-	-	-	-	350.00	350
Enclosed Vapor Degreasing	-	-	-	-	-	6.23	0.77	7
Disposal to Wastewater	369.50	44.34	133.02	44.34	29.56	73.90	44.34	739
Incorporation Into Formulation, Mixture, or Reaction Product	14.00	1.68	5.04	1.68	1.12	2.80	1.68	28
Aerosol Spray Cleaning/Degreasing	-	-	-	-	-	-	4,366.00	4,366
Adhesives, Sealants, Paints and Coatings	-	-	-	-	-	8.45	56.55	65

Table 7-50: Count of Employees, by Use Category, Worker Type, and Exposure Threshold

Use Category	Employee Type	<Action Level	Between Action Level and Limit	1 to <10 times the ECEL	10 to <25 times the ECEL	25 to <50 times the ECEL	50 to <1,000 times the ECEL	1,000+ times the ECEL	Total
Option 1 (ECEL Threshold 0.20 ppm)									
Manufacturing	Worker	65.80	19.60	44.80	5.60	2.80	1.40	-	140
Battery and Synthetic Paper Processing Aid	Worker	-	-	2.04	15.81	19.89	13.26	-	51
Battery and Synthetic Paper Processing Aid	ONU	-	-	12.24	11.28	0.48	-	-	24
HFC Manufacturing	Worker	17.86	5.32	12.16	1.52	0.76	0.38	-	38
Fluoroelastomer Manufacture	Worker	-	-	1.36	10.54	13.26	8.84	-	34
Fluoroelastomer Manufacture	ONU	-	-	8.16	7.52	0.32	-	-	16
Open-Top Vapor Degreasing	Worker	-	-	63.00	273.00	441.00	1,323.00	-	2,100
Open-Top Vapor Degreasing	ONU	42.00	84.00	812.00	294.00	98.00	70.00	-	1,400
Enclosed Vapor Degreasing	Worker	0.42	4.20	36.96	0.42	-	-	-	42
Disposal to Wastewater	Worker	8,358.09	192.14	672.49	96.07	96.07	192.14	-	9,607
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	389.76	8.96	31.36	4.48	4.48	8.96	-	448
Aerosol Spray Cleaning/Degreasing	Worker	-	-	58.52	1,463.00	2,633.40	1,697.08	-	5,852
Aerosol Spray Cleaning/Degreasing	ONU	271.44	174.00	250.56	-	-	-	-	696
`Adhesives, Sealants, Paints and Coatings	Worker	-	-	154.00	166.32	123.20	172.48	-	616
Adhesives, Sealants, Paints and Coatings	ONU	-	-	288.00	-	-	-	-	288
Option 2 (ECEL Threshold 0.0011 ppm)									
Manufacturing	Worker	-	-	14.00	16.80	16.80	75.60	16.80	140
Battery and Synthetic Paper Processing Aid	Worker	-	-	-	-	-	-	51.00	51
Battery and Synthetic Paper Processing Aid	ONU	-	-	-	-	-	2.64	21.36	24
HFC Manufacturing	Worker	-	-	3.80	4.56	4.56	20.52	4.56	38
Intermediate in HCL Production	Worker	-	-	53.20	63.84	63.84	287.28	63.84	532

Table 7-50: Count of Employees, by Use Category, Worker Type, and Exposure Threshold

Use Category	Employee Type	<Action Level	Between Action Level and Limit	1 to <10 times the ECEL	10 to <25 times the ECEL	25 to <50 times the ECEL	50 to <1,000 times the ECEL	1,000+ times the ECEL	Total
Fluoroelastomer Manufacture	Worker	-	-	-	-	-	-	34.00	34
Fluoroelastomer Manufacture	ONU	-	-	-	-	-	1.76	14.24	16
Open-Top Vapor Degreasing	Worker	-	-	-	-	-	-	2,100.00	2,100
Open-Top Vapor Degreasing	ONU	-	-	-	-	-	686.00	714.00	1,400
Enclosed Vapor Degreasing	Worker	-	-	-	-	-	37.38	4.62	42
Disposal to Wastewater	Worker	4,803.50	576.42	1,729.26	576.42	384.28	960.70	576.42	9,607
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	224.00	26.88	80.64	26.88	17.92	44.80	26.88	448
Aerosol Spray Cleaning/Degreasing	Worker	-	-	-	-	-	-	5,852.00	5,852
Aerosol Spray Cleaning/Degreasing	ONU	-	-	6.96	41.76	97.44	528.96	20.88	696
Adhesives, Sealants, Paints and Coatings	Worker	-	-	-	-	-	80.08	535.92	616
Adhesives, Sealants, Paints and Coatings	ONU	-	-	-	-	-	288.00	-	288

7.9.1 Initial Exposure Monitoring and Periodic Exposure Monitoring

The initial exposure monitoring and periodic monitoring costs are based on the research and professional judgment of industrial hygiene firm, Environmental Health & Engineering, Inc. (EH&E). To develop cost estimates for the for TCE exposure monitoring requirements, EH&E considered the primary categories that dictate exposure evaluation costs: 1) labor costs and 2) Other Direct Costs (ODCs), including laboratory analysis fees and other ODCs.

To develop cost estimates for labor, EH&E identified the types of staff that would typically support an exposure evaluation. EH&E believes two levels of staff are likely to be involved in the design and implementation of an exposure evaluation, a certified industrial hygienist, and a technical specialist. The role of a CIH would be to design the sampling plan specific to the workplace setting and tasks associated with potential exposures to the chemicals of concern. The certified industrial hygienist would also provide technical oversight during execution of the process and technically review reports.

The role of a technical specialist would be to execute the tasks outlined in the sampling plan and conduct exposure monitoring. Exposure monitoring requires setting up field equipment, collecting air samples, observing work tasks during exposure monitoring, breaking down field equipment, completing required paperwork associated with samples, and shipping samples to the laboratory for analysis. There are also labor costs associated with preparing a written report documenting the results.

No laboratories were identified that conduct analysis for TCE using NIOSH methods and achieve a LOQ below the ECEL. One laboratory was identified that used to conduct TCE analysis a using a Radiello sampler that achieves a limit of quantification (LOQ) of 0.00007 ppm for an eight-hour sample, which is lower than the ECEL of 0.20 ppm and the action limit of 0.10 ppm under Option 1.

Laboratory costs consist of sample media, analytical analysis, and reporting. To determine an estimate of per sample costs for the analysis of airborne exposures to TCE, the analysis considered fees from various national AIHA-accredited laboratories. When these tests were offered, analysis for cost $175 per sample, plus a cost of $175 for the Radiello passive sampler itself. All costs were determined based on the assumption that analyses would be conducted according to a standard laboratory turn-around-time (typically 5 to 10 business days). The number of samples needed for each assessment is contingent upon the sampling plan developed for the specific exposure evaluation. Shipping samples to the laboratory for analysis can cost up to $100 for a set of Radiello tubes, depending on the dimensions, weight, and arrival time of the package.

It is assumed that each potentially exposed worker and ONU is monitored during each exposure monitoring period. All facilities are assumed to conduct the initial exposure monitoring, while subsequent periodic exposure monitoring frequency was determined based on the ECEL threshold for each entity.

The estimated initial exposure monitoring and periodic monitoring costs are presented in Table 7-51.

Table 7-51: Summary of Costs Associated with an Exposure Evaluation of TCE at a Simple Worksite (10 workers sampled, 2022$)

Category	Sub-category	Unit Cost	Quantity	Total*
Laboratory Analysis	TCE: Media and Analysis	$270	13 units	$3,510
ODCs	Shipping	$108	1 unit	$110
Labor	CIH – sample planning and technical oversight	$71	4 hours	$285
	Technical Specialist – preparation and sample management	$55	2 hours	$110
	Technical Specialist – field data collection	$55	10 hours	$550
	Technical Specialist – report preparation	$55	8 hours	$440
			Total	**$5,005**

ODC other direct costs
CIH Certified Industrial Hygienist
* Rounded to nearest $5.

Since some of the per-facility costs presented above in Table 7-51 can be expected to vary according to the number of workers that will require monitoring and others will not, EPA re-categorized those monitoring costs that are expected to vary with the number of workers. Table 7-52 presents the re-categorized estimates together with the per facility costs.

Table 7-52: Summary of Per Facility and Per Employee Costs Associated with an Exposure Evaluation of TCE (2022$)

Category	Sub-category	Unit Cost	Quantity for a 10-Employee Site	Per-Facility Costs	Per-Employee Costs (10 employees)
Laboratory Analysis	TCE: Media and Analysis	$270	1.3 units	-	$351
ODCs	Shipping	$108	0.1 units	-	$11
Labor	CIH – sample planning and technical oversight	$71	4 hours	$143	$14
	Technical Specialist – preparation and sample management	$55	2 hours	-	$11
	Technical Specialist – field data collection	$55	10 hours	-	$55
	Technical Specialist – report preparation	$55	8 hours	$220	$22
			Total	**$363**	**$464**

Abbreviations: ODC: other direct costs. CIH: Certified Industrial Hygienist.

The per facility costs from Table 7-52 are presented in Table 7-53 and the per worker/ONU costs from Table 7-52 are presented in Table 7-54.

Table 7-53: Per Facility Monitoring Costs (2022$)

Threshold	Cost Incurred	
	Initial Monitoring Costs	Periodic Monitoring Costs
<Action Level	$363	$363 every five years
Between Action Level and Limit	-	$726 = $363 x 2
1 to <10 times the ECEL	-	$1,452 = $363 x 4
10 to <25 times the ECEL	-	$1,452 = $363 x 4
25 to <50 times the ECEL	-	$1,452 = $363 x 4
50 to <1,000 times the ECEL	-	$1,452 = $363 x 4
1,000+ times the ECEL[1]	-	$1,452 = $363 x 4

Table 7-54: Per Worker/ONU Monitoring Costs (2022$)

Threshold	Cost Incurred	
	Initial Monitoring Costs	Periodic Monitoring Costs
<Action Level	$464	$464 every five years
Between Action Level and Limit	-	$928 = $464 x 2
1 to <10 times the ECEL	-	$1,856 = $464 x 4
10 to <25 times the ECEL	-	$1,856 = $464 x 4
25 to <50 times the ECEL	-	$1,856 = $464 x 4
50 to <1,000 times the ECEL	-	$1,856 = $464 x 4
1,000+ times the ECEL[1]	-	$1,856 = $464 x 4

7.9.2 Notifications and Recordkeeping

EPA developed the cost estimate for the notifications and recordkeeping burden for WCPPs from OSHA's Final Economic Analysis and Final Regulatory Flexibility Analysis for Occupational Exposure to Respirable Crystalline Silica (OSHA 2016b). That document included a recordkeeping burden for program development and associated recordkeeping, program updates and associated recordkeeping, and exposure monitoring recordkeeping and notifications.

OSHA (2016b) assumed that a human resources manager will be responsible for program development and recordkeeping. OSHA estimated that it will take 4 hours for small employers (those with fewer than 20 employees) and medium employers (those with between 20 and 499 employees) and 8 hours for large employers (those with 500 or more employees) to develop the program and provide the appropriate recordkeeping. In addition, OSHA estimated that it will take half as much time (2 hours for small and medium employers and 4 hours for large employers) to review and update the plan (including appropriate recordkeeping), and that 20 percent of establishments will do so in any given year. OSHA estimated that it will take a human resources manager 15 minutes per sample (i.e., per employee being monitored) to provide the required recordkeeping for exposure monitoring, which includes recording the sampling results, providing employees with information about how they can access to the exposure control plans, exposure monitoring records, PPE program implementation documentation, and respirator program documentation, obtaining an acknowledgment from the employee that they have received the information, and notifying the employee of the sampling results.

The per facility costs for each threshold are presented in Table 7-55. The per worker costs for each threshold are presented in Table 7-56.

Table 7-55: Per Facility Notification and Recordkeeping Costs (2022$)

Threshold	Cost Incurred	
	Setting up WCPP and associated recordkeeping[1]	Updating WCPP and associated recordkeeping[2]
All Thresholds	$378.96	$47.37

[1] Estimated as 4 hours of labor with the fully loaded managerial wage rate for manufacturing industry ($94.74).

[2] Estimated as 2 hours of labor with the fully loaded managerial wage rate for manufacturing industry ($94.74) and adjusted by 20% to account for 20% of facilities updating records each year.

Table 7-56: Per Worker Notification and Recordkeeping Costs (2022$)

Threshold	Cost Incurred
	Exposure monitoring notifications and recordkeeping
<Action Level	$23.69 = 1 sample periods*$23.69 (every five years)
Between Action Level and Limit	$47.37 = 2 sample periods*$23.69
1 to <10 times the ECEL	$94.74 = 4 sample periods*$23.69
10 to <25 times the ECEL	$94.74 = 4 sample periods*$23.69
25 to <50 times the ECEL	$94.74 = 4 sample periods*$23.69
50 to <1,000 times the ECEL	$94.74 = 4 sample periods*$23.69
1,000+ times the ECEL	$94.74 = 4 sample periods*$23.69

7.9.3 Respiratory Personal Protective Equipment (PPE)

EPA assumed that all workers or ONUs in facilities at the following monitoring thresholds would wear the minimum required APF, unless they are already using PPE that is more protective. For workers that are using a higher APF than required, it is assumed that workers continue using the same PPE and therefore do not incur incremental costs.

- Less than ECEL: No respiratory protection
- Between ECEL and <10 times the ECEL: APF 10 respirator
- 10 to <25 times the ECEL: APF 25 respirator
- 25 to <50 times the ECEL: APF 50 respirator

- 50 to <1,000 times the ECEL: APF 1000 respirator
- 1,000 to <10,000 times the ECEL: APF 10000 respirator

Respiratory PPE costs per worker vary according to the corresponding PPE required at each monitoring threshold (see Table 7-57). The estimates account for baseline usage of PPE in the industries expected to be affected by the requirements. See Appendix B (Abt Global 2024) for a detailed description of how the PPE costs were estimated.

Table 7-57: PPE Costs per Worker or ONU by Sector and threshold (2022$)

Sector	APF	Average PPE Cost per Worker	
		Initial Costs	Annually Recurring Costs
Manufacturing	10	$1,845	$1,992
	25	$1,763	$1,344
	50	$1,920	$1,877
	1,000	$1,625	$1,177
	10,000	$8,364	$1,788
Transportation and Public Utilities	10	$2,361	$2,653
	25	$2,260	$1,870
	50	$2,405	$2,466
	1,000	$2,051	$1,626
	10,000	$8,861	$2,497
Services	10	$2,569	$2,789
	25	$2,461	$1,943
	50	$2,595	$2,551
	1,000	$2,413	$1,918
	10,000	$9,179	$2,560

7.9.4 Total Costs for Respiratory Components of the WCPP

Table 7-58 and Table 7-59 present the initial and recurring monitoring, notification and recordkeeping costs associated with the respiratory component of the WCPP by threshold.

Table 7-58:Summary of Initial and Recurring Per Worker Monitoring and Respiratory WCPP Costs, by Threshold and Sector (2022$)

Sector (use categories)	Threshold	Initial Costs			Recurring Costs			
		Monitoring	Respiratory PPE	Total	Monitoring	Notification and Record-keeping	Respiratory PPE	Total
Manufacturing (All uses where WCPP is applicable except Recycling and Disposal and Aerosol Cleaning/Degreasing)	<Action Level	$488	-	**$488**	$93	$5	-	**$98**
	Between Action Level and ECEL	-	-	**$0**	$928	$47	-	**$975**
	1 to <10 times the ECEL	-	$1,845	**$1,845**	$1,856	$95	$1,992	**$3,943**
	10 to <25 times the ECEL	-	$1,763	**$1,763**	$1,856	$95	$1,344	**$3,295**
	25 to <50 times the ECEL	-	$1,920	**$1,920**	$1,856	$95	$1,877	**$3,828**
	50 to <1,000 times the ECEL	-	$1,625	**$1,625**	$1,856	$95	$1,177	**$3,128**
	1,000 to <10,000 times the ECEL	-	$8,364	**$8,364**	$1,856	$95	$1,788	**$3,739**
Transportation and Public Utilities (Recycling and Disposal)	<Action Level	$488	-	**$488**	$93	$5	-	**$98**
	Between Action Level and ECEL	-	-	**$0**	$928	$47	-	**$975**
	1 to <10 times the ECEL	-	$2,361	**$2,361**	$1,856	$95	$2,653	**$4,604**
	10 to <25 times the ECEL	-	$2,260	**$2,260**	$1,856	$95	$1,870	**$3,820**
	25 to <50 times the ECEL	-	$2,405	**$2,405**	$1,856	$95	$2,466	**$4,417**
	50 to <1,000 times the ECEL	-	$2,051	**$2,051**	$1,856	$95	$1,626	**$3,577**
	1,000 to <10,000 times the ECEL	-	$8,861	**$8,861**	$1,856	$95	$2,497	**$4,448**
Services (Aerosol Spray Cleaning/Degreasing)	<Action Level	$488	-	**$488**	$93	$5	-	**$98**
	Between Action Level and ECEL	-	-	**$0**	$928	$47	-	**$975**
	1 to <10 times the ECEL	-	$2,569	**$2,569**	$1,856	$95	$2,789	**$4,740**
	10 to <25 times the ECEL	-	$2,461	**$2,461**	$1,856	$95	$1,943	**$3,893**
	25 to <50 times the ECEL	-	$2,595	**$2,595**	$1,856	$95	$2,551	**$4,502**
	50 to <1,000 times the ECEL	-	$2,413	**$2,413**	$1,856	$95	$1,918	**$3,868**
	1,000 to <10,000 times the ECEL	-	$9,179	**$9,179**	$1,856	$95	$2,560	**$4,510**

Table 7-59: Summary of Per Facility Respiratory WCPP Costs, by Threshold

Threshold	Initial Costs			Recurring Costs		
	Monitoring	Notification and Record-keeping	Total	Monitoring	Notification and Record-keeping	Total
<Action Level	$363	$379	$742	$73	$47	$120
Between Action Level and ECEL	-	$379	$379	$726	$47	$773
1 to <10 times the ECEL	-	$379	$379	$1,452	$47	$1,499
10 to <25 times the ECEL	-	$379	$379	$1,452	$47	$1,499
25 to <50 times the ECEL	-	$379	$379	$1,452	$47	$1,499
50 to <1,000 times the ECEL	-	$379	$379	$1,452	$47	$1,499
1,000 to < 10,000 times the ECEL	-	$379	$379	$1,452	$47	$1,499

7.10 Total WCPP Costs

Table 7-60 presents the total costs of complying with WCPP requirements by option, use category, and monitoring threshold (estimated by aggregating the costs presented in sections 7.8 and 7.9)

Table 7-60: Total WCPP Costs (Dermal and Respiratory) by Threshold and Use Category (2022$)

Use Category	Threshold	Facilities	Workers/ ONUs	Per Facility Costs		Per Worker/ONU Costs		Total Costs	
				Initial	Annual	Initial	Annual	Initial	Annual
Option 1 (ECEL Threshold 0.20 ppm)									
Manufacturing	<Action Level	0.94	65.8	$741.96	$119.97	$487.69	$97.54	$32,787	$6,531
	Between Action Level and ECEL	0.28	19.6	$378.96	$773.37	$0.00	$975.37	$106	$19,334
	1 to <10 times the ECEL	0.64	44.8	$378.96	$1,499.37	$1,845.12	$3,942.66	$82,904	$177,591
	10 to <25 times the ECEL	0.08	5.6	$378.96	$1,499.37	$1,762.99	$3,294.80	$9,903	$18,571
	25 to <50 times the ECEL	0.04	2.8	$378.96	$1,499.37	$1,920.46	$3,827.79	$5,392	$10,778
	50 to <1,000 times the ECEL	0.02	1.4	$378.96	$1,499.37	$1,624.92	$3,127.57	$2,282	$4,409
	1,000 to < 10,000 times the ECEL	-	-	$378.96	$1,499.37	$8,363.77	$3,739.10	-	-
	All thresholds	**2**	**140**	**$549.57**	**$749.41**	**$944.83**	**$1,683.67**	**$133,375**	**$237,213**
Battery and Synthetic Paper Processing Aid	<Action Level	-	-	$741.96	$119.97	$487.69	$97.54	-	-
	Between Action Level and ECEL	-	-	$378.96	$773.37	$0.00	$975.37	-	-
	1 to <10 times the ECEL	0.12	14.28	$378.96	$1,499.37	$1,845.12	$3,942.66	$26,394	$56,481
	10 to <25 times the ECEL	0.93	27.09	$378.96	$1,499.37	$1,762.99	$3,294.80	$48,112	$90,651
	25 to <50 times the ECEL	1.17	20.37	$378.96	$1,499.37	$1,920.46	$3,827.79	$39,563	$79,726
	50 to <1,000 times the ECEL	0.78	13.26	$378.96	$1,499.37	$1,624.92	$3,127.57	$21,842	$42,641
	1,000 to < 10,000 times the ECEL	-	-	$378.96	$1,499.37	$8,363.77	$3,739.10	-	-
	All thresholds	**3**	**75**	**$378.96**	**$1,499.37**	**$1,796.99**	**$3,533.35**	**$135,911**	**$269,499**
HFC Manufacturing	<Action Level	0.94	17.86	$741.96	$119.97	$487.69	$97.54	$9,407	$1,855
	Between Action Level and ECEL	0.28	5.32	$378.96	$773.37	$0.00	$975.37	$106	$5,406
	1 to <10 times the ECEL	0.64	12.16	$378.96	$1,499.37	$1,845.12	$3,942.66	$22,679	$48,902
	10 to <25 times the ECEL	0.08	1.52	$378.96	$1,499.37	$1,762.99	$3,294.80	$2,710	$5,128
	25 to <50 times the ECEL	0.04	0.76	$378.96	$1,499.37	$1,920.46	$3,827.79	$1,475	$2,969
	50 to <1,000 times the ECEL	0.02	0.38	$378.96	$1,499.37	$1,624.92	$3,127.57	$625	$1,218
	1,000 to < 10,000 times the ECEL	-	-	$378.96	$1,499.37	$8,363.77	$3,739.10	-	-
	All thresholds	**2**	**38**	**$549.57**	**$749.41**	**$944.83**	**$1,683.67**	**$37,003**	**$65,478**
Fluoroelastomer Manufacture	<Action Level	-	-	$741.96	$119.97	$487.69	$97.54	-	-
	Between Action Level and ECEL	-	-	$378.96	$773.37	$0.00	$975.37	-	-
	1 to <10 times the ECEL	0.08	9.52	$378.96	$1,499.37	$1,845.12	$3,942.66	$17,596	$37,654
	10 to <25 times the ECEL	0.62	18.06	$378.96	$1,499.37	$1,762.99	$3,294.80	$32,075	$60,434
	25 to <50 times the ECEL	0.78	13.58	$378.96	$1,499.37	$1,920.46	$3,827.79	$26,375	$53,151
	50 to <1,000 times the ECEL	0.52	8.84	$378.96	$1,499.37	$1,624.92	$3,127.57	$14,561	$28,427
	1,000 to < 10,000 times the ECEL	-	-	$378.96	$1,499.37	$8,363.77	$3,739.10	-	-
	All thresholds	**2**	**50**	**$378.96**	**$1,499.37**	**$1,796.99**	**$3,533.35**	**$90,607**	**$179,666**

Table 7-60: Total WCPP Costs (Dermal and Respiratory) by Threshold and Use Category (2022$)

Use Category	Threshold	Facilities	Workers/ ONUs	Per Facility Costs		Per Worker/ONU Costs		Total Costs	
				Initial	Annual	Initial	Annual	Initial	Annual
Open-Top Vapor Degreasing	<Action Level	-	42	$741.96	$119.97	$487.69	$97.54	$20,483	-
	Between Action Level and ECEL	-	84	$378.96	$773.37	$0.00	$975.37	$0	-
	1 to <10 times the ECEL	10.5	875	$378.96	$1,499.37	$1,845.12	$3,942.66	$1,618,458	$3,465,573
	10 to <25 times the ECEL	45.5	567	$378.96	$1,499.37	$1,762.99	$3,294.80	$1,016,859	$1,936,376
	25 to <50 times the ECEL	73.5	539	$378.96	$1,499.37	$1,920.46	$3,827.79	$1,062,982	$2,173,382
	50 to <1,000 times the ECEL	220.5	1393	$378.96	$1,499.37	$1,624.92	$3,127.57	$2,347,077	$4,687,321
	1,000 to < 10,000 times the ECEL	-	-	$378.96	$1,499.37	$8,363.77	$3,739.10	-	-
	All thresholds	**350**	**3500**	**$378.96**	**$1,499.37**	**$1,695.21**	**$3,378.26**	**$6,065,858**	**$12,262,652**
Enclosed Vapor Degreasing	<Action Level	0.07	0.42	$741.96	$119.97	$487.69	$97.54	$257	$49
	Between Action Level and ECEL	0.7	4.2	$378.96	$773.37	$0.00	$975.37	$265	$4,638
	1 to <10 times the ECEL	6.16	36.96	$378.96	$1,499.37	$1,845.12	$3,942.66	$70,530	$154,957
	10 to <25 times the ECEL	0.07	0.42	$378.96	$1,499.37	$1,762.99	$3,294.80	$767	$1,489
	25 to <50 times the ECEL	-	-	$378.96	$1,499.37	$1,920.46	$3,827.79	-	-
	50 to <1,000 times the ECEL	-	-	$378.96	$1,499.37	$1,624.92	$3,127.57	-	-
	1,000 to < 10,000 times the ECEL	-	-	$378.96	$1,499.37	$8,363.77	$3,739.10	-	-
	All thresholds	**7**	**42**	**$382.59**	**$1,412.98**	**$1,646.21**	**$3,601.00**	**$71,819**	**$161,133**
Disposal to Wastewater	<Action Level	642.93	8358.09	$741.96	$119.97	$487.69	$97.54	$4,553,143	$892,380
	Between Action Level and ECEL	14.78	192.14	$378.96	$773.37	$0.00	$975.37	$5,601	$198,838
	1 to <10 times the ECEL	51.73	672.49	$378.96	$1,499.37	$1,845.12	$3,942.66	$1,260,427	$2,728,964
	10 to <25 times the ECEL	7.39	96.07	$378.96	$1,499.37	$1,762.99	$3,294.80	$172,171	$327,612
	25 to <50 times the ECEL	7.39	96.07	$378.96	$1,499.37	$1,920.46	$3,827.79	$187,299	$378,816
	50 to <1,000 times the ECEL	14.78	192.14	$378.96	$1,499.37	$1,624.92	$3,127.57	$317,814	$623,093
	1,000 to < 10,000 times the ECEL	-	-	$378.96	$1,499.37	$8,363.77	$3,739.10	-	-
	All thresholds	**739**	**9607**	**$694.77**	**$284.77**	**$622.78**	**$514.13**	**$6,496,456**	**$5,149,703**
Incorporation Into Formulation, Mixture, or Reaction Product	<Action Level	24.36	389.76	$741.96	$119.97	$487.69	$97.54	$208,154	$40,940
	Between Action Level and ECEL	0.56	8.96	$378.96	$773.37	$0.00	$975.37	$212	$9,172
	1 to <10 times the ECEL	1.96	31.36	$378.96	$1,499.37	$1,845.12	$3,942.66	$58,606	$126,581
	10 to <25 times the ECEL	0.28	4.48	$378.96	$1,499.37	$1,762.99	$3,294.80	$8,004	$15,181
	25 to <50 times the ECEL	0.28	4.48	$378.96	$1,499.37	$1,920.46	$3,827.79	$8,710	$17,568
	50 to <1,000 times the ECEL	0.56	8.96	$378.96	$1,499.37	$1,624.92	$3,127.57	$14,772	$28,863
	1,000 to < 10,000 times the ECEL	-	-	$378.96	$1,499.37	$8,363.77	$3,739.10	-	-
	All thresholds	**28**	**448**	**$694.77**	**$284.77**	**$622.78**	**$514.13**	**$298,458**	**$238,304**
Aerosol Spray Cleaning/Degreasing	<Action Level	-	271.44	$741.96	$119.97	$487.69	$97.54	$132,377	-
	Between Action Level and ECEL	-	174	$378.96	$773.37	$0.00	$975.37	$0	-
	1 to <10 times the ECEL	43.66	309.08	$378.96	$1,499.37	$1,845.12	$3,942.66	$586,835	$1,284,061

Table 7-60: Total WCPP Costs (Dermal and Respiratory) by Threshold and Use Category (2022$)

Use Category	Threshold	Facilities	Workers/ ONUs	Per Facility Costs		Per Worker/ONU Costs		Total Costs	
				Initial	Annual	Initial	Annual	Initial	Annual
	10 to <25 times the ECEL	1091.5	1463	$378.96	$1,499.37	$1,762.99	$3,294.80	$2,992,892	$6,456,862
	25 to <50 times the ECEL	1964.7	2633.4	$378.96	$1,499.37	$1,920.46	$3,827.79	$5,801,882	$13,025,911
	50 to <1,000 times the ECEL	1266.14	1697.08	$378.96	$1,499.37	$1,624.92	$3,127.57	$3,237,439	$7,206,155
	1,000 to < 10,000 times the ECEL	-	-	$378.96	$1,499.37	$8,363.77	$3,739.10	-	-
	All thresholds	**4366**	**6548**	**$378.96**	**$1,499.37**	**$1,694.70**	**$3,302.22**	**$12,751,426**	**$27,972,989**
Option 2 (ECEL Threshold 0.0011 ppm)									
Manufacturing	<Action Level	-	-	$741.96	$119.97	$487.69	$97.54	-	-
	Between Action Level and ECEL	-	-	$378.96	$773.37	$0.00	$975.37	-	-
	1 to <10 times the ECEL	0.2	14	$378.96	$1,499.37	$1,845.12	$3,942.66	$25,907	$55,497
	10 to <25 times the ECEL	0.24	16.8	$378.96	$1,499.37	$1,762.99	$3,294.80	$29,709	$55,713
	25 to <50 times the ECEL	0.24	16.8	$378.96	$1,499.37	$1,920.46	$3,827.79	$32,355	$64,667
	50 to <1,000 times the ECEL	1.08	75.6	$378.96	$1,499.37	$1,624.92	$3,127.57	$123,253	$238,064
	1,000 to < 10,000 times the ECEL	0.24	16.8	$378.96	$1,499.37	$8,363.77	$3,739.10	$140,602	$63,177
	All thresholds	**2**	**140**	**$378.96**	**$1,499.37**	**$2,507.64**	**$3,386.56**	**$351,827**	**$477,117**
Battery and Synthetic Paper Processing Aid	<Action Level	-	-	$741.96	$119.97	$487.69	$97.54	-	-
	Between Action Level and ECEL	-	-	$378.96	$773.37	$0.00	$975.37	-	-
	1 to <10 times the ECEL	-	-	$378.96	$1,499.37	$1,845.12	$3,942.66	-	-
	10 to <25 times the ECEL	-	-	$378.96	$1,499.37	$1,762.99	$3,294.80	-	-
	25 to <50 times the ECEL	-	-	$378.96	$1,499.37	$1,920.46	$3,827.79	-	-
	50 to <1,000 times the ECEL	-	2.64	$378.96	$1,499.37	$1,624.92	$3,127.57	$4,290	$8,257
	1,000 to < 10,000 times the ECEL	3	72.36	$378.96	$1,499.37	$8,363.77	$3,739.10	$606,339	$275,060
	All thresholds	**3**	**75**	**$378.96**	**$1,499.37**	**$8,126.56**	**$3,717.58**	**$610,629**	**$283,317**
HFC Manufacturing	<Action Level	-	-	$741.96	$119.97	$487.69	$97.54	-	-
	Between Action Level and ECEL	-	-	$378.96	$773.37	$0.00	$975.37	-	-
	1 to <10 times the ECEL	0.2	3.8	$378.96	$1,499.37	$1,845.12	$3,942.66	$7,087	$15,282
	10 to <25 times the ECEL	0.24	4.56	$378.96	$1,499.37	$1,762.99	$3,294.80	$8,130	$15,384
	25 to <50 times the ECEL	0.24	4.56	$378.96	$1,499.37	$1,920.46	$3,827.79	$8,848	$17,815
	50 to <1,000 times the ECEL	1.08	20.52	$378.96	$1,499.37	$1,624.92	$3,127.57	$33,753	$65,797
	1,000 to < 10,000 times the ECEL	0.24	4.56	$378.96	$1,499.37	$8,363.77	$3,739.10	$38,230	$17,410
	All thresholds	**2**	**38**	**$378.96**	**$1,499.37**	**$2,507.64**	**$3,386.56**	**$96,048**	**$131,688**
Intermediate in HCL Production	<Action Level	-	-	$741.96	$119.97	$487.69	$97.54	-	-
	Between Action Level and ECEL	-	-	$378.96	$773.37	$0.00	$975.37	-	-
	1 to <10 times the ECEL	2.8	53.2	$378.96	$1,499.37	$1,845.12	$3,942.66	$99,221	$213,948
	10 to <25 times the ECEL	3.36	63.84	$378.96	$1,499.37	$1,762.99	$3,294.80	$113,823	$215,378
	25 to <50 times the ECEL	3.36	63.84	$378.96	$1,499.37	$1,920.46	$3,827.79	$123,875	$249,404

Table 7-60: Total WCPP Costs (Dermal and Respiratory) by Threshold and Use Category (2022$)

Use Category	Threshold	Facilities	Workers/ ONUs	Per Facility Costs		Per Worker/ONU Costs		Total Costs	
				Initial	Annual	Initial	Annual	Initial	Annual
	50 to <1,000 times the ECEL	15.12	287.28	$378.96	$1,499.37	$1,624.92	$3,127.57	$472,538	$921,160
	1,000 to < 10,000 times the ECEL	3.36	63.84	$378.96	$1,499.37	$8,363.77	$3,739.10	$535,216	$243,742
	All thresholds	**28**	**532**	**$378.96**	**$1,499.37**	**$2,507.64**	**$3,386.56**	**$1,344,673**	**$1,843,632**
Fluoroelastomer Manufacture	<Action Level	-	-	$741.96	$119.97	$487.69	$97.54	-	-
	Between Action Level and ECEL	-	-	$378.96	$773.37	$0.00	$975.37	-	-
	1 to <10 times the ECEL	-	-	$378.96	$1,499.37	$1,845.12	$3,942.66	-	-
	10 to <25 times the ECEL	-	-	$378.96	$1,499.37	$1,762.99	$3,294.80	-	-
	25 to <50 times the ECEL	-	-	$378.96	$1,499.37	$1,920.46	$3,827.79	-	-
	50 to <1,000 times the ECEL	-	1.76	$378.96	$1,499.37	$1,624.92	$3,127.57	$2,860	$5,505
	1,000 to < 10,000 times the ECEL	2	48.24	$378.96	$1,499.37	$8,363.77	$3,739.10	$404,226	$183,373
	All thresholds	**2**	**50**	**$378.96**	**$1,499.37**	**$8,126.56**	**$3,717.58**	**$407,086**	**$188,878**
Open-Top Vapor Degreasing	<Action Level	-	-	$741.96	$119.97	$487.69	$97.54	-	-
	Between Action Level and ECEL	-	-	$378.96	$773.37	$0.00	$975.37	-	-
	1 to <10 times the ECEL	-	-	$378.96	$1,499.37	$1,845.12	$3,942.66	-	-
	10 to <25 times the ECEL	-	-	$378.96	$1,499.37	$1,762.99	$3,294.80	-	-
	25 to <50 times the ECEL	-	-	$378.96	$1,499.37	$1,920.46	$3,827.79	-	-
	50 to <1,000 times the ECEL	-	686	$378.96	$1,499.37	$1,624.92	$3,127.57	$1,114,697	$2,145,516
	1,000 to < 10,000 times the ECEL	350	2814	$378.96	$1,499.37	$8,363.77	$3,739.10	$23,668,283	$11,046,621
	All thresholds	**350**	**3500**	**$378.96**	**$1,499.37**	**$7,042.96**	**$3,619.24**	**$24,782,980**	**$13,192,136**
Enclosed Vapor Degreasing	<Action Level	-	-	$741.96	$119.97	$487.69	$97.54	-	-
	Between Action Level and ECEL	-	-	$378.96	$773.37	$0.00	$975.37	-	-
	1 to <10 times the ECEL	-	-	$378.96	$1,499.37	$1,845.12	$3,942.66	-	-
	10 to <25 times the ECEL	-	-	$378.96	$1,499.37	$1,762.99	$3,294.80	-	-
	25 to <50 times the ECEL	-	-	$378.96	$1,499.37	$1,920.46	$3,827.79	-	-
	50 to <1,000 times the ECEL	6.23	37.38	$378.96	$1,499.37	$1,624.92	$3,127.57	$63,101	$126,250
	1,000 to < 10,000 times the ECEL	0.77	4.62	$378.96	$1,499.37	$8,363.77	$3,739.10	$38,932	$18,429
	All thresholds	**7**	**42**	**$378.96**	**$1,499.37**	**$2,366.20**	**$3,194.84**	**$102,033**	**$144,679**
Disposal to Wastewater	<Action Level	369.5	4803.5	$741.96	$119.97	$487.69	$97.54	$2,616,749	$512,862
	Between Action Level and ECEL	44.34	576.42	$378.96	$773.37	$0.00	$975.37	$16,803	$596,514
	1 to <10 times the ECEL	133.02	1729.26	$378.96	$1,499.37	$1,845.12	$3,942.66	$3,241,099	$7,017,335
	10 to <25 times the ECEL	44.34	576.42	$378.96	$1,499.37	$1,762.99	$3,294.80	$1,033,027	$1,965,673
	25 to <50 times the ECEL	29.56	384.28	$378.96	$1,499.37	$1,920.46	$3,827.79	$749,196	$1,515,264
	50 to <1,000 times the ECEL	73.9	960.7	$378.96	$1,499.37	$1,624.92	$3,127.57	$1,589,068	$3,115,463
	1,000 to < 10,000 times the ECEL	44.34	576.42	$378.96	$1,499.37	$8,363.77	$3,739.10	$4,837,847	$2,221,777
	All thresholds	**739**	**9607**	**$560.46**	**$766.11**	**$1,422.88**	**$1,704.87**	**$14,083,789**	**$16,944,889**

Table 7-60: Total WCPP Costs (Dermal and Respiratory) by Threshold and Use Category (2022$)

Use Category	Threshold	Facilities	Workers/ ONUs	Per Facility Costs		Per Worker/ONU Costs		Total Costs	
				Initial	Annual	Initial	Annual	Initial	Annual
Incorporation Into Formulation, Mixture, or Reaction Product	<Action Level	14	224	$741.96	$119.97	$487.69	$97.54	$119,629	$23,529
	Between Action Level and ECEL	1.68	26.88	$378.96	$773.37	$0.00	$975.37	$637	$27,517
	1 to <10 times the ECEL	5.04	80.64	$378.96	$1,499.37	$1,845.12	$3,942.66	$150,700	$325,493
	10 to <25 times the ECEL	1.68	26.88	$378.96	$1,499.37	$1,762.99	$3,294.80	$48,026	$91,083
	25 to <50 times the ECEL	1.12	17.92	$378.96	$1,499.37	$1,920.46	$3,827.79	$34,839	$70,273
	50 to <1,000 times the ECEL	2.8	44.8	$378.96	$1,499.37	$1,624.92	$3,127.57	$73,858	$144,314
	1,000 to < 10,000 times the ECEL	1.68	26.88	$378.96	$1,499.37	$8,363.77	$3,739.10	$225,455	$103,026
	All thresholds	**28**	**448**	**$560.46**	**$766.11**	**$1,422.88**	**$1,704.87**	**$653,143**	**$785,235**
Aerosol Spray Cleaning/Degreasing	<Action Level	-	-	$741.96	$119.97	$487.69	$97.54	-	-
	Between Action Level and ECEL	-	-	$378.96	$773.37	$0.00	$975.37	-	-
	1 to <10 times the ECEL	-	6.96	$378.96	$1,499.37	$1,845.12	$3,942.66	$12,842	$27,441
	10 to <25 times the ECEL	-	41.76	$378.96	$1,499.37	$1,762.99	$3,294.80	$73,623	$137,591
	25 to <50 times the ECEL	-	97.44	$378.96	$1,499.37	$1,920.46	$3,827.79	$187,130	$372,980
	50 to <1,000 times the ECEL	-	528.96	$378.96	$1,499.37	$1,624.92	$3,127.57	$859,519	$1,654,361
	1,000 to < 10,000 times the ECEL	4366	5872.88	$378.96	$1,499.37	$8,363.77	$3,739.10	$50,773,953	$28,505,564
	All thresholds	**4366**	**6548**	**$378.96**	**$1,499.37**	**$7,674.48**	**$3,688.41**	**$51,907,066**	**$30,697,937**

7.11 Prescriptive Control Costs for Energized Electrical Cleaning

Users of energized electrical cleaners, a sub-use of the industrial and commercial use as solvent for aerosol spray degreaser/cleaner, have the option to have potentially exposed persons use APF 50 respirators and dermal PPE or implement a WCPP during the 3 years preceding prohibition under Option 1. For the purpose of estimated costs and benefits EPA assumes that energized electrical cleaner users will choose to implement the required prescriptive controls under Option 1.

7.11.1 APF 50 Respirator and Dermal Control PPE Costs

Table 7-61 and Table 7-62 present the total initial and recurring annual costs for complying with the APF 50 respirator and dermal control requirements for energized electrical cleaners, respectively.

Table 7-61: Total Initial and Annual APF 50 Respirator Costs for Energized Electrical Cleaners

Number of Affected Workers	Costs per Worker		Total Costs	
	Initial Costs	Annual Costs	Initial Costs	Annual Costs
1,201	$2,595	$2,551	$3,116,749	$3,064,690

Table 7-62: Total Annual Dermal Control Costs for Energized Electrical Cleaners

Number of Affected Workers	Per worker Costs (annual)	Total Annual Costs
1,201	$202	$242,280

7.11.1 Total Energized Electrical Cleaning Prescriptive Control Costs

Table 7-63 presents the total initial and recurring energized electrical cleaning prescriptive control costs.

Table 7-63: Total Initial and Recurring Energized Electrical Cleaning Prescriptive Control Costs

Prescriptive Control	Total Costs	
	Initial	Annual
APF 50 Respirators	$3,116,749	$3,064,690
Dermal PPE	-	$242,280
Total	**$3,116,749**	**$3,306,970**

7.12 Unquantified Costs and Uncertainty in the Cost Estimates

This economic analysis does not include quantified cost estimates for all costs under the options. Although certain costs cannot be quantified, this does not mean that they are less important than the quantified costs. This section discusses these unquantified costs qualitatively as well as other uncertainties in the cost estimates.

7.12.1 Possible facility closures

While EPA identified many alternative products for existing TCE uses, replacing TCE may be challenging for some uses. Firms may discontinue operations if alternatives are unsuitable or greatly increase labor and costs for performing the work. Therefore, economic impacts of prohibiting the commercial use of TCE may be significant for some uses. Vapor degreasing is one use of TCE, where switching to a suitable alternative may be challenging, especially since some alternatives may be subject to risk management actions under TSCA (e.g., perchloroethylene and 1-Bromopropane), and other alternatives are becoming less attractive because of concerns about Per- and polyfluoroalkyl substances (PFAS) (BFK Solutions 2023). One possible compliance strategy for firms using TCE for vapor degreasing is to close and/or move their TCE vapor degreasing operation to a country where it is still permitted. It is unclear whether the rule will affect the rate of firm closures, and, if so, by how much. In addition, there is no standard generally accepted approach for estimating the cost impacts of a firm closure. Thus, EPA is unable to quantify any costs associated with potential firm closures for this analysis.

7.12.2 Products formulated with TCE

The cost estimates for switching to alternatives to products formulated with TCE include reformulation costs for each product that EPA identified. On the one hand, if there are additional products that EPA did not identify that need to be reformulated, these costs could be underestimated. On the other hand, many producers of these products already make TCE-free alternative products, since the TCE products are already prohibited in several states. Thus, the reformulation costs may be overstated to the extent to which producers use existing products to replace the TCE products instead of reformulating.

As documented in chapter 5, alternative products with similar cost and efficacy are available for most of the products that are formulated with TCE. For some applications, there may be additional unquantified costs associated with the alternatives or in cases where alternatives are not currently available. End users with economic and technologically feasible alternatives available do not have impacts that are estimated beyond rule familiarization costs. For the costs of the products themselves, in most cases there were both alternatives that were more costly and less costly, but it is unclear whether average product costs would be higher or lower after a prohibition of TCE in these products. Alternative products that are drop-in substitutes (i.e., requiring no changes by the user in how the product is used) are generally available. However, in some cases some effort might be required by firms using TCE products to identify suitable alternatives, test them for their desired applications, learn how to use them safely and effectively, and implement new processes for using the alternative products. The information to estimate how often these costs might be incurred or what the specific costs would be per-user or per-firm when they are incurred is not available. Therefore, EPA is unable to consider these costs quantitatively.

There may be some safety-critical applications where alternatives would need to undergo extensive safety reviews and testing before they could replace the TCE products. The impact of a prohibition of TCE for *these uses* could potentially result in important negative impacts of the regulatory options.

7.12.3 Rocket Booster Testing Costs

The final rule requires Federal Agencies and their contractors who use TCE for scouring rayon for use on solid rocket booster nozzles to maintain records demonstrating that a final pre-launch test of rocket booster nozzles was completed without using TCE in the production of those rocket booster nozzles for Federal agencies or their contractors. This would necessarily mean that a final pre-launch test would need to be conducted. EPA is unable to estimate the cost of this type of testing or any other testing of alternatives to using TCE for rocket booster nozzles. Thus, they are not quantified in the economic analysis.

There may be health and safety issues associated with pre-launch testing of TCE alternatives which could potentially result in important negative impacts of the regulatory options.

7.12.4 Recycling and Disposal Unquantified Costs and Uncertainties

TCE is a contaminant of concern in a significant number of cleanup sites that are managed under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund sites, as well as under The Resource Conservation and Recovery Act (RCRA). The remediation of these sites, including the removal and treatment of TCE-contaminated groundwater, is critical to EPA's mission to protect human health and the environment. Additionally, there are sites where TCE-contaminated groundwater is being addressed under the authority of other federal environmental laws or state and local government authorities. The disposal of wastewater that contains TCE to industrial pre-treatment, industrial treatment, or publicly owned treatment works is an important method used in these cleanup efforts. At many contaminated sites, TCE-contaminated wastewater is pumped out of the ground and either sent to offsite industrial treatment or publicly owned treatment works (POTWs). For POTWs above the water screening level, WCPP would be required (with the interim occupational exposure limit (ECEL)). The economic analysis estimates the number of affected POTWs as the number of clean-up sites. But more or fewer POTWs may be affected if clean-up sites dispose of wastewater with multiple POTWs, the same POTWs receive TCE-contaminated wastewater for multiple sites, if not all POTWs receiving contaminated wastewater exceed the screening level, or if TCE-contamination from unknown sources affects a larger number of POTWs.

The economic analysis assumes that clean-up sites are already in compliance with additional OSHA HAZWOPER requirements that would need to be met under the rule. If these requirements are not being met under the baseline then there would be additional compliance costs from the rule.

Under Option 2, the disposal of TCE to industrial pre-treatment, industrial treatment, or publicly owned treatment work is prohibited after the 6(g) exemption ends, 25 years after the rule is finalized. Cleanup sites would need to identify and implement alternative disposal or treatment methods. They would also need to renegotiate RCRA permits or CERCLA agreements to include those changes. These approaches could be more costly to implement and/or increase the duration of cleanups allowing any potential environmental or human health impacts to continue for a longer period of time. The information to estimate how often these costs might be incurred or what the specific costs would be per site when they are incurred is not available. Therefore, EPA is unable to consider these costs quantitatively in the economic analysis.

In addition, the economic analysis does not estimate costs regarding disposal of TCE/TCE-containing products, after the effective date prohibiting the industrial and commercial use and disposal of TCE to industrial pre-treatment, industrial treatment, or publicly owned treatment works. TCE commercial chemical product going for disposal would be characterized as U-listed hazardous waste – U228 [see 40 CFR 261.33(f)]. Under the mixture rule [see 40 CFR 261.3(a)(2)(iv)], any solid waste (e.g., chemical formulations that can no longer be used and is destined for disposal) into which U228 is mixed/comingled would also be characterized as U228. This would include formulations, products and mixtures remaining in product or raw material storage tanks, product or raw material transport vehicles or vessels, product or raw material pipelines, or in manufacturing process units or an associated non-waste-treatment-manufacturing units after the unit ceases to be operated for manufacturing, or for storage or transportation of product for more than 90 days. [See 40 CFR 261.4(c)]. The final rule includes a staggered compliance timeline throughout the supply chain to allow for much of the TCE to be used before disposal is necessary. However, some unused product may need to be disposed of as hazardous waste. Since there is no reasonable way of estimating the volume of this waste, the additional disposal costs are not quantified in this economic analysis.

7.12.5 WCPP Cost Estimate Uncertainties

As noted in section 7.9, the costs of WCPP compliance varies with how far above the ECEL a facility is according to the monitoring results. EPA used available air monitoring data as well as modelled data to estimate a distribution of exposure concentrations, described in section 7.9, but since these data were not collected in the same way monitoring data under an WCPP would be collected, these estimated distributions are uncertain. The WCPP costs also assume that when the exposure levels exceed the ECEL compliance is achieved by implementing a respirator PPE program. However, to be consistent with the hierarchy of controls, the final rule requires implementation of feasible engineering and administrative controls before using PPE to reduce exposure to or below the interim ECEL.

These controls would need to be implemented even if they are more expensive that achieving compliance through a PPE program. However, since PPE programs are costly, achieving compliance through engineering and/or administrative controls may be less expensive than the estimated PPE costs.

There also may be some unquantified costs associated with implementing a respirator program. Respirators have been found to interfere with many physiological and psychological aspects of task performance (Johnson 2016). The extent to which respirators might reduce worker productivity or necessitate offering higher wages to workers who must wear respirators is unknown and therefore unquantified in this analysis. The EPA costs of administering and enforcing a WCPP are also unquantified in this economic analysis.

7.12.6 Implications of the Unquantified Costs and Uncertain Costs for Designated Representative Provision

The rule includes provisions for workers to designate a representative that would have the same access to exposure monitoring records as the employees and would be able to observe monitoring activities that took place. In the case of unionized workers, the union would be the default designated representative. Additional paperwork costs are not expected from this requirement because the records that need to be kept are the same with and without the designated representative requirement and are expected to be provided to the designated representative and the employee simultaneously. However, designated representatives would need to be provided with PPE if they are observing the monitoring (see section 7.9.3 for the unit cost estimates for PPE). It seems unlikely that non-union workers would pay a designated representative to perform this monitoring, but unions may provide this monitoring for their workers. It is unknown how many unions might decide to do this and how often they would participate in observing monitoring if they did decide to do it. Therefore, these potential costs are not quantified in this economic analysis.

7.12.7 Implications of the unquantified costs and uncertain costs for comparing the costs of the options

The costs of switching to alternatives to TCE are unknown for battery separator manufacture, synthetic paper manufacture, HFC manufacturing, use as an intermediate in HCl production, and fluoroelastomer manufacture, which are each discussed qualitatively below.

7.12.7 (A) Battery Separator Manufacture

ENTEK and Microporous are both major producers of lead-acid and/or lithium-ion battery separators who requested an exemption under section 6(g) of TSCA for their use of TCE in battery separator manufacture. In their requests they both noted that there was only one domestic battery separator manufacturer that does not use TCE, and they asserted that this manufacturer would not have sufficient capacity to meet domestic battery separator demand on their own. In addition, they also noted that the domestic battery separator manufacturer that does not use TCE uses a “dry process” instead of a “wet process”, and the “dry process” does not allow for reliable manufacture of the 9-12 µm separators that are generally used for electric vehicle applications.

Microporous summarized this use and its importance to the national economy in their request for an exemption under section 6(g) of TSCA as follows (Microporous 2022):

> "TCE is the primary solvent used in the manufacture of battery separators. Battery separators are essential, irreplaceable components for all rechargeable batteries in the United States and around the world. Battery separators provide the necessary separation between the internal anode and cathode components that make all batteries work, and they hold the electrolyte in the proper location. TCE is a necessary solvent for the manufacture of the majority of separator materials required to produce lead batteries. Further, many separator materials used in lithium-ion and other chemistries are manufactured utilizing processes that require TCE.
>
> …
>
> Microporous is one of the nation's largest manufacturers of lead-acid battery separators. Microporous' battery separators are critical and essential to our national economy and infrastructure. Prohibiting the use of TCE in the manufacture of battery separators through this rulemaking unquestionably will harm the U.S. manufacturing, energy, transportation, and defense sectors. Microporous' battery separators are essential in gasoline and electric-powered commercial vehicles, emergency response and military vehicles, marine engines, nuclear power providers, and they are used in many other business sectors. Without battery separators, the national economy literally would come to a standstill."

ENTEK also noted the importance of their separators to the national economy (ENTEK International LLC 2021b):

> "ENTEK's separators are particularly critical to U.S. motor vehicle manufacturing, including internal combustion, start-stop, and electric vehicle production. Domestic automobile manufacturers rely almost exclusively on ENTEK's lead-acid battery separators. Significantly, ENTEK is the sole or majority supplier to most lead-acid battery manufacturing plants in the U.S. Moreover, the role of the battery is more important than ever as motor vehicle technology evolves toward electrification. Current estimates predict electric vehicles will comprise 18% of new car sales by 2030, increasing battery need to eight times current factory capacity. In addition to lithium batteries, electric vehicles also require lead-acid batteries, to manage the safety equipment that protects the lithium battery pack and to run the vehicle electronics."

Microporous also summarized the process for identifying and adopting an alternative to TCE. First, they must identify a suitable solvent substitute through research and development initiatives and a subsequent negotiated commercialization, which they estimated would require 15 years. Then they would need to modify and replace the existing processing equipment at their facility, which they estimated would take one to two years. The battery manufacturers that use their separators would then need to complete new product testing and approvals. Microporous estimated that the entire process would take 25 years to complete. ENTEK requested a 15-year exemption with an option to extend beyond 15 years. EPA does not have information to estimate the costs associated with finding and adopting an alternative to TCE.

EPA's regulation includes a 15-year TSCA section 6(g) exemption for industrial and commercial use as a processing aid for lead-acid battery separator manufacturing and a 5-year exemption for lithium ion battery separator manufacturing. EPA believes that a 15-year exemption from the prohibition on TCE as a processing aid, specific to lead-acid battery separator manufacturing, and a 5-year exemption for lithium battery separator manufacturing is sufficient to provide EPA an updated analysis of any technically feasible alternative, the supply chain of the U.S. battery industry, as well as global innovation and production in high-technology products. Under TSCA section 6(g) EPA can consider revisiting or extending time-limited exemptions by rulemaking until a safer, feasible alternative becomes available provided EPA receives an updated analysis of the specific use.

EPA recognizes that lead-acid and lithium battery separators are essential components of batteries which power vehicles and systems in the U.S. supply chain for multiple critical infrastructure sectors within the national economy. If battery separator manufacturers are unable to transition to TCE-free production processes in the timeframes under the rule and the exemption is not extended, there is a potential for supply disruptions and reliance on imports which would leave the U.S. reliant on foreign suppliers to the extent that they are available to support the national economy, national security, and critical infrastructure. Supply chain disruptions of critical components have the potential for substantial impacts on the national economy (e.g., the 2021-present semiconductor chip shortage). The magnitude of economic impacts from a potential battery separator supply chain disruption is uncertain.

7.12.7 (B) Synthetic Paper Manufacture

EPA's final rule includes a 15-year 6(g) exemption for the use of TCE as a process solvent in synthetic paper manufacture based on an exemption request submitted from PPG. PPG is a global maker of paints, coatings and specialty materials. Information in this section is based on information provided in PPG's exemption request (PPG 2023).

One of PPG's specialty materials, TESLIN substrate, is a unique polymeric microporous sheet material that is a fundamental component in a wide range of products including but not limited to:

- Secure credentials, ID cards, Driver Licenses and Passports / e-Passports
- Durable labels and tags having stringent requirements, including blood bag labels and chemical drum labels
- Energy recovery ventilators
- Filtration elements and cartridges especially for challenging oil/water and bilge water separations

TCE is used in the production process to facilitate the controlled removal of process oil required in order to achieve a microporous film. TCE possesses the following properties that allows its use, recovery, and reuse:

- Non-flammable
- Rapidly extracts process (mineral) oil from sheet
- Amenable to separation via distillation allowing reuse of TCE and oil
- Low solubility in water and higher density than water that enables water/solvent separation for recovery
- Vapor pressure that allows for evaporation but can be condensed from steam atmosphere

TCE is used in the production process to extract oil from the synthetic paper sheet. The solvent displaces the process oil from the pores of the precipitated silica, transforming the oil-filled sheet into a sheet/substrate with the required micro-porosity and other physical properties which are key to the performance attributes and value in essentially all end-use applications. The sheet filled with process oil is converted to sheet filled with TCE. In the reverse-process direction, process solvent is converted into a process solvent/process oil mixture, which is subsequently separated in a distillation system by taking advantage of the relatively low boiling point of TCE as compared to oil. The pure TCE that comes off the distillation system is fed back into the extractor, and the process oil that comes off of the distillation system is fed into a process oil storage tank where it is re-used for subsequent TESLIN mixes. The process oil and process solvent TCE are both recycled and reused.

Withing their submission, they summarized the following potential alternative solvents and asserted that none are technically or economically feasible alternatives to TCE in their production process:

- Trans-1,2-dichloroethylene
- 3M Novec 73DE
- Chemours Vertrel MCA
- Chemours Vertrel CCA
- NuGenTec FluoSolv CX
- Chemours Opteon SF79
- Cemours Opteon SF80
- Aero-Tron 100
- Hexane

EPA does not have sufficient information to estimate the costs of finding and implementing and alternative to TCE or the costs of the prohibition for this use after the 15-year exemption expires. Under TSCA section 6(g) EPA can consider revisiting or extending time-limited exemptions by rulemaking until a safer, feasible alternative becomes available provided EPA receives an updated analysis of the specific use.

7.12.7 (C) HFC Manufacturing

The majority of the annual production volume of TCE processed as an intermediate under this condition of use goes almost entirely toward the manufacture of one HFC, HFC-134a (EPA 2020e). Some domestic manufacturers of HFC-134a use perchloroethylene to produce HFC-134a, but the facilities that currently use TCE would need to make major changes to their production equipment and processes to switch to perchloroethylene from TCE.

HFC-134a is one of the regulated substances that are subject to a phasedown under the AIM Act. EPA's October 2021 Rule under the AIM Act established HFC production and consumption baseline levels from which reductions will be made and outlined a procedure for issuing HFC allowances over the next two years. These allowances represent the privilege granted to a company to produce or import HFCs in a given year. Providing a longer phaseout under TSCA for processing TCE as an intermediate for the manufacture of HFC-134a, while subject to an interim WCPP, may complement the Agency's efforts to address climate-damaging HFCs, such as HFC-134a, under the AIM Act.

Certain uses of HFC-134a are expected to continue indefinitely, but the phasedown under the AIM Act will eventually result in significant declines in the volumes of HFC-134a that is needed. At some point, the domestic manufacture of HFC-134a may be discontinued. When this discontinuation might occur is uncertain, so it is unclear whether the regulation would hasten the closure of the two plants that use TCE to produce HFC-134a. There would be some unknown cost impacts associated with hastening the closure of these two plants. However, HFC-134a supplies would be expected to remain available through imports.

7.12.7 (D) Use as an intermediate in HCl production

TCE use as an intermediate in HCl production is not regulated under the final rule, but is regulated under Option 2, the alternative option. According to the Vinyl Institute, TCE is manufactured as an unintended byproduct of the manufacture of ethylene dichloride (EDC) as part of the process for manufacturing vinyl chloride. Vinyl chloride is primarily used to produce polyvinyl chloride (PVC). There are two processes to manufacture EDC, oxychlorination and direct chlorination and both are typically used by producers at a facility to achieve a balanced operation. TCE is produced from the oxychlorination process but not the direct chlorination process. TCE is typically found in heavy end liquids resulting from the purification of EDC. The TCE is generally either used as a feedstock in a RCRA-approved incinerator "to produce muriatic acid or stronger HCl (hydrochloric acid)" or is used in a Catoxid® process to "manufacture anhydrous HCl". The HCl produced from both incineration and the Catoxid® process is returned as a feedstock to the oxychlorination process (The Vinyl Institute 2017).

A 2001 EPA memo on the Regulatory Determination on the Status of CatoxidTM Units states that the "…CatoxidTM process is a manufacturing process which uses a fluidized bed reactor to make a hydrogen chloride intermediate product which is, in turn, used to manufacture ethylene dichloride (EDC)" and "the CatoxidTM unit operates as a recycling unit designed specifically to react secondary material feeds to produce a chemical intermediate (hydrogen chloride gas) used directly in the manufacture of EDC". The prohibition on the processing as a reactant/intermediate use of TCE affects firms manufacturing HCl from TCE as an intermediate.

EPA also identified 6 petroleum refinery sites that appear to be using TCE for HCl production, which is then used in the reforming and isomerization process. Note perchloroethylene is generally preferred to TCE for this use (and is used at nearly every petroleum refinery site), but TCE emissions reported at these sites indicate that it also appears to be used at a small number of refineries. Since these refineries also use perchloroethylene for this process, EPA assumes perchloroethylene would be used instead of TCE at these refineries for this use.

Excluding the refineries, this analysis identified 24 sites potentially involved in the manufacture of HCl from TCE. Those sites that are using TCE as a reactant/intermediate would need to make process and physical plant changes in order to comply with the prohibition on the processing as a reactant/intermediate use. EPA does not have sufficient information about how many of these sites are using TCE as a reactant what those changes may require to estimate the costs of the prohibition to this sector under Option 2, the alternative option.

7.12.7 (E) Fluoroelastomer Manufacture

Fluoroelastomers are synthetic polymers designed for applications in hostile environments due to their resistance to flame, chemicals, and oxidation. Fluoroelastomers are widely used in applications where resistance to heat and corrosion are important, such as aerospace, automotive, chemical, petroleum, and energy applications (Azienda Lavorazione Prodott Ausiliari 2014). EPA identified 2 sites that may be using TCE for fluoroelastomer production, but it's possible that these sites are using TCE in another way.

A.L.P.A., which uses TCE in fluoroelastomer manufacture in Europe, submitted an alternatives analysis to the European Chemicals Agency (ECHA) in to 2014 in an application for authorization to use TCE in fluoroelastomer manufacture (Azienda Lavorazione Prodott Ausiliari 2014). In March 2022, A.L.P.A. informed ECHA that it intends to use acetonitrile (CAS# 75-08-8) instead of TCE by 2023. Acetonitrile does not require a new plant configuration or different safety systems (ECHA 2022), but little additional information is available about the costs of transitioning to acetonitrile.

7.13 Total Annualized Costs

Table 7-64 through Table 7-66 present the total annualized costs for 7, 3 and 2 percent discount rates, respectively. Note that EPA was unable to estimate costs of prohibition for four use categories that have a prohibition requirement under one of the options. Since the costs of prohibition are unknown, the costs of compliance with a WCPP are used a lower bound estimate for prohibition in these instances. EPA believes that WCPP costs are a reasonable lower bound estimate because it must be true that the prohibition costs are at least as large as the WCPP costs. This must be the case because every available compliance strategy under a WCPP requirement is also available under a prohibition requirement (i.e., switching to alternatives).[13]

Table 7-64: Total 2% 20-Year Annualized Costs Under the Regulatory Options by Use Category (2022$)

Use Category	Option 1 (ECEL 0.20 ppm)		Option 2 (ECEL 0.0011 ppm)	
	Total Annualized Cost	Notes	Total Annualized Cost	Notes
Laboratory Use	$1,020,962	20-Years of WCPP Costs	$1,020,962	20-Years of WCPP Costs
Manufacturing	$257,925		$496,593	
Battery and Synthetic Paper Processing Aid	$271,592	20-Years of WCPP Costs[1]	$311,972	20-Years of WCPP Costs[2]
HFC Manufacturing	$36,605	9-Years of WCPP Costs[3]	$71,153	9-Years of WCPP Costs[3]
Intermediate in HCl Production	-	Not subject to rule under Option 1	$1,916,912	20-Years of WCPP Costs[4]
Fluoroelastomer Manufacture	$181,062	20-Years of WCPP Costs[4]	$207,982	20-Years of WCPP Costs[4]
Open-Top Vapor Degreasing	$45,445,026	Alternatives cost from Table 7-41 with WCPP costs incurred during transition to prohibition under exemptions[5]	$45,493,389	Alternatives cost from Table 7-41 with WCPP costs incurred during transition to prohibition under exemptions[5]
Enclosed Vapor Degreasing	$917,124		$921,179	
Conveyorized Vapor Degreasing	$1,037,791	Alternatives cost from Table 7-41	$1,037,791	Alternatives cost from Table 7-41
Web Vapor Degreasing	$129,724		$129,724	
Batch Cold Cleaning	$6,745,641		$6,745,641	
Disposal to Wastewater	$7,077,581	20-Years of WCPP Costs[6]	$18,630,260	20-Years of WCPP Costs[6]
Energized Electrical Cleaners[7]	$575,451	1 year of Prescriptive Control costs followed by prohibition	$575,451	Estimated as Option 1 Costs
Mold Release[7]	$52,573	Costs of rule familiarization and reformulation.	$52,573	Costs of rule familiarization and reformulation.
Liquid Cleaners and Degreasers[7]	$75,756		$75,756	
Aerosol Spray Cleaning/Degreasing (except EEC)[7]	$99,119		$99,119	
Lubricants and Greases[7]	$28,124		$28,124	
Adhesives, Sealants, Paints and Coatings[7]	$60,332		$60,332	
Spot Removers[7]	$38,715		$38,715	
Pepper Spray[7]	$3,754		$3,754	
Total	**$64,054,859**	-	**$77,917,383**	-

[1]TCE use is prohibited after 15 years, but since the costs of TCE alternatives are unknown, the WCPP costs are used as a lower bound estimate.

[2]TCE use is prohibited after 10 years for battery separator manufacture and in six months for synthetic paper, but since the costs of TCE alternatives are unknown, the WCPP costs are used as a lower bound estimate.

[13] Note that it is possible that the costs of WCPP compliance might overstate the costs under both a WCPP requirement and a prohibition requirement. For example, if switching to alternatives is the less costly and preferred compliance strategy under a WCPP requirement. However, it would still be the case that costs under a WCPP requirement are at least as large as the costs under a prohibition requirement.

[3]TCE use is prohibited after 8.5 years. It is unknown what the cost implications of a 8.5 year phase out would be, so the costs reflect 9 years of WCPP costs under both options.

[4]Since the regulatory costs of prohibition under this use are unknown, the analysis uses the WCPP costs as a proxy for the prohibition costs to calculate total costs. Thus, the total costs are estimated as the 20-year annualized costs of WCPP compliance. Interim WCPP requirements apply for 2 years under both options for these use categories.

[5]There is longer term compliance timeframe applicable to five Open-Top Vapor Degreasers using TCE for narrow tubes and medical device (7 years), one Open-Top Vapor Degreaser using TCE in naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes (10 years), one enclosed vapor degreasing application using TCE to scour rayon fabric for use in rocket booster engine nozzles (10 years). WCPP compliance is required for 7 years, followed by prohibition for industrial and commercial use of TCE in closed loop vapor degreasing necessary for human-rated rocket engine cleaning by Federal agencies and their contractors. The analysis accounts for one enclosed vapor degreaser and one Open-Top Vapor Degreaser with 9 years of WCPP costs and prohibition costs in years 10-20, One enclosed vapor degreaser and five Open-Top Vapor Degreaser with 6 years of WCPP costs and prohibition costs in years 7-20. Other vapor degreasers have prohibition costs starting at "time zero".

[6]Since the regulatory costs of prohibition under this use are unknown, the analysis uses the WCPP costs as a proxy for the prohibition costs to calculate total costs. Thus, the total costs are estimated as the 20-year annualized costs of WCPP compliance.

[7]The costs for the Import/Repackage and Incorporation into Formulation, Mixture, or Reaction Product use categories are accounted under the respective end-use categories for their products.

Table 7-65: Total 3% 20-Year Annualized Costs Under the Regulatory Options by Use Category (2022$)

Use Category	Option 1 (ECEL 0.20 ppm) Total Annualized Cost	Option 1 (ECEL 0.20 ppm) Notes	Option 2 (ECEL 0.0011 ppm) Total Annualized Cost	Option 2 (ECEL 0.0011 ppm) Notes
Laboratory Use	$1,019,851	20-Years of WCPP Costs	$1,019,851	20-Years of WCPP Costs
Manufacturing	$257,227		$495,780	
Battery and Synthetic Paper Processing Aid	$270,832	20-Years of WCPP Costs[1]	$313,678	20-Years of WCPP Costs[2]
HFC Manufacturing	$38,271	9-Years of WCPP Costs[3]	$74,458	9-Years of WCPP Costs[3]
Intermediate in HCl Production	-	Not subject to rule under Option 1	$1,913,754	20-Years of WCPP Costs[4]
Fluoroelastomer Manufacture	$180,554	20-Years of WCPP Costs[4]	$209,118	20-Years of WCPP Costs[4]
Open-Top Vapor Degreasing	$51,402,026	Alternatives cost from Table 7-41 with WCPP costs incurred during transition to prohibition under exemptions[5]	$51,454,277	Alternatives cost from Table 7-41 with WCPP costs incurred during transition to prohibition under exemptions[5]
Enclosed Vapor Degreasing	$1,011,662		$1,016,091	
Conveyorized Vapor Degreasing	$1,175,495	Alternatives cost from Table 7-41	$1,175,495	Alternatives cost from Table 7-41
Web Vapor Degreasing	$146,937		$146,937	
Batch Cold Cleaning	$7,640,714		$7,640,714	
Disposal to Wastewater	$7,076,676	20-Years of WCPP Costs[6]	$18,606,842	20-Years of WCPP Costs[6]
Energized Electrical Cleaners[7]	$622,687	1 year of Prescriptive Control costs followed by prohibition	$622,687	Estimated as Option 1 Costs
Mold Release[7]	$57,453	Costs of rule familiarization and reformulation.	$57,453	Costs of rule familiarization and reformulation.
Liquid Cleaners and Degreasers[7]	$82,789		$82,789	
Aerosol Spray Cleaning/Degreasing (except EEC)[7]	$108,321		$108,321	
Lubricants and Greases[7]	$30,735		$30,735	
Adhesives, Sealants, Paints and Coatings[7]	$65,933		$65,933	
Spot Removers[7]	$42,309		$42,309	
Pepper Spray[7]	$4,103		$4,103	
Total	**$71,234,573**	-	**$85,081,323**	-

[1]TCE use is prohibited after 15 years, but since the costs of TCE alternatives are unknown, the WCPP costs are used as a lower bound estimate.

[2]TCE use is prohibited after 10 years for battery separator manufacture and in six months for synthetic paper, but since the costs of TCE alternatives are unknown, the WCPP costs are used as a lower bound estimate.

[3]TCE use is prohibited after 8.5 years. It is unknown what the cost implications of a 8.5 year phase out would be, so the costs reflect 9 years of WCPP costs under both options.

[4]Since the regulatory costs of prohibition under this use are unknown, the analysis uses the WCPP costs as a proxy for the prohibition costs to calculate total costs. Thus, the total costs are estimated as the 20-year annualized costs of WCPP compliance. Interim WCPP requirements apply for 2 years under both options for these use categories.

[5]There is longer term compliance timeframe applicable to five Open-Top Vapor Degreasers using TCE for narrow tubes and medical device (7 years), one Open-Top Vapor Degreaser using TCE in naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes (10 years), one enclosed vapor degreasing application using TCE to scour rayon fabric for use in rocket booster engine nozzles (10 years). WCPP compliance is required for 7 years, followed by prohibition for industrial and commercial use of TCE in closed loop vapor degreasing necessary for human-rated rocket engine cleaning by Federal agencies and their contractors. The analysis accounts for one enclosed vapor degreaser and one Open-Top Vapor Degreaser with 9 years of WCPP costs and prohibition costs in years 10-20, One enclosed vapor degreaser and five Open-Top Vapor Degreaser

with 6 years of WCPP costs and prohibition costs in years 7-20. Other vapor degreasers have prohibition costs starting at "time zero".

[6]Since the regulatory costs of prohibition under this use are unknown, the analysis uses the WCPP costs as a proxy for the prohibition costs to calculate total costs. Thus, the total costs are estimated as the 20-year annualized costs of WCPP compliance.

[7]The costs for the Import/Repackage and Incorporation into Formulation, Mixture, or Reaction Product use categories are accounted under the respective end-use categories for their products.

Table 7-66: Total 7% 20-Year Annualized Costs Under the Regulatory Options by Use Category (2022$)

Use Category	Option 1 (ECEL 0.20 ppm)		Option 2 (ECEL 0.0011 ppm)	
	Total Annualized Cost	Notes	Total Annualized Cost	Notes
Laboratory Use	$1,015,018	20-Years of WCPP Costs	$1,015,018	20-Years of WCPP Costs
Manufacturing	$254,189		$492,243	
Battery and Synthetic Paper Processing Aid	$267,524	20-Years of WCPP Costs[1]	$321,094	20-Years of WCPP Costs[2]
HFC Manufacturing	$44,392	9-Years of WCPP Costs[3]	$86,691	9-Years of WCPP Costs[3]
Intermediate in HCl Production	-	Not subject to rule under Option 1	$1,900,018	20-Years of WCPP Costs[4]
Fluoroelastomer Manufacture	$178,349	20-Years of WCPP Costs[4]	$214,063	20-Years of WCPP Costs[4]
Open-Top Vapor Degreasing	$77,266,553	Alternatives cost from Table 7-41 with WCPP costs incurred during transition to prohibition under exemptions[5]	$77,335,094	Alternatives cost from Table 7-41 with WCPP costs incurred during transition to prohibition under exemptions[5]
Enclosed Vapor Degreasing	$1,409,320		$1,415,334	
Conveyorized Vapor Degreasing	$1,774,397	Alternatives cost from Table 7-41	$1,774,397	Alternatives cost from Table 7-41
Web Vapor Degreasing	$221,800		$221,800	
Batch Cold Cleaning	$11,533,580		$11,533,580	
Disposal to Wastewater	$7,072,738	20-Years of WCPP Costs[6]	$18,504,991	20-Years of WCPP Costs[6]
Energized Electrical Cleaners[7]	$820,958	1 year of Prescriptive Control costs followed by prohibition	$820,958	Estimated as Option 1 Costs
Mold Release[7]	$78,680	Costs of rule familiarization and reformulation.	$78,680	Costs of rule familiarization and reformulation.
Liquid Cleaners and Degreasers[7]	$113,376		$113,376	
Aerosol Spray Cleaning/Degreasing (except EEC)[7]	$148,340		$148,340	
Lubricants and Greases[7]	$42,090		$42,090	
Adhesives, Sealants, Paints and Coatings[7]	$90,292		$90,292	
Spot Removers[7]	$57,941		$57,941	
Pepper Spray[7]	$5,618		$5,618	
Total	**$102,395,154**	-	**$116,171,618**	-

[1]TCE use is prohibited after 15 years, but since the costs of TCE alternatives are unknown, the WCPP costs are used as a lower bound estimate.

[2]TCE use is prohibited after 10 years for battery separator manufacture and in six months for synthetic paper, but since the costs of TCE alternatives are unknown, the WCPP costs are used as a lower bound estimate.

[3]TCE use is prohibited after 8.5 years. It is unknown what the cost implications of a 8.5 year phase out would be, so the costs reflect 9 years of WCPP costs under both options.

[4]Since the regulatory costs of prohibition under this use are unknown, the analysis uses the WCPP costs as a proxy for the

prohibition costs to calculate total costs. Thus, the total costs are estimated as the 20-year annualized costs of WCPP compliance. Interim WCPP requirements apply for 2 years under both options for these use categories.

[5]There is longer term compliance timeframe applicable to five Open-Top Vapor Degreasers using TCE for narrow tubes and medical device (7 years), one Open-Top Vapor Degreaser using TCE in naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes (10 years), one enclosed vapor degreasing application using TCE to scour rayon fabric for use in rocket booster engine nozzles (10 years). WCPP compliance is required for 7 years, followed by prohibition for industrial and commercial use of TCE in closed loop vapor degreasing necessary for human-rated rocket engine cleaning by Federal agencies and their contractors. The analysis accounts for one enclosed vapor degreaser and one Open-Top Vapor Degreaser with 9 years of WCPP costs and prohibition costs in years 10-20, One enclosed vapor degreaser and five Open-Top Vapor Degreaser with 6 years of WCPP costs and prohibition costs in years 7-20. Other vapor degreasers have prohibition costs starting at "time zero".

[6]Since the regulatory costs of prohibition under this use are unknown, the analysis uses the WCPP costs as a proxy for the prohibition costs to calculate total costs. Thus, the total costs are estimated as the 20-year annualized costs of WCPP compliance.

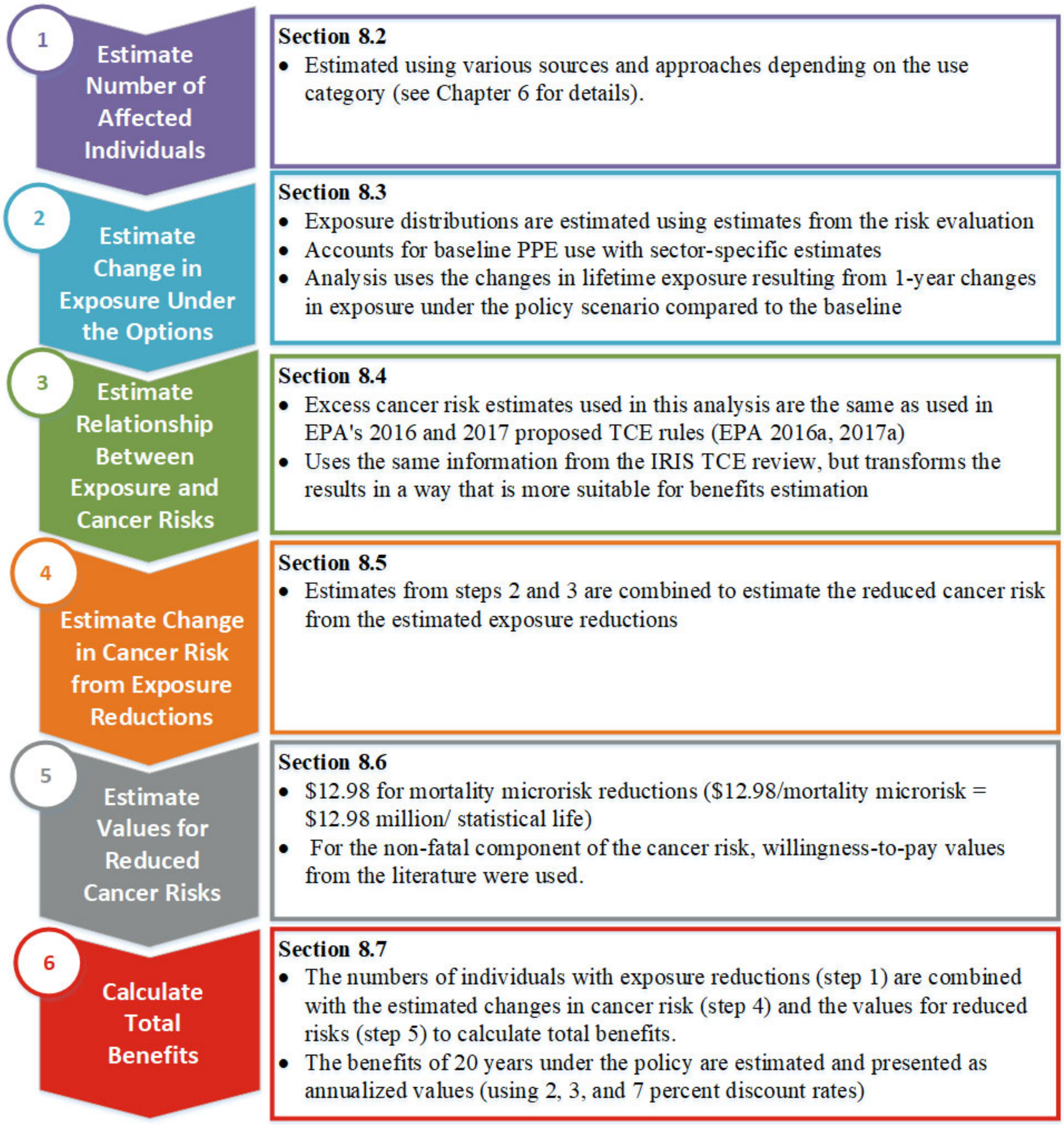
[7]The costs for the Import/Repackage and Incorporation into Formulation, Mixture, or Reaction Product use categories are accounted under the respective end-use categories for their products.

8. Benefits Analysis

This Chapter presents the monetized benefits estimates under the regulatory options and includes a discussion of unquantified non-cancer benefits. As described above in section 7.2, the timeline for the analysis is 20 years, and therefore benefits are annualized over 20 years of reduced exposure risks. The benefits in each year of reduced exposure risks are estimated to be the same for a given risk reduction measure (e.g., WCPP compliance). It is also the case that the incremental increase in the annual benefit from risk reductions under prohibition compared to risk reductions under the WCPP are very small. Thus, annualized benefits are not sensitive to the analysis timeframe.

The regulatory options are summarized in Section 8.1. The cancer benefits estimates are described in section 8.2 through 8.7, following the approach outlined in Figure 8-1.

Figure 8-1: Outline of Approach for Estimating Cancer Benefits



Section 8.9 discusses the non-cancer benefits that are not monetized in this economic analysis.

8.1 Summary of Regulatory Options Considered

Table 8-1 summarizes the regulatory options by use category. The options are described in more detail in section 1.2.

Table 8-1: Summary of Regulatory Options by Use Category

Use Category	Option 1 (ECEL of 0.2 ppm)	Option 2 (ECEL of 0.0011ppm)
Laboratory Use	**WCPP followed by prohibition[1]** [1]Asphalt Testing: WCPP for 10 years followed by prohibition (10-year 6g exemption). Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.	**Prohibition/WCPP followed by prohibition[2]** [2]Asphalt Testing: Prohibited. Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.
Manufacturing	**WCPP for limited uses until prohibited[3]** [3]Interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization.	
Import/Repackage		
Battery and Synthetic Paper Processing Aid	**WCPP followed by prohibition[4]** [4]20-year exemption with WCPP 6 months after rule finalization for lead acid battery separators. 5-year exemption with WCPP 6 months after rule finalization for lithium battery separators.15-year exemption with WCPP 6 months after rule finalization for synthetic paper.	**WCPP followed by prohibition[5]** [5]10-year exemption with WCPP 6 months after rule finalization for battery separator manufacture. Synthetic paper use prohibited.
HFC Manufacturing	**Long-Term Phase Out with WCPP followed by Prohibition[6]** [6]Long-term phase out to prohibition over 8.5 years, interim requirements of WCPP.	
Intermediate in HCl Production	**Not Subject to Rule**	**WCPP followed by prohibition[7]** [7]WCPP 6 months to 2 years after rule finalization followed by prohibition.
Fluoroelastomer Manufacture	**WCPP followed by Prohibition[8]** [8]WCPP 6 months to 2 years after rule finalization followed by prohibition.	
Open-Top Vapor Degreasing	**Prohibition with Interim WCPP for Exemptions[9]** [9]A 6(g) exemption for 7 years applies to OTVD for narrow tubes for aerospace or medical device use. A 6(g) exemption for 10 years applies to naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes for OTVDs. A 6(g) exemption for 7 years applies to human-rated rocket engine cleaning in EVDs by Federal agencies and their A 6(g) exemption for 10 years applies to rayon fabric scouring in EVDs for rocket booster nozzle production for Federal agencies and their contractors.	
Enclosed Vapor Degreasing		
Conveyorized/Web Vapor Degreasing		
Batch Cold Cleaning		
Disposal to Wastewater	**Prohibition 1 year after rule finalization with WCPP requirements for POTWs exceeding a water screening level and worker protection requirements for cleanup sites and industrial treatment/pre-treatment. [10]** [10]For POTWs above the water screening level, WCPP would be required (with the interim occupational exposure limit (ECEL)). For cleanup site workers and industrial treatment/pre-treatment, use TSCA regulatory limit (new interim occupational exposure limit (ECEL)) within the framework of existing OSHA HAZWOPER requirements.	**Prohibition[11]** [11]One year after rule finalization.

Table 8-1: Summary of Regulatory Options by Use Category

<table>
<tr><th>Use Category</th><th>Option 1 (ECEL of 0.2 ppm)</th><th>Option 2 (ECEL of 0.0011ppm)</th></tr>
<tr><td>Energized Electrical Cleaners</td><td>Prohibition with Interim APF50 Respirator Requirement[12]

[12]Prohibit 3 years after rule finalization with interim prescriptive respiratory protection requirements of APF 50 respirator use.</td><td>Prohibition[13]

[13]Six months after rule finalization.</td></tr>
<tr><td>Incorporation into Formulation, Mixture, or Reaction Product</td><td colspan="2" rowspan="14">Prohibition[14,15]

[14]Prohibition six months after rule finalization.

[15]Adhesives and Sealants for Aerospace uses have a 5-year exemption with interim WCPP. Since the numbers of workers affected by the exemption is unknown, the exemption is not accounted for in the analysis and the costs and benefits from prohibition are assumed for all affected users of adhesives, sealants, paints, and coatings.</td></tr>
<tr><td>Commercial Use Pepper Spray</td></tr>
<tr><td>Incorporation into Articles</td></tr>
<tr><td>Mold Release</td></tr>
<tr><td>Liquid Cleaners and Degreasers</td></tr>
<tr><td>Aerosol Spray Cleaning/Degreasing (except EEC)</td></tr>
<tr><td>Lubricants and Greases</td></tr>
<tr><td>Adhesives, Sealants, Paints and Coatings[3]</td></tr>
<tr><td>Functional Fluids</td></tr>
<tr><td>Spot Removers</td></tr>
<tr><td>Film Cleaner</td></tr>
<tr><td>Toner Aid</td></tr>
<tr><td>Polish</td></tr>
</table>

8.1.1 Accounting for the timing of implementing phased-in requirements

With the exception of the prohibitions on manufacture and import for most conditions of use, most other requirements are effective between 6 to 12 months after the rule is finalized. To simplify the calculations, "time zero" for the analysis is 6-12 months after the rule is finalized. The timing of requirements that are phased in over time are accounted for by rounding to the nearest year. Thus, no distinction is made for implementation 6 to 12 months after rule finalization is made. For example, under Option 1 lead acid battery separator manufacturers must comply with a WCPP starting 6 months after the rule is finalized through 10 years after the rule is finalized. After 10 years TCE is prohibited for this use. The analysis accounts for this as 9 years of meeting WCPP requirements and 11 years of prohibition.

It is also worth noting that the prohibition on TCE for laboratory uses goes into effect more than 20 years after the rule is finalized, which is after the end of the analytical timeframe for our analysis. Whether alternatives for TCE in laboratory testing will be available in 25 or 30 years is unknown, and what their costs would be is also unknown. Therefore, this analysis does not extend its timeframe because the costs and benefits are highly uncertain.

Table 8-2: Summary of Timing of Requirements under the Rule and the Analysis by Use Category

<table>
<tr><th>Use Category</th><th>Option 1 (ECEL of 0.2 ppm)</th><th>Option 2 (ECEL of 0.0011ppm)</th></tr>
<tr><td>Laboratory Use</td><td>Rule: Asphalt Testing: WCPP for 10 years followed by prohibition (10-year 6g exemption). Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization
Analysis: Exposure data for analyzing benefits unavailable.</td><td>Rule: Asphalt Testing: Prohibited. Other lab uses: Exempt for 50 years, interim requirements of Workplace Chemical Protection Program (WCPP) 6 months after rule finalization. Other lab uses: Exempt for 50 years, interim requirements of WCPP 6 months after rule finalization
Analysis: Exposure data for analyzing benefits unavailable.</td></tr>
<tr><td>Manufacturing</td><td rowspan="2">Rule: WCPP 6 months after rule finalization for limited uses until prohibition.
Analysis: 20 years of WCPP for Manufacturing; other uses are discontinued.</td><td rowspan="2">Rule: WCPP 6 months after rule finalization for limited uses until prohibition.
Analysis: 20 years of WCPP for Manufacturing; other uses are discontinued.</td></tr>
<tr><td>Import/Repackage</td></tr>
<tr><td>Battery and Synthetic Paper Processing Aid</td><td>Rule: 15-year exemption with WCPP 6 months after rule finalization for lead acid batteries. 5-year exemption with WCPP 6 months after rule finalization for lithium batteries.15-year exemption with WCPP 6 months after rule finalization for synthetic paper.
Analysis: 14 years of WCPP and 6 years of prohibition. Note that the lithium ion separator manufacturer producers the lead-acid separator in the same facility.</td><td>Rule: 10-year exemption with WCPP 6 months after rule finalization for battery separator manufacture. Synthetic paper prohibited six months after rule finalization.
Analysis: Battery separator manufacture: 9 years of WCPP and 11 years of prohibition. Note that the lithium ion separator manufacturer producers the lead-acid separator in the same facility. Synthetic paper: Prohibition at “time zero”.</td></tr>
<tr><td>HFC Manufacturing</td><td>Rule: Long-term phase out to prohibition over 8.5 years, interim requirements of WCPP
Analysis: 9 years of WCPP (no benefits after year 9 since it is a baseline phase-out).</td><td>Rule: Long-term phase out to prohibition over 8.5 years, interim requirements of WCPP
Analysis: 9 years of WCPP (no benefits after year 9 since it is a baseline phase-out).</td></tr>
<tr><td>Intermediate in HCl Production</td><td>Rule: Not subject to the rule
Analysis: Benefits are zero because they are exempt.</td><td rowspan="2">Rule: Exempt for 2 years (with interim WCPP)
Analysis: 1 year of WCPP and 19 years of prohibition.</td></tr>
<tr><td>Fluoroelastomer Manufacture</td><td>Rule: Exempt for 2 years (with interim WCPP)
Analysis: 1 year of WCPP and 19 years of prohibition.</td></tr>
<tr><td>Open-Top Vapor Degreasing</td><td>Rule: Prohibition 1 year after rule finalization except for 6g exemptions. A 6g exemption for 7 years applies to narrow tubes and medical device use. A 6g exemption for 10 years applies to naval combat systems, radars, sensors, equipment, and fabrication and prototyping processes.
Analysis: 5 OTVDs are assumed to have 6 years of WCPP and 14 years of prohibition. 1 OTVD is assumed to have 9 years of WCPP and 11 years of prohibition. Other OTVDs are assumed to have 20 years of prohibition.</td><td>Rule: Prohibition 1 year after rule finalization
Analysis: Prohibition at “time zero”</td></tr>
</table>

Table 8-2: Summary of Timing of Requirements under the Rule and the Analysis by Use Category

Use Category	Option 1 (ECEL of 0.2 ppm)	Option 2 (ECEL of 0.0011ppm)
Enclosed Vapor Degreasing	**Rule:** Prohibition 1 year after rule finalization, except for 6g exemptions. A 6g exemption for 7 years applies to human-rated rocket engine cleaning by Federal agencies and their contractors. A 6g exemption for 10 years applies to rayon fabric scouring for rocket booster nozzle production for Federal agencies and their contractors. **Analysis:** Prohibition at time zero, except for one vapor degreaser with 6 years of WCPP and 14 years of prohibition and one vapor degreaser with 9 years of WCPP and 11 years of prohibition.	
Conveyorized/Web Vapor Degreasing	**Rule:** Prohibition 1 year after rule finalization **Analysis:** Prohibition at "time zero"	
Batch Cold Cleaning		
Disposal to Wastewater	**Rule**: Prohibition 1 year after rule finalization[1,2] with WCPP requirements for POTWs exceeding a water screening level and worker protection requirements for cleanup sites and industrial treatment/pre-treatment. **Analysis:** Benefits for clean-up sites are not estimated, as these facilities are likely to be in compliance under the baseline. Benefits are estimated as the WCPP benefits for the affected POTWs.	**Rule**: Prohibition 1 year after rule finalization[2] **Analysis:** Benefits for clean-up sites are not estimated. Benefits are estimated as the prohibition benefits for the affected POTWs.
Energized Electrical Cleaners	**Rule:** Prohibit 3 years after rule finalization with interim prescriptive respiratory protection requirements[3] **Analysis:** 2 years of APF 50 PPE and 18 years of prohibition.	**Rule:** Prohibition 6 months after rule finalization **Analysis:** Prohibition at "time zero"
Incorporation into Formulation, Mixture, or Reaction Product	**Rule:** Prohibit 6 months after rule finalization[3] **Analysis:** Prohibition at "time zero"	
Commercial Use Pepper Spray		
Incorporation into Articles		
Mold Release		
Liquid Cleaners and Degreasers		
Aerosol Spray Cleaning/Degreasing (except EEC)		
Lubricants and Greases		
Adhesives, Sealants, Paints and Coatings[3]		
Functional Fluids		
Spot Removers		
Film Cleaner		
Toner Aid		
Polish		

[1]For POTWs above the water screening level, WCPP would be required (with the interim occupational exposure limit (ECEL)).
[2]For cleanup site workers and industrial treatment/pre-treatment, use TSCA regulatory limit (new interim occupational exposure limit (ECEL)) within the framework of existing OSHA HAZWOPER requirements.
[3]Adhesives and Sealants for Aerospace uses have a 5-year exemption with interim WCPP. Since the numbers of workers affected by the exemption is unknown, the exemption is not accounted for in the analysis and the benefits from prohibition are assumed for all affected users of adhesives, sealants, paints, and coatings.

8.2 Number of Individuals with Exposure Reduction

Table 8-3 presents the estimated numbers of individuals with exposure reductions. Descriptions of how these estimates were derived are presented in section 6.2.

Table 8-3: Number of Individuals with TCE Exposure

Use Category	Occupational Users	Occupational Non-Users	Total Occupational Users and ONUs	Consumer Users
Laboratory Use	251	2,259	2,510	-
Manufacturing	140	68	208	-
Import/Repackage	18	9	27	-
Battery and Synthetic Paper Processing Aid	51	24	75	-
HFC Manufacturing	38	18	56	-
Intermediate in HCl Production	532	252	784	-
Fluoroelastomer Manufacture	34	16	50	-
Open-Top Vapor Degreasing	2,100	1,400	3,500	-
Enclosed Vapor Degreasing	42	28	70	-
Conveyorized Vapor Degreasing	48	32	80	-
Web Vapor Degreasing	6	4	10	-
Batch Cold Cleaning	312	208	520	-
Disposal to Wastewater	9,607	3,695	13,302	-
Incorporation Into Formulation, Mixture, or Reaction Product	448	140	588	-
Mold Release	371	44	415	67
Liquid Cleaners and Degreasers	16,053	1,667	17,720	190
Aerosol Spray Cleaning/Degreasing	5,852	696	6,548	12,089
Lubricants and Greases	1,751	76	1,827	3,159
Adhesives, Sealants, Paints and Coatings	616	288	904	2,184
Spot Removers	14,940	3,735	18,675	2,911
Film Cleaner				
Toner Aid	-	-	-	-
Polish	-	-	-	-
Pepper Spray	-	-	-	-
Total	**53,210**	**14,659**	**67,869**	**20,600**

Table 8-4 presents the estimated numbers of individuals with exposure reductions mapped to the categories for which exposures are estimated. This analysis only includes benefits estimates for workers and occupational non-users (ONUs); benefits for consumers who would avoid exposure under the regulatory option are not estimated. Note that ONU exposures are only available for select use categories, and benefits are only estimated for the ONUs where exposure estimates were available. Thus, Table 8-4 includes fewer individuals than were included Table 8-3, since individuals for which exposure reductions and the resulting benefits cannot be estimated are not included in Table 8-3.

Table 8-4: Number of Individuals with Estimated Benefits for Occupational TCE Exposure Reductions, by Exposure Type

Use Category	Exposure Type	Number of Individuals Exposed
Manufacturing	Worker	140
Import/Repackage	Worker	18
Battery and Synthetic Paper Processing Aid	Worker	51
Battery and Synthetic Paper Processing Aid	ONU	24
HFC Manufacturing	Worker	38
Intermediate in HCL Production	Worker	532
Fluoroelastomer Manufacture	Worker	34
Fluoroelastomer Manufacture	ONU	16
Open-Top Vapor Degreasing	Worker	2,100
Open-Top Vapor Degreasing	ONU	1,400
Enclosed Vapor Degreasing	Worker	42
Conveyorized Vapor Degreasing	Worker	48
Web Vapor Degreasing	Worker	6
Web Vapor Degreasing	ONU	4
Batch Cold Cleaning	Worker	312
Batch Cold Cleaning	ONU	208
Disposal to Wastewater	Worker	9,607
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	448
Mold Release	Worker	371
Mold Release	ONU	44
Liquid Cleaners and Degreasers	Worker	16,053
Liquid Cleaners and Degreasers	ONU	1,667
Aerosol Spray Cleaning/Degreasing	Worker	5,852
Aerosol Spray Cleaning/Degreasing	ONU	696
Lubricants and Greases	Worker	1,751
Lubricants and Greases	ONU	76
Adhesives, Sealants, Paints and Coatings	Worker	616
Adhesives, Sealants, Paints and Coatings	ONU	288
Spot Removers	Worker	14,940
Spot Removers	ONU	3,735
Total	-	**61,117**

8.3 Exposure Values from Risk Evaluation Used in the Benefits Analysis

The supplemental exposure files for the final risk evaluation included central (median) and high-end (95th percentile) changes in the Lifetime Average Daily Concentration (LADC) estimates for each of the use category/exposure type combinations listed above in Table 8-4 (EPA 2020l). These LADC estimates were divided by 31 years (central) or 40 years (high end) to get a change in LADC from eliminating one year of exposure. Then the mean change in the LADC was calculated by assuming exposures are distributed lognormally.[14] These exposure estimates reflect exposure without respiratory PPE, so they are adjusted

[14]Measured concentrations of various contaminants are very often found to have frequency distributions that are log-normal, including indoor-air contaminants (Ott 1990). Ott (1990) also provides a physical explanation for why some common processes in nature, including processes relevant to indoor air pollutant concentrations, can explain why lognormal distributions arise naturally. Therefore, EPA believes assuming exposure levels follow a log-normal distribution is a reasonable approach.

by the percentages shown in Table 8-5 to account for estimated baseline PPE use. The estimated percentage of baseline PPE use by APF shown in Table 8-5 is described in Appendix B (Abt Global 2024). The adjustment to exposure to account for baseline PPE use is calculated based on the APF and the percentage of baseline use of each APF. For example, the 73% adjustment for manufacturing is calculated as 73% = 72% + 11%/10 + 0%/25 + 7%/50 + 8%/1,000 + 2%/10,000.[15]

Table 8-5: Adjustment to Exposure to Account for Baseline PPE Use

Sector	Percent Baseline PPE use, by APF						Adjustment to Exposure to Account for Baseline PPE Use
	No PPE	APF 10	APF 25	APF 50	APF 1,000	APF 10,000	
Manufacturing	72%	11%	0%	7%	8%	2%	73%
Transportation and Public Utilities	88%	4%	0%	3%	4%	2%	89%
Services	95%	3%	0%	1%	1%	0%	95%
Note: Baseline PPE use for the transportation and public utilities sector are used for disposal to wastewater. Baseline PPE use for the services sector are used for aerosol spray and liquid cleaning/degreasing and spot removers. Baseline PPE use for the manufacturing sector is used for all other use categories.							

Table 8-6 presents the mean increase in the LADC from one year of baseline occupational exposure with the baseline PPE adjustment and describes how this was calculated from the 50^{th} and 95^{th} percentile LADCs calculated for the risk evaluation.

[15] As another example, suppose 50% of workers do not wear PPE in the baseline and 50% wear APF 10 respirators. The 50% wearing APF 10 respirators would have 1/10 of the exposure compared to workers not wearing PPE. Thus, the baseline adjustment factor in this example would be calculated as 55% = 50%×1 + 50%×1/10. Where the 50%×1 accounts for the 50% not wearing respirators and the 50%×1/10 accounts for the 50% reducing their exposure by 1/10 by wearing APF 10 respirators.

Table 8-6: Mean Increase in LADC from One Year of Baseline Occupational Exposure, by Use Category and Exposure Type

Use Category	Exposure Type	Change in LADC Estimated for Risk Evaluation[1] (ppm)		Change in LADC from One Year of Occupational Exposure (ppm)		Mean Change in LADC from One Year of Occupational Exposure (ppm)	
		50th Percentile A	95th Percentile B	50th Percentile C = A/31	95th Percentile D = B/40	Without Accounting for Baseline PPE Use[2] E	After Accounting for Baseline PPE Use[3] F
Manufacturing	Worker	0.010435	0.287905	0.000337	0.007198	0.001905	0.001390
Import/Repackage	Worker	0.000045	0.133474	0.000001	0.003337	0.001765	0.001288
Battery and Synthetic Paper Processing Aid	Worker	0.578745	2.249289	0.018669	0.056232	0.023372	0.017058
Battery and Synthetic Paper Processing Aid	ONU	0.178562	0.509828	0.005760	0.012746	0.006472	0.004724
HFC Manufacturing	Worker	0.010435	0.287905	0.000337	0.007198	0.001905	0.001390
Intermediate in HCl Production	Worker	0.010435	0.287905	0.000337	0.007198	0.001905	0.001390
Fluoroelastomer Manufacture	Worker	0.578745	2.249289	0.018669	0.056232	0.023372	0.017058
Fluoroelastomer Manufacture	ONU	0.178562	0.509828	0.005760	0.012746	0.006472	0.004724
Open-Top Vapor Degreasing	Worker	1.252195	9.104631	0.040393	0.227616	0.070185	0.051222
Open-Top Vapor Degreasing	ONU	0.100455	1.064432	0.003240	0.026611	0.007353	0.005366
Enclosed Vapor Degreasing	Worker	0.041538	0.170254	0.001340	0.004256	0.001715	0.001252
Conveyorized Vapor Degreasing	Worker	2.938424	5.653392	0.094788	0.141335	0.097625	0.071249
Web Vapor Degreasing	Worker	0.513526	1.320505	0.016565	0.033013	0.018087	0.013200
Web Vapor Degreasing	ONU	0.269024	0.871558	0.008678	0.021789	0.010150	0.007407
Batch Cold Cleaning	Worker	0.280000	5.150000	0.009032	0.128750	0.033299	0.024303
Batch Cold Cleaning	ONU	0.150000	3.130000	0.004839	0.078250	0.020252	0.014780
Disposal to Wastewater	Worker	0.000045	0.133474	0.000001	0.003337	0.001765	0.001564
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	0.000045	0.133474	0.000001	0.003337	0.001765	0.001288
Mold Release	Worker	0.653000	2.209000	0.021065	0.055225	0.025010	0.018253
Mold Release	ONU	0.012000	0.093000	0.000387	0.002325	0.000701	0.000512
Liquid Cleaners and Degreasers	Worker	0.084182	0.263011	0.002716	0.006575	0.003138	0.002290
Liquid Cleaners and Degreasers	ONU	0.042341	0.163026	0.001366	0.004076	0.001703	0.001243

Table 8-6: Mean Increase in LADC from One Year of Baseline Occupational Exposure, by Use Category and Exposure Type

Use Category	Exposure Type	Change in LADC Estimated for Risk Evaluation[1] (ppm)		Change in LADC from One Year of Occupational Exposure (ppm)		Mean Change in LADC from One Year of Occupational Exposure (ppm)	
		50th Percentile A	95th Percentile B	50th Percentile C = A/31	95th Percentile D = B/40	Without Accounting for Baseline PPE Use[2] E	After Accounting for Baseline PPE Use[3] F
Aerosol Spray Cleaning/Degreasing	Worker	0.653000	2.209000	0.021065	0.055225	0.025010	0.023779
Aerosol Spray Cleaning/Degreasing	ONU	0.012000	0.093000	0.000387	0.002325	0.000701	0.000667
Lubricants and Greases	Worker	0.653000	2.209000	0.021065	0.055225	0.025010	0.018253
Lubricants and Greases	ONU	0.012000	0.093000	0.000387	0.002325	0.000701	0.000512
Adhesives, Sealants, Paints and Coatings	Worker	0.420688	4.623562	0.013571	0.115589	0.031688	0.023126
Adhesives, Sealants, Paints and Coatings	ONU	0.085398	0.117082	0.002755	0.002927	0.002757	0.002012
Spot Removers	Worker	0.084182	0.263011	0.002716	0.006575	0.003138	0.002983
Spot Removers	ONU	0.042341	0.163026	0.001366	0.004076	0.001703	0.001620

[1]See https://www.epa.gov/sites/default/files/2020-11/21._tce_supplemental_information_file_risk_calculator_for_occupational_exposures.xlsx
[2]Estimated from columns C and D, assuming exposure is lognormally distributed (i.e., calculated in excel using the following formula: =EXP(LN(C)+(((LN(C)-LN(D))/(NORMSINV(0.5)-NORMSINV(0.95)))^2)/2)).
[3]See Table 8-5.

Table 8-7 presents the estimated exposure under a WCPP as a percentage of the baseline exposure for each monitoring threshold. The estimates in Table 8-7 are calculated assuming that PPE with the minimum compliant APF is worn by workers and ONUs not wearing baseline compliant PPE. The following example illustrates how the values in Table 8-7 are calculated:

- Suppose 50% of workers do not wear PPE in the baseline and 50% wear APF 10 respirators
    - The baseline adjustment factor in this example would be calculated as 55% = 50% × 1 + 50%×1/10. Where the 50% × 1 accounts for the 50% not wearing respirators (the "× 1" indicating no reduction in exposure from PPE) and the 50%×1/10 accounts for the 50% reducing their exposure by 1/10 by wearing APF 10 respirators.
    - If monitoring results indicate that exposure exceeds the ECEL by less than 10 times the limit, the 50% of workers not wearing APF 10 respirators in the baseline would need to wear APF 10 respirators under the WCPP (The 50% already wearing APF 10 respirators could just continue to wear them). Thus, exposure under the ECEL compared to the baseline would be calculated as follows:
        - 18% = (100% × 1/10) / (50%×1+50%×1/10), where:
            - "(100% × 1/10)" is the exposure adjustment for the 100% of workers wearing APF 10 respirators under the WCPP and the "(50%×1+50%×1/10)" is the baseline exposure relative to the risk evaluation estimates for exposure without PPE

Table 8-7: Exposure Under the WCPP as a Percentage of Baseline Exposure, by Monitoring Threshold

Sector	1 to <10 times the ECEL	10 to <25 times the ECEL	25 to <50 times the ECEL	50 to <1,000 times the ECEL	1,000+ times the ECEL
Manufacturing	11.5%	4.8%	2.5%	0.1%	0.01%
Transportation and Public Utilities	10.4%	4.2%	2.1%	0.1%	0.01%
Services	10.3%	4.1%	2.1%	0.1%	0.01%
Note: Estimates for the transportation and public utilities sector estimates are used for disposal to wastewater. The services sector estimates are used for aerosol spray cleaning/degreasing and Spot Removers. All other use categories use the manufacturing sector estimates.					

The supplemental exposure files for the final risk evaluation included central (median) and high-end (95th percentile) 8-hour time weighted average exposure estimates for each of the use category/exposure type combinations listed above in Table 8-4 (EPA 2020l). The estimated percentages of workers and ONUs in each ECEL threshold category was estimated from these median and 95th percentile values by assuming a lognormal distribution[16] for exposure (see the estimated percentages of workers and ONUs in each ECEL threshold category presented in Table 8-8).

Table 8-9 presents the mean increase in the LADC for the use categories affected by WCPP requirements under the regulatory options, disaggregated by the ECEL threshold levels, from one year of *baseline*

[16]Measured concentrations of various contaminants are very often found to have frequency distributions that are log-normal, including indoor-air contaminants (Ott 1990). Ott (1990) also provides a physical explanation for why some common processes in nature, including processes relevant to indoor air pollutant concentrations, can explain why lognormal distributions arise naturally. Therefore, EPA believes assuming exposure levels follow a log-normal distribution is a reasonable approach.

occupational exposure. Table 8-10 presents the mean increase in the LADC from one year of exposure *with compliance with the WCPP*. Table 8-11 presents the incremental reductions in the mean LADCs under the WCPP (i.e., the difference between the LADCs presented in Table 8-9 and Table 8-10).

Table 8-8: Estimated Percentage of Workers and ONUs by ECEL Threshold Category

Use Category	Exposure Type	<Action Level	Between Action Level and Limit	1 to <10 times the ECEL	10 to <25 times the ECEL	25 to <50 times the ECEL	50 to <1,000 times the ECEL	1,000+ times the ECEL
Option 1 (ECEL Threshold 0.20 ppm)								
Manufacturing	Worker	47%	14%	32%	4%	2%	1%	-
Battery and Synthetic Paper Processing Aid	Worker	-	-	4%	31%	39%	26%	-
Battery and Synthetic Paper Processing Aid	ONU	-	-	51%	47%	2%	-	-
HFC Manufacturing	Worker	47%	14%	32%	4%	2%	1%	-
Fluoroelastomer Manufacture	Worker	-	-	4%	31%	39%	26%	-
Fluoroelastomer Manufacture	ONU	-	-	51%	47%	2%	-	-
Open-Top Vapor Degreasing	Worker	-	-	3%	13%	21%	63%	-
Open-Top Vapor Degreasing	ONU	3%	6%	58%	21%	7%	5%	-
Enclosed Vapor Degreasing	Worker	1%	10%	88%	1%	-	-	-
Disposal to Wastewater	Worker	87%	2%	7%	1%	1%	2%	-
Incorp. Into Formulation, Mixture, or Reaction Product	Worker	87%	2%	7%	1%	1%	2%	-
Aerosol Spray Cleaning/Degreasing	Worker	-	-	1%	25%	45%	29%	-
Aerosol Spray Cleaning/Degreasing	ONU	39%	25%	36%	-	-	-	-
Adhesives, Sealants, Paints and Coatings	Worker	-	-	25%	27%	20%	28%	-
Adhesives, Sealants, Paints and Coatings	ONU	-	-	100%	-	-	-	-
Option 2 (ECEL Threshold 0.0011 ppm)								

Table 8-8: Estimated Percentage of Workers and ONUs by ECEL Threshold Category

Use Category	Exposure Type	<Action Level	Between Action Level and Limit	1 to <10 times the ECEL	10 to <25 times the ECEL	25 to <50 times the ECEL	50 to <1,000 times the ECEL	1,000+ times the ECEL
Manufacturing	Worker	-	-	10%	12%	12%	54%	12%
Battery and Synthetic Paper Processing Aid	Worker	-	-	-	-	-	-	100%
Battery and Synthetic Paper Processing Aid	ONU	-	-	-	-	-	11%	89%
HFC Manufacturing	Worker	-	-	10%	12%	12%	54%	12%
Intermediate in HCL Production	Worker	-	-	10%	12%	12%	54%	12%
Fluoroelastomer Manufacture	Worker	-	-	-	-	-	-	100%
Fluoroelastomer Manufacture	ONU	-	-	-	-	-	11%	89%
Open-Top Vapor Degreasing	Worker	-	-	-	-	-	-	100%
Open-Top Vapor Degreasing	ONU	-	-	-	-	-	49%	51%
Enclosed Vapor Degreasing	Worker	-	-	-	-	-	89%	11%
Disposal to Wastewater	Worker	50%	6%	18%	6%	4%	10%	6%
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	50%	6%	18%	6%	4%	10%	6%
Aerosol Spray Cleaning/Degreasing	Worker	-	-	-	-	-	-	100%
Aerosol Spray Cleaning/Degreasing	ONU	-	-	1%	6%	14%	76%	3%
Adhesives, Sealants, Paints and Coatings	Worker	-	-	-	-	-	13%	87%
Adhesives, Sealants, Paints and Coatings	ONU	-	-	-	-	-	100%	-

Table 8-9: Estimated Baseline Increase in LADC from One Year of Occupational Exposure, by Facility ECEL Threshold Category (adjusted for baseline PPE Use)

Use Category	Exposure Type	Median and 95% LADC Across all Facilities		<Action Level	Between Action Level and Limit	1 to <10 times the ECEL	10 to <25 times the ECEL	25 to <50 times the ECEL	50 to <1,000 times the ECEL	1,000+ times the ECEL	Average Across All Thresholds[1]
		Median	95th Percentile								
Option 1 (ECEL Threshold 0.20 ppm)											
Manufacturing	Worker	0.010435	0.287905	0.000080	0.000309	0.001328	0.006061	0.014966	0.034282	-	0.001390
Battery and Synthetic Paper Processing Aid	Worker	0.578745	2.249289	-	-	0.003595	0.007685	0.015166	0.033142	-	0.017058
Battery and Synthetic Paper Processing Aid	ONU	0.178562	0.509828	-	-	0.003029	0.006248	0.012130	-	-	0.004724
HFC Manufacturing	Worker	0.010435	0.287905	0.000080	0.000309	0.001328	0.006061	0.014966	0.034282	-	0.001390
Fluoroelastomer Manufacture	Worker	0.578745	2.249289	-	-	0.003595	0.007685	0.015166	0.033142	-	0.017058
Fluoroelastomer Manufacture	ONU	0.178562	0.509828	-	-	0.003029	0.006248	0.012130	-	-	0.004724
Open-Top Vapor Degreasing	Worker	1.252195	9.104631	-	-	0.003347	0.007614	0.015600	0.074375	-	0.051222
Open-Top Vapor Degreasing	ONU	0.100455	1.064432	0.000168	0.000339	0.001846	0.006743	0.014769	0.036407	-	0.005366
Enclosed Vapor Degreasing	Worker	0.041538	0.170254	0.000191	0.000332	0.001326	0.005014	-	-	-	0.001252
Disposal to Wastewater	Worker	0.000045	0.133474	0.000018	0.000368	0.001899	0.008977	0.020261	0.055802	-	0.001564
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	0.000045	0.133474	0.000015	0.000303	0.001564	0.007393	0.016688	0.045961	-	0.001288
Aerosol Spray Cleaning/Degreasing	Worker	0.653000	2.209000	-	-	0.005124	0.010412	0.020105	0.041646	-	0.023779
Aerosol Spray Cleaning/Degreasing	ONU	0.012000	0.093000	0.000149	0.000397	0.001414	-	-	-	-	0.000667
Adhesives, Sealants, Paints and Coatings	Worker	0.420688	4.623562	-	-	0.002301	0.007077	0.015376	0.062732	-	0.023126
Adhesives, Sealants, Paints and Coatings	ONU	0.085398	0.117082	-	-	0.002012	-	-	-	-	0.002012
Option 2 (ECEL Threshold 0.0011 ppm)											

Table 8-9: Estimated Baseline Increase in LADC from One Year of Occupational Exposure, by Facility ECEL Threshold Category (adjusted for baseline PPE Use)

Use Category	Exposure Type	Median and 95% LADC Across all Facilities		<Action Level	Between Action Level and Limit	1 to <10 times the ECEL	10 to <25 times the ECEL	25 to <50 times the ECEL	50 to <1,000 times the ECEL	1,000+ times the ECEL	Average Across All Thresholds[1]
		Median	95th Percentile								
Manufacturing	Worker	0.010435	0.287905	-	-	0.000013	0.000041	0.000086	0.000624	0.008643	0.001390
Battery and Synthetic Paper Processing Aid	Worker	0.578745	2.249289	-	-	-	-	-	-	0.017058	0.017058
Battery and Synthetic Paper Processing Aid	ONU	0.178562	0.509828	-	-	-	-	-	0.001936	0.005068	0.004724
HFC Manufacturing	Worker	0.010435	0.287905	-	-	0.000013	0.000041	0.000086	0.000624	0.008643	0.001390
Intermediate in HCL Production	Worker	0.010435	0.287905	-	-	0.000013	0.000041	0.000086	0.000624	0.008643	0.001390
Fluoroelastomer Manufacture	Worker	0.578745	2.249289	-	-	-	-	-	-	0.017058	0.017058
Fluoroelastomer Manufacture	ONU	0.178562	0.509828	-	-	-	-	-	0.001936	0.005068	0.004724
Open-Top Vapor Degreasing	Worker	1.252195	9.104631	-	-	-	-	-	-	0.051222	0.051222
Open-Top Vapor Degreasing	ONU	0.100455	1.064432	-	-	-	-	-	0.001073	0.009491	0.005366
Enclosed Vapor Degreasing	Worker	0.041538	0.170254	-	-	-	-	-	0.000997	0.003316	0.001252
Disposal to Wastewater	Worker	0.000045	0.133474	0.000000	0.000002	0.000011	0.000047	0.000107	0.000684	0.024777	0.001564
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	0.000045	0.133474	0.000000	0.000002	0.000009	0.000039	0.000088	0.000563	0.020408	0.001288
Aerosol Spray Cleaning/Degreasing	Worker	0.653000	2.209000	-	-	-	-	-	-	0.023779	0.023779
Aerosol Spray Cleaning/Degreasing	ONU	0.012000	0.093000	-	-	0.000029	0.000057	0.000116	0.000682	0.004280	0.000667
Adhesives, Sealants, Paints and Coatings	Worker	0.420688	4.623562	-	-	-	-	-	0.001428	0.026369	0.023126
Adhesives, Sealants, Paints and Coatings	ONU	0.085398	0.117082	-	-	-	-	-	0.002012	-	0.002012

[1]This average value is the weighted average across the 7 thresholds (weighted using the percentages presented in Table 8-8) and is the same as the value shown in Table 8-6.

Table 8-10: Estimated Post-Compliance Increase in LADC from One Year of Occupational Exposure Under a WCPP, by Facility ECEL Threshold Category

Use Category	Exposure Type	<Action Level[1]	Between Action Level and Limit[1]	1 to <10 times the ECEL[2]	10 to <25 times the ECEL[2]	25 to <50 times the ECEL[2]	50 to <1,000 times the ECEL[2]	1,000+ times the ECEL[2]	Average Across All Thresholds[3]
Option 1 (ECEL Threshold 0.20 ppm)									
Manufacturing	Worker	0.000080	0.000309	0.000153	0.000288	0.000372	0.000046	-	0.000149
Battery and Synthetic Paper Processing Aid	Worker	-	-	0.000415	0.000365	0.000377	0.000045	-	0.000289
Battery and Synthetic Paper Processing Aid	ONU	-	-	0.000350	0.000297	0.000302	-	-	0.000324
HFC Manufacturing	Worker	0.000080	0.000309	0.000153	0.000288	0.000372	0.000046	-	0.000149
Fluoroelastomer Manufacture	Worker	-	-	0.000415	0.000365	0.000377	0.000045	-	0.000289
Fluoroelastomer Manufacture	ONU	-	-	0.000350	0.000297	0.000302	-	-	0.000324
Open-Top Vapor Degreasing	Worker	-	-	0.000387	0.000362	0.000388	0.000100	-	0.000203
Open-Top Vapor Degreasing	ONU	0.000168	0.000339	0.000213	0.000321	0.000367	0.000049	-	0.000245
Enclosed Vapor Degreasing	Worker	0.000191	0.000332	0.000153	0.000238	-	-	-	0.000172
Disposal to Wastewater	Worker	0.000018	0.000368	0.000219	0.000427	0.000504	0.000075	-	0.000049
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	0.000015	0.000303	0.000181	0.000352	0.000415	0.000062	-	0.000040
Aerosol Spray Cleaning/Degreasing	Worker	-	-	0.000592	0.000495	0.000500	0.000056	-	0.000371
Aerosol Spray Cleaning/Degreasing	ONU	0.000149	0.000397	0.000163	-	-	-	-	0.000216
Adhesives, Sealants, Paints and Coatings	Worker	-	-	0.000266	0.000337	0.000382	0.000084	-	0.000257
Adhesives, Sealants, Paints and Coatings	ONU	-	-	0.000232	-	-	-	-	0.000232
Option 2 (ECEL Threshold 0.0011 ppm)									

Table 8-10: Estimated Post-Compliance Increase in LADC from One Year of Occupational Exposure Under a WCPP, by Facility ECEL Threshold Category

Use Category	Exposure Type	<Action Level[1]	Between Action Level and Limit[1]	1 to <10 times the ECEL[2]	10 to <25 times the ECEL[2]	25 to <50 times the ECEL[2]	50 to <1,000 times the ECEL[2]	1,000+ times the ECEL[2]	Average Across All Thresholds[3]
Manufacturing	Worker	-	-	0.0000015	0.0000019	0.0000021	0.0000008	0.0000012	0.0000012
Battery and Synthetic Paper Processing Aid	Worker	-	-	-	-	-	-	0.0000023	0.0000023
Battery and Synthetic Paper Processing Aid	ONU	-	-	-	-	-	0.0000026	0.0000007	0.0000009
HFC Manufacturing	Worker	-	-	-	-	-	0.0000014	0.0000013	0.0000014
Intermediate in HCL Production	Worker	-	-	0.0000026	0.0000021	0.0000022	0.0000007	0.0000005	0.0000010
Fluoroelastomer Manufacture	Worker	-	-	-	-	-	-	0.0000023	0.0000023
Fluoroelastomer Manufacture	ONU	-	-	0.0000026	0.0000021	0.0000022	0.0000007	0.0000005	0.0000010
Open-Top Vapor Degreasing	Worker	-	-	-	-	-	-	0.0000070	0.0000070
Open-Top Vapor Degreasing	ONU	-	-	-	-	-	0.0000014	0.0000013	0.0000014
Enclosed Vapor Degreasing	Worker	-	-	-	-	-	0.0000013	0.0000005	0.0000012
Disposal to Wastewater	Worker	0.0000002	0.0000020	0.0000012	0.0000022	0.0000027	0.0000009	0.0000034	0.0000010
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	0.0000002	0.0000016	0.0000010	0.0000018	0.0000022	0.0000008	0.0000028	0.0000008
Aerosol Spray Cleaning/Degreasing	Worker	-	-	-	-	-	-	0.0000033	0.0000033
Aerosol Spray Cleaning/Degreasing	ONU	-	-	0.0000034	0.0000027	0.0000029	0.0000009	0.0000006	0.0000013
Adhesives, Sealants, Paints and Coatings	Worker	-	-	-	-	-	0.0000019	0.0000036	0.0000034
Adhesives, Sealants, Paints and Coatings	ONU	-	-	-	-	-	0.0000027	-	0.0000027

[1]These values are the same as those shown in Table 8-9, since steps to reduce exposure are not required when monitoring results indicate that exposure is below the ECEL.
[2]These values are calculated by multiplying the baseline exposure estimates in Table 8-9 by the corresponding percentage shown in Table 8-7.
[3]This average value is the weighted average across the 7 thresholds.

Table 8-11: Estimated Incremental Reduction in LADC from One Year of Occupational Exposure Under a WCPP, by Facility ECEL Threshold Category[1]

Use Category	Exposure Type	<Action Level	Between Action Level and Limit	1 to <10 times the ECEL	10 to <25 times the ECEL	25 to <50 times the ECEL	50 to <1,000 times the ECEL	1,000+ times the ECEL	Average Across All Thresholds
Option 1 (ECEL Threshold 0.20 ppm)									
Manufacturing	Worker	-	-	0.001174	0.005772	0.014594	0.034235	-	0.001241
Battery and Synthetic Paper Processing Aid	Worker	-	-	0.003180	0.007320	0.014789	0.033097	-	0.016769
Battery and Synthetic Paper Processing Aid	ONU	-	-	0.002679	0.005951	0.011828	-	-	0.004400
HFC Manufacturing	Worker	-	-	0.001174	0.005772	0.014594	0.034235	-	0.001241
Fluoroelastomer Manufacture	Worker	-	-	0.003180	0.007320	0.014789	0.033097	-	0.016769
Fluoroelastomer Manufacture	ONU	-	-	0.002679	0.005951	0.011828	-	-	0.004400
Open-Top Vapor Degreasing	Worker	-	-	0.002961	0.007252	0.015212	0.074275	-	0.051019
Open-Top Vapor Degreasing	ONU	-	-	0.001633	0.006422	0.014402	0.036358	-	0.005122
Enclosed Vapor Degreasing	Worker	-	-	0.001173	0.004776	-	-	-	0.001080
Disposal to Wastewater	Worker	-	-	0.001679	0.008550	0.019757	0.055727	-	0.001515
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	-	-	0.001383	0.007042	0.016273	0.045899	-	0.001248
Aerosol Spray Cleaning/Degreasing	Worker	-	-	0.004532	0.009917	0.019605	0.041590	-	0.023408
Aerosol Spray Cleaning/Degreasing	ONU	-	-	0.001251	-	-	-	-	0.000450
Adhesives, Sealants, Paints and Coatings	Worker	-	-	0.002036	0.006741	0.014994	0.062648	-	0.022869
Adhesives, Sealants, Paints and Coatings	ONU	-	-	0.001780	-	-	-	-	0.001780
Option 2 (ECEL Threshold 0.0011 ppm)									

Table 8-11: Estimated Incremental Reduction in LADC from One Year of Occupational Exposure Under a WCPP, by Facility ECEL Threshold Category[1]

Use Category	Exposure Type	<Action Level	Between Action Level and Limit	1 to <10 times the ECEL	10 to <25 times the ECEL	25 to <50 times the ECEL	50 to <1,000 times the ECEL	1,000+ times the ECEL	Average Across All Thresholds
Manufacturing	Worker	-	-	0.000011	0.000039	0.000084	0.000623	0.008642	0.001389
Battery and Synthetic Paper Processing Aid	Worker	-	-	-	-	-	-	0.017055	0.017055
Battery and Synthetic Paper Processing Aid	ONU	-	-	-	-	-	0.001933	0.005067	0.004723
HFC Manufacturing	Worker	-	-	0.000011	0.000039	0.000084	0.000623	0.008642	0.001389
Intermediate in HCL Production	Worker	-	-	0.000011	0.000039	0.000084	0.000623	0.008642	0.001389
Fluoroelastomer Manufacture	Worker	-	-	-	-	-	-	0.017055	0.017055
Fluoroelastomer Manufacture	ONU	-	-	-	-	-	0.001933	0.005067	0.004723
Open-Top Vapor Degreasing	Worker	-	-	-	-	-	-	0.051215	0.051215
Open-Top Vapor Degreasing	ONU	-	-	-	-	-	0.001072	0.009489	0.005365
Enclosed Vapor Degreasing	Worker	-	-	-	-	-	0.000995	0.003315	0.001251
Disposal to Wastewater	Worker	-	-	0.000009	0.000045	0.000104	0.000683	0.024774	0.001563
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	-	-	0.000008	0.000037	0.000086	0.000562	0.020405	0.001288
Aerosol Spray Cleaning/Degreasing	Worker	-	-	-	-	-	-	0.023775	0.023775
Aerosol Spray Cleaning/Degreasing	ONU	-	-	0.000026	0.000055	0.000113	0.000681	0.004279	0.000665
Adhesives, Sealants, Paints and Coatings	Worker	-	-	-	-	-	0.001426	0.026365	0.023123
Adhesives, Sealants, Paints and Coatings	ONU	-	-	-	-	-	0.002009	-	0.002009

[1]The estimates presented in this table are calculated as the difference between the values in Table 8-9 and Table 8-10.

8.4 Excess Cancer Risk Estimates

The excess cancer risk estimates used in this analysis are the same as used in EPA's 2016 and 2017 proposed TCE rules (EPA 2016a, 2017a). Typically, for cancer effects resulting from exposure through the inhalation route, the EPA Integrated Risk Information System (IRIS) derives an inhalation unit risk. This is an upper-bound estimate (not a true confidence limit) of the excess risk of cancer due to lifetime exposure to the chemical through the inhalation route at a unit of concentration (e.g., 1 $\mu g/m^3$). In the case of TCE, the IRIS derived inhalation unit risk of 2 x 10-2 per ppm (or 4 x 10-6 per $\mu g/m^3$) is based on kidney cancer (renal cell carcinoma), but it is also adjusted for potential risks for Non-Hodgkin Lymphoma (NHL) and liver cancer (EPA 2014b). The EPA's (2014b) risk assessment used this adjusted inhalation unit risk as the input for the occupational cancer estimates in the risk assessment (EPA 2014b). Therefore, the inhalation unit risk used in EPA's (2014b) risk assessment is an upper bound estimate on the risk of developing kidney, liver or NHL cancers after a lifetime of continuous exposure to TCE at a concentration of 1 ppm in air.

For the purposes of benefits estimation, it is desirable to have estimates of the number of cancer cases broken down by cancer type, as treatment profiles and survival rates for various cancers differ. Therefore, for the purpose of estimating benefits for the rule, rather than simply using the unit risk values for combined cancer presented in EPA's (2014b) risk assessment, this economic analysis instead uses estimates of the risk per unit of TCE exposure for developing kidney, liver, and NHL cancer individually. Additionally, the economic analysis uses the central estimate of this risk in order to derive an arithmetic mean "expected value" estimate of the health benefits due to the avoided cancer cases.

A weighted linear regression model was used by IRIS to model the exposure-response data on kidney cancer (renal cell carcinoma) incidence to obtain a slope estimate (regression coefficient) for the relative risk of renal cell carcinoma versus cumulative exposure. The regression coefficient was used in a lifetable analysis to estimate the lowest effective concentration corresponding to an extra risk of 1% (LEC_{01}), which was used as the (point of departure) POD for linear extrapolation to generate the unit risk estimate.

The linear regression coefficient was calculated using a one-way 95% upper confidence limit, and therefore it does not include a lower confidence limit for the estimate. Since this approach does not estimate a lower bound, the lower confidence limit is assumed to be zero.

Table 8-12: Excess Cancer Risk

Cancer Type	Average Ratio to Kidney (RCC) Extra Risk Estimates	Upper Bound (risk per ppm)	Central Estimate (risk per ppm)[1]	Lower Estimate (risk per ppm)
Kidney Cancer	-	5.49 x 10-3	2.60 x 10-3	0
Non-Hodgkin Lymphoma	2	1.10 x 10-2	5.19 x 10-3	0
Liver Cancer	1	5.49 x 10-3	2.59 x 10-3	0

[1] Central risk estimates were calculated by reducing the upper bound estimates for NHL and liver cancer by the ratio of the central unit risk estimate for RCC to the upper bound risk estimate for RCC.

Sources: Appendix C of U.S. Environmental Protection Agency (EPA) 2011b; Raaschou-Nielsen, Hansen et al. 2003

As with renal cell carcinoma, to include NHL and liver cancer in the benefits analysis, it is preferable to have upper, lower, and central estimates of risk for each cancer type. However, the IRIS TCE Review did not present individual unit risks for these cancers. Instead, EPA adjusted the individual excess risks for renal cell carcinoma (5.49 x 10^{-3} per ppm) to account for these additional cancers. This approach was taken because the available data were not sufficient to derive dose-response functions to obtain the necessary risk estimates.

EPA stated that the epidemiologic studies provide information to estimate the "*relative* potency of TCE across tumor sites" (EPA 2011b, pp. 5-147) as opposed to the actual potency. Therefore, this analysis uses the relative potency ratios estimated by EPA IRIS to estimate an inhalation excess cancer risk for each cancer relative to the inhalation unit risk for renal cell carcinoma. This uses the same information from the IRIS TCE review, but presents the results in a way that is more suitable for benefits estimation.

EPA IRIS estimated the relative contributions to extra risk (for cancer incidence) from two different data sets to derive the factor for adjusting the unit risk estimate for renal cell carcinoma to a unit risk estimate for the three types of cancers (renal cell carcinoma, NHL, and liver) combined. The first calculation is based on the results of the meta-analyses of human epidemiologic data for the three cancer types (see Appendix C of EPA 2011b); the second calculation is based on the results of the Raaschou-Nielsen, Hansen et al. (2003) study, the largest human epidemiologic study with relative risk estimates for all three cancer types.

In order to obtain the upper, lower, and central estimates of risk for NHL and liver cancer, the analysis used the ratios of the extra risks for each cancer compared to the extra risk for renal cell carcinoma to modify the upper bound estimates of the inhalation unit risk for renal cell carcinoma. This is consistent with the approach that EPA IRIS took to adjust the renal cell carcinoma inhalation unit risk for NHL and liver cancer. The resulting inhalation unit risks for NHL and liver cancer are presented in the second and third rows of Table 8-12. This calculation is based on the rounded results from EPA IRIS, and the RCC estimates in Table 8-12.

Because of the complexities of the IRIS derivations of inhalation unit risks (dose-response data from multiple species and studies, multi-tumor analyses, physiologically based pharmacokinetic (PBPK) modeling with different internal dose metrics for each tumor type, and animal-to-human extrapolation), the proportional adjustments applied here to estimate a central risk may have under- or over-estimated the true central risk.

8.5 Microrisk Reductions for Kidney Cancer, Non-Hodgkin Lymphoma, and Liver Cancer per Individual Attributable to Reducing TCE Exposure Under the Regulatory Options

This section presents the estimated reductions in cancer risk per individual attributable to reducing TCE exposure under the regulatory options. The estimated risk reductions are presented in terms of microrisk reductions, where a microrisk is equivalent to reducing the risk for a case of cancer by one in one million. The microrisk reductions are calculated by combining the changes in the LADCs presented above in Table 8-6 and Table 8-11 with the excess cancer risk estimates presented in Table 8-12.

Table 8-13 and Table 8-14 present the estimates for the microrisk reductions per exposed individual under a scenario for eliminating one year of exposure (Table 8-13) and under a scenario for reducing exposure for one year under a WCPP (Table 8-14), by use category, exposure type, and cancer site from one year of exposure. As noted above, the microrisk reductions are calculated by combining the changes in the LADCs presented above in Table 8-6 and Table 8-11 with the excess cancer risk estimates presented in Table 8-12, and applying the baseline PPE adjustments presented in Table 8-5. For example, the low estimate for the NHL microrisk reduction of 7.22 in the Manufacturing row of Table 8-13 is calculated as 0.0013904 × (5.19 × 10E-3) × 1,000,000.

Table 8-13: Reduced Microrisk Per Exposed Individual from Eliminating One Year of Exposure, by cancer site

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver
Manufacturing	Worker	3.62	7.22	3.60
Import/Repackage	Worker	3.35	6.69	3.34
Battery and Synthetic Paper Processing Aid	Worker	44.35	88.53	44.18
Battery and Synthetic Paper Processing Aid	ONU	12.28	24.52	12.23
HFC Manufacturing	Worker	3.62	7.22	3.60
Intermediate in HCl Production	Worker	3.62	7.22	3.60
Fluoroelastomer Manufacture	Worker	44.35	88.53	44.18
Fluoroelastomer Manufacture	ONU	12.28	24.52	12.23
Open-Top Vapor Degreasing	Worker	133.18	265.84	132.67
Open-Top Vapor Degreasing	ONU	13.95	27.85	13.90
Enclosed Vapor Degreasing	Worker	3.25	6.50	3.24
Conveyorized Vapor Degreasing	Worker	185.25	369.78	184.53
Web Vapor Degreasing	Worker	34.32	68.51	34.19
Web Vapor Degreasing	ONU	19.26	38.44	19.19
Batch Cold Cleaning	Worker	63.19	126.13	62.94
Batch Cold Cleaning	ONU	38.43	76.71	38.28
Disposal to Wastewater	Worker	4.07	8.12	4.05
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	3.35	6.69	3.34
Mold Release	Worker	47.46	94.73	47.27
Mold Release	ONU	1.33	2.66	1.33
Liquid Cleaners and Degreasers	Worker	5.95	11.89	5.93
Liquid Cleaners and Degreasers	ONU	3.23	6.45	3.22
Aerosol Spray Cleaning/Degreasing	Worker	61.82	123.41	61.59
Aerosol Spray Cleaning/Degreasing	ONU	1.73	3.46	1.73
Lubricants and Greases	Worker	47.46	94.73	47.27
Lubricants and Greases	ONU	1.33	2.66	1.33
Adhesives, Sealants, Paints and Coatings	Worker	60.13	120.03	59.90
Adhesives, Sealants, Paints and Coatings	ONU	5.23	10.44	5.21
Spot Removers	Worker	7.76	15.48	7.73
Spot Removers	ONU	4.21	8.41	4.19

Table 8-14: Reduced Microrisk Per Exposed Individual from One Year of Reduced Exposure Under a WCPP, by Option and cancer site

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver
Option 1 (ECEL Threshold 0.20 ppm)				
Manufacturing	Worker	3.23	6.44	3.21
Battery and Synthetic Paper Processing Aid	Worker	43.60	87.03	43.43
Battery and Synthetic Paper Processing Aid	ONU	11.44	22.83	11.39
HFC Manufacturing	Worker	3.23	6.44	3.21
Fluoroelastomer Manufacture	Worker	43.60	87.03	43.43
Fluoroelastomer Manufacture	ONU	11.44	22.83	11.39
Open-Top Vapor Degreasing	Worker	132.65	264.79	132.14
Open-Top Vapor Degreasing	ONU	13.32	26.58	13.26
Enclosed Vapor Degreasing	Worker	2.81	5.60	2.80
Disposal to Wastewater	Worker	3.95	7.88	3.93
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	3.24	6.48	3.23
Aerosol Spray Cleaning/Degreasing	Worker	61.01	121.78	60.77
Aerosol Spray Cleaning/Degreasing	ONU	1.19	2.37	1.18
Adhesives, Sealants, Paints and Coatings	Worker	59.46	118.69	59.23
Adhesives, Sealants, Paints and Coatings	ONU	4.63	9.24	4.61
Option 2 (ECEL Threshold 0.0011ppm)				
Manufacturing	Worker	3.61	7.21	3.60
Battery and Synthetic Paper Processing Aid	Worker	44.34	88.52	44.17
Battery and Synthetic Paper Processing Aid	ONU	12.28	24.51	12.23
HFC Manufacturing	Worker	3.61	7.21	3.60
Intermediate in HCL Production	Worker	3.61	7.22	3.60
Fluoroelastomer Manufacture	Worker	44.34	88.52	44.17
Fluoroelastomer Manufacture	ONU	12.28	24.51	12.23
Open-Top Vapor Degreasing	Worker	133.16	265.81	132.65
Open-Top Vapor Degreasing	ONU	13.95	27.84	13.89
Enclosed Vapor Degreasing	Worker	3.25	6.49	3.24
Disposal to Wastewater	Worker	4.06	8.11	4.05
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	3.35	6.68	3.33
Aerosol Spray Cleaning/Degreasing	Worker	61.82	123.40	61.58
Aerosol Spray Cleaning/Degreasing	ONU	1.73	3.45	1.72
Adhesives, Sealants, Paints and Coatings	Worker	60.12	120.01	59.89
Adhesives, Sealants, Paints and Coatings	ONU	5.22	10.43	5.20

8.6 Value of Microrisk Reductions for Kidney Cancer, Non-Hodgkin Lymphoma, and Liver Cancer

Table 8-15 presents the low and high estimated monetized values for a cancer microrisk reduction by sector, cancer site, and discount rate. The derivation of these estimates is described in the Abt Associates (2023) report, Estimated Values of Avoiding Cancer Risks by Cancer Site and Population. The values are estimated from willingness-to-pay values found in the literature. A value of $0.43 is used for the low estimate for avoiding a non-fatal liver cancer microrisk (Bosworth, Cameron et al. 2009). A value of $7.57 is used for the low and high estimate for avoiding a non-fatal non-Hodgkin lymphoma cancer microrisk and the high estimate for avoiding a non-fatal liver cancer microrisk (Magat, Viscusi et al.

1996). A value of $0.71 is used for the low and high estimate for avoiding a non-fatal kidney cancer risk (Bosworth, Cameron et al. 2009).

The value for mortality risk, $12.98, is estimated using EPA's (2014a) recommended value for a statistical life (VSL) of $4.8 million in 1990 dollars and EPA's (2014a) recommended method for adjusting the VSL for income growth and inflation. Specifically, the $4.8 million in 1990 dollars is adjusted for inflation using the Consumer Price Index (U.S. BLS 2023a) and then adjusted for income growth using real GDP per capita (U.S. Bureau of Economic Analysis 2023a) and an income elasticity of 0.4.[17]

As noted in the Abt Associates (2023) report, there is very little peer-reviewed literature available on the timing between exposure and diagnosis and exposure and death (for fatal cancer cases). This timing is important in benefits analysis in order to discount the values of future reduced cancer risks so that they can be compared with costs incurred near the time of exposure. The methods for estimating the timing between exposure, diagnosis, and death (and the probability cancer is fatal), are described in the Abt Associates (2023) report, *Estimated Values of Avoiding Cancer Risks by Cancer Site and Population*. As described in Abt Associates (2023) report, the timing between exposure, diagnosis, and death (for fatal cancer) depend on the age at the time of exposure. Thus, the values differ slightly across the affected population sector because the ages of the populations differ.

Table 8-15: Value for Microrisk Reductions (2022$)

Affected Population Sector	Cancer Site	Estimated Value for a 1/1,000,000 Reduction in Cancer Risk					
		Low Estimate			High Estimate		
		2%	3%	7%	2%	3%	7%
Manufacturing	Kidney	$3.61	$2.87	$1.37	$3.61	$2.87	$1.37
	Non-Hodgkin Lymphoma	$6.16	$4.94	$2.40	$6.16	$4.94	$2.40
	Liver	$7.51	$6.08	$3.07	$7.83	$6.35	$3.22
Transportation and Public Utilities	Kidney	$3.60	$2.87	$1.37	$3.60	$2.87	$1.37
	Non-Hodgkin Lymphoma	$6.16	$4.93	$2.40	$6.16	$4.93	$2.40
	Liver	$7.50	$6.08	$3.07	$7.82	$6.34	$3.22
Services	Kidney	$3.54	$2.82	$1.35	$3.54	$2.82	$1.35
	Non-Hodgkin Lymphoma	$6.06	$4.84	$2.37	$6.06	$4.84	$2.37
	Liver	$7.34	$5.91	$2.96	$7.66	$6.17	$3.10
Source: Abt Associates 2023							

8.7 Total Benefits

Total benefits from one year of exposure reduction from either eliminating exposure or reducing it with a WCPP are presented in Table 8-16 through Table 8-27. The regulatory options require different combinations of these exposure reduction measures in some cases (see Table 8-1; *e.g.*, under Option 1 battery manufacturers would comply with a WCPP for the first 9 years of the analytical timeframe and then eliminate TCE use for the last 11 years). Thus the benefits under the regulatory options presented in Table 8-28 through Table 8-30 reflect the combinations of the exposure reduction benefits presented in Table 8-16 through Table 8-27, which are annualized over the 20-year analytical timeframe.

[17] The consumer price index increased by 123.91% between 1990 and 2020, so $4.8 million (1990$) is converted to $10.75 million (2022$) after adjusting for inflation. GDP per capita increased by 60.16% between 1990 and 2021, and this analysis uses EPA's (2014a) recommended income elasticity of 0.4 to calculate the income adjustment factor of 1.20732 (=1.6016^0.4). Thus, the $10.75 million (2022$) is adjusted for income growth using an adjustment factor of 1.20732, and the resulting estimate is $12.98 million.

Figure 8-2: Example Explaining How the Option 1 Low 2% 20-Year Annualized Value of $11 for the Manufacturing Use Category in Table 8-20 was Calculated

1 Estimate Number of Affected Individuals	**Section 8.2** For example, there are an estimated 140 individuals with baseline exposure in the Manufacturing Use Category (See Table 8-3).
2 Estimate Change in Exposure Under the Options	**Section 8.3** For example, the baseline exposure for manufacturing is 0.00139 ppm (see Table 8-6). As shown in Table 8-8, exposure is distributed across workers in six ECEL threshold categories: (1) <Action Level (47% of workers), (2) Between Action Level and Limit (14% of workers), (3) Between ECEL and 10 times the ECEL (32% of workers), (4) 10 to <50 times the ECEL (4% of workers), (5) 50 to <1,000 times the ECEL(2% of workers), (6) 1,000 to 10,000 times the ECEL (1% of workers). As indicated in Table 8-7, exposure under the ECEL as a percentage of baseline exposure is as follows: (1) Between ECEL and 10 times the ECEL (11.5%), (2) 10 to <50 times the ECEL (4.8%), (3) 50 to <1,000 times the ECEL(2.5%), (4) 1,000 to 10,000 times the ECEL (0.1%) Given this, the baseline exposure under the WCPP is 0.000149 (see Table 8-10), which is calculated as 47%*8.03E-05 + 14%*3.09E-04 + 32%*1.53E-04 + 4%*2.88E-04 + 2%*3.72E-04 + 1%*4.62E-05. Thus, the incremental change in exposure is 1.241E-03 ppm (see Table 8-11; calculated as 1.390E-03 - 1.495E-04).
3 Estimate Relationship Between Exposure and Cancer Risks	**Section 8.4** For example, excess risk is 2.60E-03 for kidney cancer, 5.19E-03 for NHL, and 2.59E-03 for liver cancer, as shown in Table 8-12.
4 Estimate Change in Cancer Risk from Exposure Reductions	**Section 8.5** For example, the low estimate for reduced kidney cancer risk of 3.23 shown in Table 8-14 is calculated as the product of: • 2.60E-03 (Excess kidney cancer estimate shown in Table 8-12) • 1.241E-03 ppm (the change in exposure, in ppm, from Table 8-14) • 1,000,000 (to convert from risk to microrisk) For example, the low estimate for reduced NHL risk of 6.44 shown in

Figure 8-2: Example Explaining How the Option 1 Low 2% 20-Year Annualized Value of $11 for the Manufacturing Use Category in Table 8-20 was Calculated

	Table 8-14 is calculated as the product of: • 5.19E-03 (Excess kidney cancer estimate shown in Table 8-12) • 1.241E-03 ppm (the change in exposure, in ppm, from Table 8-14) • 1,000,000 (to convert from risk to microrisk) For example, the low estimate for reduced kidney risk of 3.21 shown in Table 8-14 is calculated as the product of: • 2.59E-03 (Excess kidney cancer estimate shown in Table 8-12) • 1.241E-03 ppm (the change in exposure, in ppm, from Table 8-14) • 1,000,000 (to convert from risk to microrisk)
	**Section 8.6** For example, for the manufacturing use category, $3.49 is the 2% value used for the low estimate for kidney cancer risk, $6.02 is the 2% value used for the low estimate for NHL risk, and $7.32 is the 2% value used for the low estimate for liver cancer risk (See Table 8-15).
	**Section 8.7** For example, the estimated 20-year annualized low estimate for benefits under Option 1 for the manufacturing use category shown in Table 8-28 is $9,955. This is calculated using equations 1 and 2 in section 7.2 and the corresponding annual value of $10,964 shown in Table 8-22, The $9,955 includes a benefit of $1,631 for avoiding kidney cancer risk, $5,554 for avoiding NHL risk, and $3,379 for avoiding liver cancer risk (also shown in Table 8-22). The $1,631 for avoiding kidney cancer risk is calculated as the product of the following: • 3.2263 (change in microrisk, Table 8-14) • 140 (individuals affected, Table 8-3) • $3.61 (low 2% value of microrisk, Table 8-15) The $5,554 for avoiding NHL cancer risk is calculated as the product of the following: • 6.44 (change in microrisk, Table 8-14) • 140 (individuals affected, Table 8-3) • $6.16 (low 2% value of microrisk, Table 8-15) The $3,379 for avoiding kidney cancer risk is calculated as the product

Figure 8-2: Example Explaining How the Option 1 Low 2% 20-Year Annualized Value of $11 for the Manufacturing Use Category in Table 8-20 was Calculated

	of the following: • 3.214 (change in microrisk, Table 8-14) • 140 (individuals affected, Table 8-3) • $7.51 (low 2% value of microrisk, Table 8-15)

Table 8-16: Total Cancer Benefits from Eliminating 1 Year of Occupational Exposure, by Cancer Site, Use Category and Exposure Type (Low Estimate, 2% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Manufacturing	Worker	$1,827	$6,223	$3,786	$11,836
Import/Repackage	Worker	$218	$741	$451	$1,410
Battery and Synthetic Paper Processing Aid	Worker	$8,165	$27,812	$16,921	$52,899
Battery and Synthetic Paper Processing Aid	ONU	$1,064	$3,624	$2,205	$6,894
HFC Manufacturing	Worker	$496	$1,689	$1,028	$3,213
Intermediate in HCl Production	Worker	$6,943	$23,648	$14,388	$44,978
Fluoroelastomer Manufacture	Worker	$5,444	$18,542	$11,281	$35,266
Fluoroelastomer Manufacture	ONU	$709	$2,416	$1,470	$4,596
Open-Top Vapor Degreasing	Worker	$1,009,620	$3,438,945	$2,092,266	$6,540,831
Open-Top Vapor Degreasing	ONU	$70,513	$240,181	$146,127	$456,821
Enclosed Vapor Degreasing	Worker	$493	$1,681	$1,023	$3,197
Conveyorized Vapor Degreasing	Worker	$32,100	$109,337	$66,521	$207,958
Web Vapor Degreasing	Worker	$743	$2,532	$1,541	$4,816
Web Vapor Degreasing	ONU	$278	$947	$576	$1,802
Batch Cold Cleaning	Worker	$71,168	$242,412	$147,484	$461,064
Batch Cold Cleaning	ONU	$28,855	$98,287	$59,798	$186,941
Disposal to Wastewater	Worker	$140,661	$480,447	$291,916	$913,024
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$5,418	$18,453	$11,227	$35,098
Mold Release	Worker	$63,560	$216,495	$131,717	$411,771
Mold Release	ONU	$211	$720	$438	$1,369
Liquid Cleaners and Degreasers	Worker	$345,045	$1,175,284	$715,047	$2,235,375
Liquid Cleaners and Degreasers	ONU	$19,452	$66,256	$40,310	$126,018
Aerosol Spray Cleaning/Degreasing	Worker	$1,280,757	$4,376,531	$2,645,367	$8,302,654
Aerosol Spray Cleaning/Degreasing	ONU	$4,270	$14,592	$8,820	$27,682
Lubricants and Greases	Worker	$299,981	$1,021,788	$621,659	$1,943,428
Lubricants and Greases	ONU	$365	$1,243	$756	$2,365
Adhesives, Sealants, Paints and Coatings	Worker	$133,712	$455,447	$277,095	$866,254
Adhesives, Sealants, Paints and Coatings	ONU	$5,438	$18,524	$11,270	$35,233
Spot Removers	Worker	$410,227	$1,401,807	$847,313	$2,659,347
Spot Removers	ONU	$55,676	$190,253	$114,997	$360,926

Table 8-17: Total Cancer Benefits from Eliminating 1 Year of Occupational Exposure, by Cancer Site, Use Category and Exposure Type (High Estimate, 2% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Manufacturing	Worker	$1,827	$6,223	$3,948	$11,998
Import/Repackage	Worker	$218	$741	$470	$1,429
Battery and Synthetic Paper Processing Aid	Worker	$8,165	$27,812	$17,642	$53,620
Battery and Synthetic Paper Processing Aid	ONU	$1,064	$3,624	$2,299	$6,987
HFC Manufacturing	Worker	$496	$1,689	$1,071	$3,257
Intermediate in HCl Production	Worker	$6,943	$23,648	$15,001	$45,591
Fluoroelastomer Manufacture	Worker	$5,444	$18,542	$11,761	$35,746
Fluoroelastomer Manufacture	ONU	$709	$2,416	$1,533	$4,658
Open-Top Vapor Degreasing	Worker	$1,009,620	$3,438,945	$2,181,417	$6,629,982
Open-Top Vapor Degreasing	ONU	$70,513	$240,181	$152,353	$463,047
Enclosed Vapor Degreasing	Worker	$493	$1,681	$1,066	$3,240
Conveyorized Vapor Degreasing	Worker	$32,100	$109,337	$69,356	$210,792
Web Vapor Degreasing	Worker	$743	$2,532	$1,606	$4,882
Web Vapor Degreasing	ONU	$278	$947	$601	$1,826
Batch Cold Cleaning	Worker	$71,168	$242,412	$153,768	$467,349
Batch Cold Cleaning	ONU	$28,855	$98,287	$62,346	$189,489
Disposal to Wastewater	Worker	$140,661	$480,447	$304,371	$925,479
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$5,418	$18,453	$11,705	$35,576
Mold Release	Worker	$63,560	$216,495	$137,329	$417,384
Mold Release	ONU	$211	$720	$457	$1,388
Liquid Cleaners and Degreasers	Worker	$345,045	$1,175,284	$745,515	$2,265,843
Liquid Cleaners and Degreasers	ONU	$19,452	$66,256	$42,028	$127,736
Aerosol Spray Cleaning/Degreasing	Worker	$1,280,757	$4,376,531	$2,760,696	$8,417,984
Aerosol Spray Cleaning/Degreasing	ONU	$4,270	$14,592	$9,204	$28,067
Lubricants and Greases	Worker	$299,981	$1,021,788	$648,148	$1,969,917
Lubricants and Greases	ONU	$365	$1,243	$789	$2,397
Adhesives, Sealants, Paints and Coatings	Worker	$133,712	$455,447	$288,902	$878,061
Adhesives, Sealants, Paints and Coatings	ONU	$5,438	$18,524	$11,750	$35,713
Spot Removers	Worker	$410,227	$1,401,807	$884,253	$2,696,287
Spot Removers	ONU	$55,676	$190,253	$120,011	$365,940

Table 8-18: Total Cancer Benefits from Eliminating 1 Year of Occupational Exposure, by Cancer Site, Use Category and Exposure Type (Low Estimate, 3% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Manufacturing	Worker	$1,453	$4,991	$3,065	$9,508
Import/Repackage	Worker	$173	$595	$365	$1,133
Battery and Synthetic Paper Processing Aid	Worker	$6,491	$22,304	$13,699	$42,495
Battery and Synthetic Paper Processing Aid	ONU	$846	$2,907	$1,785	$5,538
HFC Manufacturing	Worker	$394	$1,355	$832	$2,581
Intermediate in HCl Production	Worker	$5,520	$18,965	$11,648	$36,132
Fluoroelastomer Manufacture	Worker	$4,328	$14,869	$9,133	$28,330
Fluoroelastomer Manufacture	ONU	$564	$1,938	$1,190	$3,692
Open-Top Vapor Degreasing	Worker	$802,661	$2,757,855	$1,693,872	$5,254,389
Open-Top Vapor Degreasing	ONU	$56,059	$192,613	$118,302	$366,974
Enclosed Vapor Degreasing	Worker	$392	$1,348	$828	$2,568
Conveyorized Vapor Degreasing	Worker	$25,520	$87,683	$53,855	$167,057
Web Vapor Degreasing	Worker	$591	$2,031	$1,247	$3,869
Web Vapor Degreasing	ONU	$221	$760	$467	$1,447
Batch Cold Cleaning	Worker	$56,580	$194,402	$119,401	$370,383
Batch Cold Cleaning	ONU	$22,941	$78,821	$48,412	$150,173
Disposal to Wastewater	Worker	$112,138	$384,514	$236,647	$733,298
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$4,307	$14,798	$9,089	$28,195
Mold Release	Worker	$50,531	$173,618	$106,636	$330,785
Mold Release	ONU	$168	$577	$355	$1,100
Liquid Cleaners and Degreasers	Worker	$274,315	$942,516	$578,893	$1,795,724
Liquid Cleaners and Degreasers	ONU	$15,464	$53,134	$32,635	$101,233
Aerosol Spray Cleaning/Degreasing	Worker	$1,020,264	$3,495,447	$2,129,989	$6,645,700
Aerosol Spray Cleaning/Degreasing	ONU	$3,402	$11,654	$7,102	$22,158
Lubricants and Greases	Worker	$238,489	$819,421	$503,287	$1,561,197
Lubricants and Greases	ONU	$290	$997	$612	$1,900
Adhesives, Sealants, Paints and Coatings	Worker	$106,303	$365,245	$224,333	$695,880
Adhesives, Sealants, Paints and Coatings	ONU	$4,324	$14,855	$9,124	$28,303
Spot Removers	Worker	$326,791	$1,119,595	$682,237	$2,128,623
Spot Removers	ONU	$44,352	$151,951	$92,593	$288,897

Table 8-19: Total Cancer Benefits from Eliminating 1 Year of Occupational Exposure, by Cancer Site, Use Category and Exposure Type (High Estimate, 3% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Manufacturing	Worker	$1,453	$4,991	$3,201	$9,645
Import/Repackage	Worker	$173	$595	$381	$1,149
Battery and Synthetic Paper Processing Aid	Worker	$6,491	$22,304	$14,307	$43,103
Battery and Synthetic Paper Processing Aid	ONU	$846	$2,907	$1,864	$5,617
HFC Manufacturing	Worker	$394	$1,355	$869	$2,618
Intermediate in HCl Production	Worker	$5,520	$18,965	$12,165	$36,649
Fluoroelastomer Manufacture	Worker	$4,328	$14,869	$9,538	$28,735
Fluoroelastomer Manufacture	ONU	$564	$1,938	$1,243	$3,745
Open-Top Vapor Degreasing	Worker	$802,661	$2,757,855	$1,769,093	$5,329,610
Open-Top Vapor Degreasing	ONU	$56,059	$192,613	$123,556	$372,228
Enclosed Vapor Degreasing	Worker	$392	$1,348	$865	$2,605
Conveyorized Vapor Degreasing	Worker	$25,520	$87,683	$56,246	$169,449
Web Vapor Degreasing	Worker	$591	$2,031	$1,303	$3,924
Web Vapor Degreasing	ONU	$221	$760	$487	$1,468
Batch Cold Cleaning	Worker	$56,580	$194,402	$124,704	$375,685
Batch Cold Cleaning	ONU	$22,941	$78,821	$50,562	$152,323
Disposal to Wastewater	Worker	$112,138	$384,514	$246,767	$743,418
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$4,307	$14,798	$9,493	$28,598
Mold Release	Worker	$50,531	$173,618	$111,371	$335,520
Mold Release	ONU	$168	$577	$370	$1,116
Liquid Cleaners and Degreasers	Worker	$274,315	$942,516	$604,600	$1,821,432
Liquid Cleaners and Degreasers	ONU	$15,464	$53,134	$34,084	$102,682
Aerosol Spray Cleaning/Degreasing	Worker	$1,020,264	$3,495,447	$2,223,694	$6,739,405
Aerosol Spray Cleaning/Degreasing	ONU	$3,402	$11,654	$7,414	$22,470
Lubricants and Greases	Worker	$238,489	$819,421	$525,637	$1,583,547
Lubricants and Greases	ONU	$290	$997	$640	$1,927
Adhesives, Sealants, Paints and Coatings	Worker	$106,303	$365,245	$234,295	$705,842
Adhesives, Sealants, Paints and Coatings	ONU	$4,324	$14,855	$9,529	$28,709
Spot Removers	Worker	$326,791	$1,119,595	$712,251	$2,158,637
Spot Removers	ONU	$44,352	$151,951	$96,667	$292,970

Table 8-20: Total Cancer Benefits from Eliminating 1 Year of Occupational Exposure, by Cancer Site, Use Category and Exposure Type (Low Estimate, 7% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Manufacturing	Worker	$693	$2,425	$1,548	$4,666
Import/Repackage	Worker	$83	$289	$184	$556
Battery and Synthetic Paper Processing Aid	Worker	$3,099	$10,836	$6,917	$20,852
Battery and Synthetic Paper Processing Aid	ONU	$404	$1,412	$901	$2,717
HFC Manufacturing	Worker	$188	$658	$420	$1,266
Intermediate in HCl Production	Worker	$2,635	$9,214	$5,881	$17,730
Fluoroelastomer Manufacture	Worker	$2,066	$7,224	$4,611	$13,901
Fluoroelastomer Manufacture	ONU	$269	$941	$601	$1,812
Open-Top Vapor Degreasing	Worker	$383,152	$1,339,849	$855,294	$2,578,295
Open-Top Vapor Degreasing	ONU	$26,760	$93,577	$59,735	$180,072
Enclosed Vapor Degreasing	Worker	$187	$655	$418	$1,260
Conveyorized Vapor Degreasing	Worker	$12,182	$42,599	$27,193	$81,974
Web Vapor Degreasing	Worker	$282	$987	$630	$1,898
Web Vapor Degreasing	ONU	$106	$369	$236	$710
Batch Cold Cleaning	Worker	$27,008	$94,446	$60,290	$181,744
Batch Cold Cleaning	ONU	$10,951	$38,294	$24,445	$73,689
Disposal to Wastewater	Worker	$53,529	$187,187	$119,491	$360,207
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$2,056	$7,190	$4,589	$13,835
Mold Release	Worker	$24,121	$84,349	$53,844	$162,314
Mold Release	ONU	$80	$280	$179	$540
Liquid Cleaners and Degreasers	Worker	$130,945	$457,903	$292,303	$881,150
Liquid Cleaners and Degreasers	ONU	$7,382	$25,814	$16,478	$49,674
Aerosol Spray Cleaning/Degreasing	Worker	$488,424	$1,711,614	$1,066,796	$3,266,834
Aerosol Spray Cleaning/Degreasing	ONU	$1,628	$5,707	$3,557	$10,892
Lubricants and Greases	Worker	$113,843	$398,099	$254,127	$766,069
Lubricants and Greases	ONU	$139	$484	$309	$932
Adhesives, Sealants, Paints and Coatings	Worker	$50,744	$177,447	$113,273	$341,464
Adhesives, Sealants, Paints and Coatings	ONU	$2,064	$7,217	$4,607	$13,888
Spot Removers	Worker	$156,443	$548,231	$341,696	$1,046,370
Spot Removers	ONU	$21,232	$74,406	$46,375	$142,013

Table 8-21: Total Cancer Benefits from Eliminating 1 Year of Occupational Exposure, by Cancer Site, Use Category and Exposure Type (High Estimate, 7% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Manufacturing	Worker	$693	$2,425	$1,623	$4,741
Import/Repackage	Worker	$83	$289	$193	$565
Battery and Synthetic Paper Processing Aid	Worker	$3,099	$10,836	$7,255	$21,190
Battery and Synthetic Paper Processing Aid	ONU	$404	$1,412	$945	$2,761
HFC Manufacturing	Worker	$188	$658	$441	$1,287
Intermediate in HCl Production	Worker	$2,635	$9,214	$6,169	$18,017
Fluoroelastomer Manufacture	Worker	$2,066	$7,224	$4,837	$14,127
Fluoroelastomer Manufacture	ONU	$269	$941	$630	$1,841
Open-Top Vapor Degreasing	Worker	$383,152	$1,339,849	$897,083	$2,620,084
Open-Top Vapor Degreasing	ONU	$26,760	$93,577	$62,654	$182,990
Enclosed Vapor Degreasing	Worker	$187	$655	$438	$1,281
Conveyorized Vapor Degreasing	Worker	$12,182	$42,599	$28,522	$83,302
Web Vapor Degreasing	Worker	$282	$987	$661	$1,929
Web Vapor Degreasing	ONU	$106	$369	$247	$722
Batch Cold Cleaning	Worker	$27,008	$94,446	$63,236	$184,690
Batch Cold Cleaning	ONU	$10,951	$38,294	$25,639	$74,883
Disposal to Wastewater	Worker	$53,529	$187,187	$125,329	$366,046
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$2,056	$7,190	$4,814	$14,059
Mold Release	Worker	$24,121	$84,349	$56,475	$164,945
Mold Release	ONU	$80	$280	$188	$548
Liquid Cleaners and Degreasers	Worker	$130,945	$457,903	$306,585	$895,432
Liquid Cleaners and Degreasers	ONU	$7,382	$25,814	$17,284	$50,480
Aerosol Spray Cleaning/Degreasing	Worker	$488,424	$1,711,614	$1,117,253	$3,317,291
Aerosol Spray Cleaning/Degreasing	ONU	$1,628	$5,707	$3,725	$11,060
Lubricants and Greases	Worker	$113,843	$398,099	$266,544	$778,486
Lubricants and Greases	ONU	$139	$484	$324	$947
Adhesives, Sealants, Paints and Coatings	Worker	$50,744	$177,447	$118,808	$346,998
Adhesives, Sealants, Paints and Coatings	ONU	$2,064	$7,217	$4,832	$14,113
Spot Removers	Worker	$156,443	$548,231	$357,857	$1,062,531
Spot Removers	ONU	$21,232	$74,406	$48,568	$144,207

Table 8-22: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (Low Estimate, 2% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Option 1 (ECEL Threshold 0.20 ppm)					
Manufacturing	Worker	$1,631	$5,554	$3,379	$10,564
Battery and Synthetic Paper Processing Aid	Worker	$8,027	$27,342	$16,635	$52,004
Battery and Synthetic Paper Processing Aid	ONU	$991	$3,376	$2,054	$6,421
HFC Manufacturing	Worker	$443	$1,508	$917	$2,867
Fluoroelastomer Manufacture	Worker	$5,351	$18,228	$11,090	$34,669
Fluoroelastomer Manufacture	ONU	$661	$2,250	$1,369	$4,280
Open-Top Vapor Degreasing	Worker	$1,005,614	$3,425,302	$2,083,965	$6,514,881
Open-Top Vapor Degreasing	ONU	$67,300	$229,236	$139,468	$436,003
Enclosed Vapor Degreasing	Worker	$426	$1,450	$882	$2,757
Disposal to Wastewater	Worker	$136,513	$466,278	$283,307	$886,098
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$5,247	$17,874	$10,875	$33,996
Aerosol Spray Cleaning/Degreasing	Worker	$1,263,863	$4,318,804	$2,610,474	$8,193,141
Aerosol Spray Cleaning/Degreasing	ONU	$2,926	$9,999	$6,044	$18,969
Adhesives, Sealants, Paints and Coatings	Worker	$132,223	$450,377	$274,011	$856,611
Adhesives, Sealants, Paints and Coatings	ONU	$4,810	$16,385	$9,969	$31,164
Option 2 (ECEL Threshold 0.0011 ppm)					

Table 8-22: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (Low Estimate, 2% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Manufacturing	Worker	$1,825	$6,218	$3,783	$11,826
Battery and Synthetic Paper Processing Aid	Worker	$8,164	$27,809	$16,919	$52,891
Battery and Synthetic Paper Processing Aid	ONU	$1,064	$3,624	$2,205	$6,892
HFC Manufacturing	Worker	$495	$1,688	$1,027	$3,210
Intermediate in HCL Production	Worker	$6,937	$23,627	$14,375	$44,938
Fluoroelastomer Manufacture	Worker	$5,443	$18,539	$11,279	$35,261
Fluoroelastomer Manufacture	ONU	$709	$2,416	$1,470	$4,595
Open-Top Vapor Degreasing	Worker	$1,009,481	$3,438,474	$2,091,979	$6,539,934
Open-Top Vapor Degreasing	ONU	$70,495	$240,120	$146,090	$456,704
Enclosed Vapor Degreasing	Worker	$493	$1,679	$1,022	$3,194
Disposal to Wastewater	Worker	$140,581	$480,176	$291,752	$912,509
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$5,414	$18,441	$11,220	$35,075
Aerosol Spray Cleaning/Degreasing	Worker	$1,280,622	$4,376,071	$2,645,088	$8,301,781
Aerosol Spray Cleaning/Degreasing	ONU	$4,263	$14,569	$8,806	$27,638
Adhesives, Sealants, Paints and Coatings	Worker	$133,692	$455,380	$277,055	$866,127
Adhesives, Sealants, Paints and Coatings	ONU	$5,431	$18,499	$11,255	$35,185

Table 8-23: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (High Estimate, 2% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Option 1 (ECEL Threshold 0.20 ppm)					

Table 8-23: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (High Estimate, 2% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Manufacturing	Worker	$1,631	$5,554	$3,523	$10,708
Battery and Synthetic Paper Processing Aid	Worker	$8,027	$27,342	$17,344	$52,713
Battery and Synthetic Paper Processing Aid	ONU	$991	$3,376	$2,141	$6,508
HFC Manufacturing	Worker	$443	$1,508	$956	$2,906
Fluoroelastomer Manufacture	Worker	$5,351	$18,228	$11,562	$35,142
Fluoroelastomer Manufacture	ONU	$661	$2,250	$1,428	$4,339
Open-Top Vapor Degreasing	Worker	$1,005,614	$3,425,302	$2,172,763	$6,603,679
Open-Top Vapor Degreasing	ONU	$67,300	$229,236	$145,410	$441,946
Enclosed Vapor Degreasing	Worker	$426	$1,450	$920	$2,795
Disposal to Wastewater	Worker	$136,513	$466,278	$295,395	$898,186
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$5,247	$17,874	$11,338	$34,459
Aerosol Spray Cleaning/Degreasing	Worker	$1,263,863	$4,318,804	$2,724,282	$8,306,949
Aerosol Spray Cleaning/Degreasing	ONU	$2,926	$9,999	$6,307	$19,232
Adhesives, Sealants, Paints and Coatings	Worker	$132,223	$450,377	$285,686	$868,287
Adhesives, Sealants, Paints and Coatings	ONU	$4,810	$16,385	$10,393	$31,589
Option 2 (ECEL Threshold 0.0011 ppm)					

Table 8-23: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (High Estimate, 2% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Manufacturing	Worker	$1,825	$6,218	$3,944	$11,987
Battery and Synthetic Paper Processing Aid	Worker	$8,164	$27,809	$17,640	$53,612
Battery and Synthetic Paper Processing Aid	ONU	$1,064	$3,624	$2,299	$6,986
HFC Manufacturing	Worker	$495	$1,688	$1,071	$3,254
Intermediate in HCL Production	Worker	$6,937	$23,627	$14,987	$45,551
Fluoroelastomer Manufacture	Worker	$5,443	$18,539	$11,760	$35,742
Fluoroelastomer Manufacture	ONU	$709	$2,416	$1,532	$4,657
Open-Top Vapor Degreasing	Worker	$1,009,481	$3,438,474	$2,181,118	$6,629,073
Open-Top Vapor Degreasing	ONU	$70,495	$240,120	$152,314	$462,929
Enclosed Vapor Degreasing	Worker	$493	$1,679	$1,065	$3,237
Disposal to Wastewater	Worker	$140,581	$480,176	$304,200	$924,957
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$5,414	$18,441	$11,698	$35,554
Aerosol Spray Cleaning/Degreasing	Worker	$1,280,622	$4,376,071	$2,760,406	$8,417,098
Aerosol Spray Cleaning/Degreasing	ONU	$4,263	$14,569	$9,190	$28,022
Adhesives, Sealants, Paints and Coatings	Worker	$133,692	$455,380	$288,860	$877,932
Adhesives, Sealants, Paints and Coatings	ONU	$5,431	$18,499	$11,735	$35,665

Table 8-24: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (Low Estimate, 3% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Option 1 (ECEL Threshold 0.20 ppm)					
Manufacturing	Worker	$1,296	$4,454	$2,736	$8,486
Battery and Synthetic Paper Processing Aid	Worker	$6,382	$21,927	$13,467	$41,776
Battery and Synthetic Paper Processing Aid	ONU	$788	$2,707	$1,663	$5,158
HFC Manufacturing	Worker	$352	$1,209	$743	$2,303
Fluoroelastomer Manufacture	Worker	$4,254	$14,618	$8,978	$27,851
Fluoroelastomer Manufacture	ONU	$525	$1,805	$1,108	$3,439
Open-Top Vapor Degreasing	Worker	$799,477	$2,746,914	$1,687,152	$5,233,543
Open-Top Vapor Degreasing	ONU	$53,504	$183,835	$112,911	$350,251
Enclosed Vapor Degreasing	Worker	$338	$1,163	$714	$2,215
Disposal to Wastewater	Worker	$108,831	$373,174	$229,668	$711,673
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$4,172	$14,334	$8,804	$27,310
Aerosol Spray Cleaning/Degreasing	Worker	$1,006,806	$3,449,342	$2,101,894	$6,558,042
Aerosol Spray Cleaning/Degreasing	ONU	$2,331	$7,986	$4,866	$15,183
Adhesives, Sealants, Paints and Coatings	Worker	$105,120	$361,179	$221,836	$688,134
Adhesives, Sealants, Paints and Coatings	ONU	$3,824	$13,140	$8,070	$25,035
Option 2 (ECEL Threshold 0.0011 ppm)					

Table 8-24: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (Low Estimate, 3% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Manufacturing	Worker	$1,451	$4,986	$3,063	$9,500
Battery and Synthetic Paper Processing Aid	Worker	$6,491	$22,301	$13,697	$42,489
Battery and Synthetic Paper Processing Aid	ONU	$846	$2,906	$1,785	$5,537
HFC Manufacturing	Worker	$394	$1,353	$831	$2,579
Intermediate in HCL Production	Worker	$5,515	$18,948	$11,638	$36,100
Fluoroelastomer Manufacture	Worker	$4,327	$14,867	$9,131	$28,326
Fluoroelastomer Manufacture	ONU	$564	$1,937	$1,190	$3,691
Open-Top Vapor Degreasing	Worker	$802,552	$2,757,478	$1,693,640	$5,253,669
Open-Top Vapor Degreasing	ONU	$56,045	$192,563	$118,272	$366,880
Enclosed Vapor Degreasing	Worker	$392	$1,347	$827	$2,566
Disposal to Wastewater	Worker	$112,075	$384,297	$236,513	$732,885
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$4,304	$14,789	$9,083	$28,177
Aerosol Spray Cleaning/Degreasing	Worker	$1,020,157	$3,495,080	$2,129,765	$6,645,001
Aerosol Spray Cleaning/Degreasing	ONU	$3,396	$11,636	$7,090	$22,122
Adhesives, Sealants, Paints and Coatings	Worker	$106,287	$365,191	$224,300	$695,778
Adhesives, Sealants, Paints and Coatings	ONU	$4,318	$14,835	$9,112	$28,265

Table 8-25: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (High Estimate, 3% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Option 1 (ECEL Threshold 0.20 ppm)					
Manufacturing	Worker	$1,296	$4,454	$2,857	$8,608
Battery and Synthetic Paper Processing Aid	Worker	$6,382	$21,927	$14,065	$42,374
Battery and Synthetic Paper Processing Aid	ONU	$788	$2,707	$1,737	$5,232
HFC Manufacturing	Worker	$352	$1,209	$776	$2,336
Fluoroelastomer Manufacture	Worker	$4,254	$14,618	$9,377	$28,249
Fluoroelastomer Manufacture	ONU	$525	$1,805	$1,158	$3,488
Open-Top Vapor Degreasing	Worker	$799,477	$2,746,914	$1,762,075	$5,308,466
Open-Top Vapor Degreasing	ONU	$53,504	$183,835	$117,925	$355,265
Enclosed Vapor Degreasing	Worker	$338	$1,163	$746	$2,247
Disposal to Wastewater	Worker	$108,831	$373,174	$239,489	$721,494
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$4,172	$14,334	$9,195	$27,701
Aerosol Spray Cleaning/Degreasing	Worker	$1,006,806	$3,449,342	$2,194,363	$6,650,511
Aerosol Spray Cleaning/Degreasing	ONU	$2,331	$7,986	$5,080	$15,397
Adhesives, Sealants, Paints and Coatings	Worker	$105,120	$361,179	$231,687	$697,985
Adhesives, Sealants, Paints and Coatings	ONU	$3,824	$13,140	$8,429	$25,393
Option 2 (ECEL Threshold 0.0011 ppm)					
Manufacturing	Worker	$1,451	$4,986	$3,199	$9,636
Battery and Synthetic Paper Processing Aid	Worker	$6,491	$22,301	$14,306	$43,097
Battery and Synthetic Paper Processing Aid	ONU	$846	$2,906	$1,864	$5,616
HFC Manufacturing	Worker	$394	$1,353	$868	$2,615
Intermediate in HCL Production	Worker	$5,515	$18,948	$12,154	$36,617
Fluoroelastomer Manufacture	Worker	$4,327	$14,867	$9,537	$28,731
Fluoroelastomer Manufacture	ONU	$564	$1,937	$1,243	$3,744
Open-Top Vapor Degreasing	Worker	$802,552	$2,757,478	$1,768,851	$5,328,880
Open-Top Vapor Degreasing	ONU	$56,045	$192,563	$123,524	$372,133
Enclosed Vapor Degreasing	Worker	$392	$1,347	$864	$2,602
Disposal to Wastewater	Worker	$112,075	$384,297	$246,627	$742,999
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$4,304	$14,789	$9,487	$28,580
Aerosol Spray Cleaning/Degreasing	Worker	$1,020,157	$3,495,080	$2,223,460	$6,738,696

Table 8-25: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (High Estimate, 3% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Aerosol Spray Cleaning/Degreasing	ONU	$3,396	$11,636	$7,402	$22,434
Adhesives, Sealants, Paints and Coatings	Worker	$106,287	$365,191	$234,261	$705,739
Adhesives, Sealants, Paints and Coatings	ONU	$4,318	$14,835	$9,517	$28,670

Table 8-26: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (Low Estimate, 7% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Option 1 (ECEL Threshold 0.20 ppm)					
Manufacturing	Worker	$619	$2,164	$1,381	$4,164
Battery and Synthetic Paper Processing Aid	Worker	$3,046	$10,653	$6,800	$20,499
Battery and Synthetic Paper Processing Aid	ONU	$376	$1,315	$840	$2,531
HFC Manufacturing	Worker	$168	$587	$375	$1,130
Fluoroelastomer Manufacture	Worker	$2,031	$7,102	$4,533	$13,666
Fluoroelastomer Manufacture	ONU	$251	$877	$560	$1,687
Open-Top Vapor Degreasing	Worker	$381,632	$1,334,533	$851,901	$2,568,066
Open-Top Vapor Degreasing	ONU	$25,540	$89,313	$57,013	$171,866
Enclosed Vapor Degreasing	Worker	$162	$565	$361	$1,087
Disposal to Wastewater	Worker	$51,951	$181,667	$115,967	$349,585
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$1,991	$6,964	$4,445	$13,401
Aerosol Spray Cleaning/Degreasing	Worker	$481,982	$1,689,037	$1,052,725	$3,223,744
Aerosol Spray Cleaning/Degreasing	ONU	$1,116	$3,910	$2,437	$7,464
Adhesives, Sealants, Paints and Coatings	Worker	$50,179	$175,472	$112,012	$337,663
Adhesives, Sealants, Paints and Coatings	ONU	$1,826	$6,384	$4,075	$12,284
Option 2 (ECEL Threshold 0.0011 ppm)					
Manufacturing	Worker	$693	$2,422	$1,546	$4,662
Battery and Synthetic Paper Processing Aid	Worker	$3,098	$10,834	$6,916	$20,849
Battery and Synthetic Paper Processing Aid	ONU	$404	$1,412	$901	$2,717
HFC Manufacturing	Worker	$188	$658	$420	$1,265
Intermediate in HCL Production	Worker	$2,632	$9,205	$5,876	$17,714
Fluoroelastomer Manufacture	Worker	$2,066	$7,223	$4,611	$13,899
Fluoroelastomer Manufacture	ONU	$269	$941	$601	$1,811
Open-Top Vapor Degreasing	Worker	$383,100	$1,339,665	$855,177	$2,577,941
Open-Top Vapor Degreasing	ONU	$26,753	$93,553	$59,720	$180,026
Enclosed Vapor Degreasing	Worker	$187	$654	$418	$1,259
Disposal to Wastewater	Worker	$53,499	$187,081	$119,424	$360,004
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$2,055	$7,185	$4,587	$13,826
Aerosol Spray Cleaning/Degreasing	Worker	$488,373	$1,711,434	$1,066,684	$3,266,491

Table 8-26: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (Low Estimate, 7% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Aerosol Spray Cleaning/Degreasing	ONU	$1,626	$5,698	$3,551	$10,875
Adhesives, Sealants, Paints and Coatings	Worker	$50,736	$177,421	$113,257	$341,414
Adhesives, Sealants, Paints and Coatings	ONU	$2,061	$7,208	$4,601	$13,870

Table 8-27: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (High Estimate, 7% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Option 1 (ECEL Threshold 0.20 ppm)					
Manufacturing	Worker	$619	$2,164	$1,449	$4,232
Battery and Synthetic Paper Processing Aid	Worker	$3,046	$10,653	$7,132	$20,831
Battery and Synthetic Paper Processing Aid	ONU	$376	$1,315	$881	$2,572
HFC Manufacturing	Worker	$168	$587	$393	$1,149
Fluoroelastomer Manufacture	Worker	$2,031	$7,102	$4,755	$13,888
Fluoroelastomer Manufacture	ONU	$251	$877	$587	$1,715
Open-Top Vapor Degreasing	Worker	$381,632	$1,334,533	$893,524	$2,609,690
Open-Top Vapor Degreasing	ONU	$25,540	$89,313	$59,798	$174,651
Enclosed Vapor Degreasing	Worker	$162	$565	$378	$1,104
Disposal to Wastewater	Worker	$51,951	$181,667	$121,633	$355,251
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$1,991	$6,964	$4,663	$13,618
Aerosol Spray Cleaning/Degreasing	Worker	$481,982	$1,689,037	$1,102,516	$3,273,535
Aerosol Spray Cleaning/Degreasing	ONU	$1,116	$3,910	$2,553	$7,579
Adhesives, Sealants, Paints and Coatings	Worker	$50,179	$175,472	$117,485	$343,136
Adhesives, Sealants, Paints and Coatings	ONU	$1,826	$6,384	$4,274	$12,483
Option 2 (ECEL Threshold 0.0011 ppm)					
Manufacturing	Worker	$693	$2,422	$1,622	$4,737
Battery and Synthetic Paper Processing Aid	Worker	$3,098	$10,834	$7,254	$21,187
Battery and Synthetic Paper Processing Aid	ONU	$404	$1,412	$945	$2,761
HFC Manufacturing	Worker	$188	$658	$440	$1,286
Intermediate in HCL Production	Worker	$2,632	$9,205	$6,163	$18,001
Fluoroelastomer Manufacture	Worker	$2,066	$7,223	$4,836	$14,125
Fluoroelastomer Manufacture	ONU	$269	$941	$630	$1,841
Open-Top Vapor Degreasing	Worker	$383,100	$1,339,665	$896,960	$2,619,725
Open-Top Vapor Degreasing	ONU	$26,753	$93,553	$62,638	$182,944
Enclosed Vapor Degreasing	Worker	$187	$654	$438	$1,279
Disposal to Wastewater	Worker	$53,499	$187,081	$125,259	$365,839
Incorporation Into Formulation, Mixture, or Reaction Product	Worker	$2,055	$7,185	$4,811	$14,050
Aerosol Spray Cleaning/Degreasing	Worker	$488,373	$1,711,434	$1,117,135	$3,316,942

Table 8-27: Total Cancer Benefits from 1 Year of WCPP, by Cancer Site, Use Category and Exposure Type (High Estimate, 7% Discount Rate, 2022$)

Use Category	Exposure Type	Kidney	Non-Hodgkin Lymphoma	Liver	Total
Aerosol Spray Cleaning/Degreasing	ONU	$1,626	$5,698	$3,719	$11,043
Adhesives, Sealants, Paints and Coatings	Worker	$50,736	$177,421	$118,790	$346,947
Adhesives, Sealants, Paints and Coatings	ONU	$2,061	$7,208	$4,826	$14,094

Table 8-28: Total 20-Year Annualized Benefits by Use Category and Regulatory Option (2 Percent Discount Rate)

Use Category	Low Estimate		High Estimate		Notes[1]	
	Option 1	Option 2	Option 1	Option 2	Option 1	Option 2
Manufacturing	$9,955	$11,144	$10,091	$11,296	WCPP	WCPP
Import/Repackage	$1,329	$1,329	$1,347	$1,347	Prohibit	Prohibit
Battery and Synthetic Paper Processing Aid	$55,169	$56,344	$55,921	$57,112	WCPP/Prohibit[2]	WCPP/Prohibit[2]
HFC Manufacturing	$1,349	$1,510	$1,367	$1,531	WCPP[3]	WCPP[3]
Intermediate in HCL Production	$0	$42,384	$0	$42,962	-	WCPP/Prohibit[4]
Fluoroelastomer Manufacture	$37,513	$37,564	$38,024	$38,076	WCPP/Prohibit[4]	WCPP/Prohibit[4]
Open-Top Vapor Degreasing	$6,580,750	$6,594,356	$6,670,446	$6,684,237	WCPP/Prohibit[5]	WCPP/Prohibit[5]
Enclosed Vapor Degreasing	$2,875	$3,012	$2,914	$3,053	WCPP/Prohibit[6]	WCPP/Prohibit[6]
Conveyorized Vapor Degreasing	$195,973	$195,973	$198,644	$198,644	Prohibit	Prohibit
Web Vapor Degreasing	$6,236	$6,236	$6,321	$6,321	Prohibit	Prohibit
Batch Cold Cleaning	$610,659	$610,659	$618,982	$618,982	Prohibit	Prohibit
Disposal to Wastewater	$860,405	$859,919	$872,142	$871,650	WCPP	WCPP
Energized Electrical Cleaners	$77,160	$77,351	$78,232	$78,426	APF50/Prohibit[7]	Prohibit
Incorporation Into Formulation, Mixture, or Reaction Product	$33,066	$33,075	$33,517	$33,526	Prohibit	Prohibit
Mold Release	$389,330	$389,330	$394,637	$394,637	Prohibit	Prohibit
Liquid Cleaners and Degreasers	$2,225,301	$2,225,301	$2,255,632	$2,255,632	Prohibit	Prohibit
Aerosol Spray Cleaning/Degreasing (except EEC)	$6,239,196	$6,239,196	$6,325,863	$6,325,863	Prohibit	Prohibit
Lubricants and Greases	$1,833,653	$1,833,653	$1,858,645	$1,858,645	Prohibit	Prohibit
Adhesives, Sealants, Paints and Coatings	$849,532	$849,532	$861,111	$861,111	Prohibit	Prohibit
Dry Cleaning and Spot Removers	$2,846,209	$2,846,209	$2,885,745	$2,885,745	Prohibit	Prohibit
Total	**$22,855,659**	**$22,914,077**	**$23,169,579**	**$23,228,794**	Prohibit	Prohibit

[1]Notes indicate how benefits were estimated and do not necessarily directly correspond to the option requirements. See Table 7-2 for more detail about differences between requirements under the options and the analysis assumptions.
[2]WCPP for 16 years and then prohibition for 4.
[3]WCPP for 9 years and then no benefits (elimination in the baseline is assumed starting in year 10).
[4]WCPP for 1 year and then prohibition for 19.
[5]Five OTVDs are assumed to have 6 years of WCPP and 14 years of prohibition. One OTVD is assumed to have 9 years of WCPP and 11 years of prohibition. Other OTVDs are assumed to have 20 years of prohibition.
[6]One enclosed vapor degreaser is assumed to have 6 years of WCPP and 14 years of prohibition and one enclosed vapor degreaser is assumed to have 9 years of WCPP and 11 years of prohibition. Other vapor degreasers are assumed to have 20 years of prohibition.
[7]Here the benefits are split into Energized Electrical Cleaner (EEC) users and other aerosol degreaser users. EEC users are estimated to be 20.53% of all aerosol degreaser users (see Table 6-20). Using the estimates presented in Table 8-5, the benefits from using APF50 respirators for 2 years are estimated as 97.92% of the benefits of eliminating

all exposure (97.92% = 1-(95%/50+3%/50+0%/50+1%/50+1%/1000+0%/10000)/(95%/1+3%/10+0%/25+1%/50+1%/1000+0%/10000)). In addition, EEC users are assumed to be exposed once monthly instead of 250 days per year; thus, the aerosol user benefits are adjusted by 4.8% (4.8%=12/250).

Table 8-29: Total 20-Year Annualized Benefits by Use Category and Regulatory Option (3 Percent Discount Rate)

Use Category	Low Estimate		High Estimate		Notes[1]	
	Option 1	Option 2	Option 1	Option 2	Option 1	Option 2
Manufacturing	$7,952	$8,902	$8,065	$9,029	WCPP	WCPP
Import/Repackage	$1,061	$1,061	$1,077	$1,077	Prohibit	Prohibit
Battery and Synthetic Paper Processing Aid	$47,589	$45,005	$48,270	$45,649	WCPP/Prohibit[2]	WCPP/Prohibit[2]
HFC Manufacturing	$1,130	$1,264	$1,146	$1,283	WCPP[3]	WCPP[3]
Intermediate in HCL Production	$0	$33,854	$0	$34,339	-	Prohibit/ WCPP[4]
Fluoroelastomer Manufacture	$29,960	$30,005	$30,389	$30,434	WCPP/Prohibit[4]	Prohibit/WCPP[4]
Open-Top Vapor Degreasing	$5,255,545	$5,267,311	$5,330,782	$5,342,718	WCPP/Prohibit[5]	WCPP/Prohibit[5]
Enclosed Vapor Degreasing	$2,288	$2,406	$2,321	$2,440	WCPP/Prohibit[6]	WCPP/Prohibit[6]
Conveyorized Vapor Degreasing	$156,535	$156,535	$158,776	$158,776	Prohibit	Prohibit
Web Vapor Degreasing	$4,981	$4,981	$5,053	$5,053	Prohibit	Prohibit
Batch Cold Cleaning	$487,770	$487,770	$494,753	$494,753	Prohibit	Prohibit
Disposal to Wastewater	$687,113	$686,726	$696,596	$696,203	WCPP	WCPP
Energized Electrical Cleaners	$61,398	$61,563	$62,264	$62,431	APF50/Prohibit[7]	Prohibit
Incorporation Into Formulation, Mixture, or Reaction Product	$26,411	$26,419	$26,789	$26,797	Prohibit	Prohibit
Mold Release	$310,982	$310,982	$315,434	$315,434	Prohibit	Prohibit
Liquid Cleaners and Degreasers	$1,777,483	$1,777,483	$1,802,929	$1,802,929	Prohibit	Prohibit
Aerosol Spray Cleaning/Degreasing (except EEC)	$4,965,691	$4,965,691	$5,035,708	$5,035,708	Prohibit	Prohibit
Lubricants and Greases	$1,464,649	$1,464,649	$1,485,617	$1,485,617	Prohibit	Prohibit
Adhesives, Sealants, Paints and Coatings	$678,573	$678,573	$688,287	$688,287	Prohibit	Prohibit
Dry Cleaning and Spot Removers	$2,265,259	$2,265,259	$2,297,199	$2,297,199	Prohibit	Prohibit
Total	**$18,232,371**	**$18,276,440**	**$18,491,456**	**$18,536,156**	Prohibit	Prohibit

[1]Notes indicate how benefits were estimated and do not necessarily directly correspond to the option requirements. See Table 7-2 for more detail about differences between requirements under the options and the analysis assumptions.
[2]WCPP for 16 years and then prohibition for 4.
[3]WCPP for 9 years and then no benefits (elimination in the baseline is assumed starting in year 10).
[4]WCPP for 1 year and then prohibition for 19.
[5]Five OTVDs are assumed to have 6 years of WCPP and 14 years of prohibition. One OTVD is assumed to have 9 years of WCPP and 11 years of prohibition. Other OTVDs are assumed to have 20 years of prohibition.
[6]One enclosed vapor degreaser is assumed to have 6 years of WCPP and 14 years of prohibition and one enclosed vapor degreaser is assumed to have 9 years of WCPP and 11 years of prohibition. Other vapor degreasers are assumed to have 20 years of prohibition.
[7]Here the benefits are split into Energized Electrical Cleaner (EEC) users and other aerosol degreaser users. EEC users are estimated to be 20.53% of all aerosol degreaser users (see Table 6-20). Using the estimates presented in Table 8-5, the benefits from using APF50 respirators for 2 years are estimated as 97.92% of the benefits of eliminating

all exposure (97.92% = 1-(95%/50+3%/50+0%/50+1%/50+1%/1000+0%/10000)/(95%/1+3%/10+0%/25+1%/50+1%/1000+0%/10000)). In addition, EEC users are assumed to be exposed once monthly instead of 250 days per year; thus, the aerosol user benefits are adjusted by 4.8% (4.8%=12/250).

Table 8-30: Total 20-Year Annualized Benefits by Use Category and Regulatory Option (7 Percent Discount Rate)

Use Category	Low Estimate		High Estimate		Notes[1]	
	Option 1	Option 2	Option 1	Option 2	Option 1	Option 2
Manufacturing	$3,805	$4,260	$3,867	$4,329	WCPP	WCPP
Import/Repackage	$508	$508	$516	$516	Prohibit	Prohibit
Battery and Synthetic Paper Processing Aid	$22,296	$21,535	$22,658	$21,884	WCPP/Prohibit[2]	WCPP/Prohibit[2]
HFC Manufacturing	$635	$711	$645	$723	WCPP[3]	WCPP[3]
Intermediate in HCL Production	$0	$16,199	$0	$16,462	-	WCPP/Prohibit[4]
Fluoroelastomer Manufacture	$14,329	$14,357	$14,561	$14,590	WCPP/Prohibit[4]	WCPP/Prohibit[4]
Open-Top Vapor Degreasing	$2,512,991	$2,520,450	$2,553,722	$2,561,302	WCPP/Prohibit [5]	WCPP/Prohibit [5]
Enclosed Vapor Degreasing	$1,079	$1,151	$1,096	$1,170	WCPP/Prohibit[6]	WCPP/Prohibit[6]
Conveyorized Vapor Degreasing	$74,903	$74,903	$76,117	$76,117	Prohibit	Prohibit
Web Vapor Degreasing	$2,384	$2,384	$2,422	$2,422	Prohibit	Prohibit
Batch Cold Cleaning	$233,402	$233,402	$237,185	$237,185	Prohibit	Prohibit
Disposal to Wastewater	$329,139	$328,953	$334,474	$334,285	WCPP	WCPP
Energized Electrical Cleaners	$29,406	$29,511	$29,860	$29,967	APF50/Prohibit[7]	Prohibit
Incorporation Into Formulation, Mixture, or Reaction Product	$12,637	$12,642	$12,842	$12,847	Prohibit	Prohibit
Mold Release	$148,807	$148,807	$151,219	$151,219	Prohibit	Prohibit
Liquid Cleaners and Degreasers	$850,540	$850,540	$864,325	$864,325	Prohibit	Prohibit
Aerosol Spray Cleaning/Degreasing (except EEC)	$2,380,373	$2,380,373	$2,417,138	$2,417,138	Prohibit	Prohibit
Lubricants and Greases	$700,847	$700,847	$712,206	$712,206	Prohibit	Prohibit
Adhesives, Sealants, Paints and Coatings	$324,703	$324,703	$329,965	$329,965	Prohibit	Prohibit
Dry Cleaning and Spot Removers	$1,085,883	$1,085,883	$1,102,655	$1,102,655	Prohibit	Prohibit
Total	**$8,728,666**	**$8,752,119**	**$8,867,475**	**$8,891,308**	Prohibit	Prohibit

[1]Notes indicate how benefits were estimated and do not necessarily directly correspond to the option requirements. See Table 7-2 for more detail about differences between requirements under the options and the analysis assumptions.
[2]WCPP for 16 years and then prohibition for 4.
[3]WCPP for 9 years and then no benefits (elimination in the baseline is assumed starting in year 10).
[4]WCPP for 1 year and then prohibition for 19.
[5]Five OTVDs are assumed to have 6 years of WCPP and 14 years of prohibition. One OTVD is assumed to have 9 years of WCPP and 11 years of prohibition. Other OTVDs are assumed to have 20 years of prohibition.
[6]One enclosed vapor degreaser is assumed to have 6 years of WCPP and 14 years of prohibition and one enclosed vapor degreaser is assumed to have 9 years of WCPP and 11 years of prohibition. Other vapor degreasers are assumed to have 20 years of prohibition.
[7]Here the benefits are split into Energized Electrical Cleaner (EEC) users and other aerosol degreaser users. EEC users are estimated to be 20.53% of all aerosol degreaser users (see Table 6-20). Using the estimates presented in Table 8-5, the benefits from using APF50 respirators for 2 years are estimated as 97.92% of the benefits of eliminating

all exposure (97.92% = 1-(95%/50+3%/50+0%/50+1%/50+1%/1000+0%/10000)/(95%/1+3%/10+0%/25+1%/50+1%/1000+0%/10000)). In addition, EEC users are assumed to be exposed once monthly instead of 250 days per year; thus, the aerosol user benefits are adjusted by 4.8% (4.8%=12/250).

8.8 Benefits for Reducing Cancer Risks for Consumer Users of TCE Products

As noted in section 6.3, the percentage of total consumption assumed to be for consumer use for the calculations is an assumed value based on EPA judgement, and therefore the estimated numbers of exposed consumers should be considered highly uncertain. Because of this uncertainty, the total benefits estimates do not include the monetized benefits estimated for consumers presented here. In this section the estimated benefits for reducing cancer risks for consumer users of TCE products are presented. The same methodology from the cancer benefits analysis presented in sections 8.3 through 8.7 is used to generate these estimates, but consumer-specific exposure estimates are used, an exposure duration of one day per year is used, and monetized values that reflect the demographics of the employed population are used (instead of the sector-specific values used in Chapter 8).

8.8.1 Estimated Number of Consumer Users Exposed Annually

Table 8-31 presents the estimated number of consumer users with TCE exposure (see Table 6-21 and section 6.3).

Table 8-31: Number of Consumer Users with TCE Exposure

Use Category	Consumer Users
Mold Release	67
Liquid Cleaners and Degreasers	190
Aerosol Spray Cleaning/Degreasing	12,089
Lubricants and Greases	3,159
Adhesives, Sealants, Paints and Coatings	2,184
Spot Removers	2,911
Total	**20,600**

8.8.2 Consumer User Exposure Estimates

Table 8-32 presents the estimated exposure for consumer users. Column (A) of Table 8-32 shows the values from the supplementary exposure file from the risk evaluation.[18] In column (B), the simple average exposure for each use category is presented; a simple average is used because the number of users by condition of use is not known. Column (C) presents the estimated change in the LADC from one year of consumer exposure (one day of exposure is assumed for the exposure duration).

[18] See "Risk Evaluation for TCE, Supplemental Information File: Exposure Modeling Results and Risk Estimates for Consumer Inhalation Exposures (XLSX) (xlsx)" at https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/additional-supporting-documents-trichloroethylene-final.

Table 8-32: TCE Exposure for Consumer Users

Use Category	Consumer Condition of Use Descriptor	24 hr Max TWA (ppm) (A)	24 hr Max TWA by Use Category (ppm) (B)	Change in LADC from one year of exposure (ppm) (C)
Mold Release	Mold Release	1.75	1.75	0.00006
Liquid Cleaners and Degreasers	Liquid Elec. Degreaser	2.33	6.83	0.00024
	Liquid Degreaser	15.65		
	Liquid Gun Scrubber	0.07		
	Liquid Tire Cleaner	9.28		
Aerosol Spray Cleaning/Degreasing	Brake & Parts Cleaner	9.06	11.20	0.00039
	Aerosol Elec. Degreaser	1.58		
	Aerosol Spray Degreaser	41.09		
	Aerosol Gun Scrubber	0.08		
	Aerosol Tire Cleaner	4.17		
Lubricants and Greases	Tap & Die Fluid	1.57	1.13	0.00004
	Penetrating Lubricant	0.69		
Adhesives, Sealants, Paints and Coatings	Solvent-Based Adhesive & Seal	0.56	0.61	0.00002
	Tire Repair Cement	0.66		
Spot Removers	Carpet Cleaner	6.36	4.38	0.00015
	Aerosol Spot Remover	2.04		
	Liquid Spot Remover	4.73		
Average for All Uses		**7.50**	**7.50**	**0.00026**

8.8.3 Reductions in Cancer Risks for Consumer Users

Table 8-33 presents the estimated microrisk reductions from eliminating 1-year of consumer exposures. These estimates are calculated using the same methods and parameters described in Chapter 8 and combining them with the exposure estimates presented in Table 8-32.

Table 8-33: Estimated Cancer Microrisk Reductions Per Person from Eliminating 1 Year of Consumer Exposures

Use Category	Microrisk (Low)			Microrisk (High)		
	Kidney	NHL	Liver	Kidney	NHL	Liver
Mold Release	0.2	0.3	0.2	0.2	0.3	0.2
Liquid Cleaners and Degreasers	0.6	1.2	0.6	0.6	1.2	0.6
Aerosol Spray Cleaning/Degreasing	1.0	2.0	1.0	1.0	2.0	1.0
Lubricants and Greases	0.1	0.2	0.1	0.1	0.2	0.1
Adhesives, Sealants, Paints and Coatings	0.1	0.1	0.1	0.1	0.1	0.1
Spot Removers	0.4	0.8	0.4	0.4	0.8	0.4
Average for All Uses	0.7	1.4	0.7	0.7	1.4	0.7

8.8.4 Estimated Values for Consumer Microrisk Reductions

Table 8-34 presents the low and high estimated monetized values for a cancer microrisk reduction by sector, cancer site, and discount rate. The derivation of these monetized values is described in the Abt Associates (2023) technical support document, *Estimated Values of Avoiding Cancer Risks by Cancer Site and Population*. A value of $0.43 is used for the low estimate for avoiding a non-fatal liver cancer microrisk (Bosworth et al. 2009). A value of $7.57 is used for the low and high estimate for avoiding a non-fatal non-Hodgkin lymphoma cancer mirorisk and the high estimate for avoiding a non-fatal liver cancer mirorisk (Magat et al. 1996). A value of $0.71 is used for the low and high estimate for avoiding a non-fatal kidney cancer risk (Bosworth et al. 2009). $12.98 is the value used for a mortality microrisk reduction.

The $12.98 value for mortality risk is estimated using EPA's (2014a) recommended value for a statistical life (VSL) of $4.8 million in 1990 dollars and EPA's (2014a) recommended method for adjusting the VSL for income growth and inflation. Specifically, the $4.8 million in 1990 dollars is adjusted for inflation using the Consumer Price Index (U.S. BLS 2023a) and then adjusted for income growth using real GDP per capita (U.S. Bureau of Economic Analysis 2023a) and an income elasticity of 0.4.[19] The employed population is used to estimate the sex and age distribution of the affected consumers.

Table 8-34: Estimated Values for Consumer Microrisk Reductions (2022$)

Cancer Site	Estimated Value for a 1/1,000,000 Reduction in Cancer Risk					
	Low Estimate			High Estimate		
	2%	3%	7%	2%	3%	7%
Kidney	$3.49	$2.76	$1.29	$3.49	$2.76	$1.29
Non-Hodgkin Lymphoma	$5.98	$4.75	$2.26	$5.98	$4.75	$2.26
Liver	$7.26	$5.80	$2.83	$7.57	$6.06	$2.97

8.8.5 Total Annualized Consumer Benefits from Reduced Cancer Risk

Table 8-35 presents the estimated annualized benefits for affected consumers, which are calculated by combining the estimated numbers of individuals, the microrisk reductions in Table 8-33, the values in Table 8-34, and the annualization factors (94.2%, 93.7%, and 91.37%).[20]

[19] The consumer price index increased by 123.91% between 1990 and 2020, so $4.8 million (1990$) is converted to $10.75 million (2022$) after adjusting for inflation. GDP per capita increased by 60.16% between 1990 and 2021, and this analysis uses EPA's (2014a) recommended income elasticity of 0.4 to calculate the income adjustment factor of 1.20732 (=1.6016^0.4). Thus, the $10.75 million (2022$) is adjusted for income growth using an adjustment factor of 1.20732, and the resulting estimate is $12.98 million..

[20] See equation 2 in section 7.2 for the annualization formula.

Table 8-35: Total Estimated 20-Year Annualized Benefits for Consumer Microrisk Reductions (2022$)

Use Category	Affected Individuals	Total Estimated Benefits for Consumer Reductions in Cancer Risk					
		Low Estimate			High Estimate		
		2%	3%	7%	2%	3%	7%
Mold Release	67	$228	$180	$84	$231	$183	$85
Liquid Cleaners and Degreasers	190	$2,528	$1,999	$933	$2,562	$2,028	$948
Aerosol Spray Cleaning/Degreasing	12,089	$263,928	$208,695	$97,359	$267,525	$211,694	$98,934
Lubricants and Greases	3,159	$6,959	$5,503	$2,567	$7,054	$5,582	$2,609
Adhesives, Sealants, Paints and Coatings	2,184	$2,595	$2,052	$957	$2,631	$2,082	$973
Spot Removers	2,911	$24,851	$19,650	$9,167	$25,190	$19,933	$9,315
Total	**20,600**	**$301,089**	**$238,079**	**$111,068**	**$305,193**	**$241,501**	**$112,865**

8.9 Qualitative Discussion of the Benefits of Non-Cancer Risk Reductions

As discussed in EPA's risk evaluation (EPA 2020e), there are a number of non-cancer endpoints associated with exposure to TCE. This analysis is unable to quantify the magnitude of avoided risk of non-cancer endpoints due to reductions in TCE exposure under the rule, and thus is unable to develop monetized estimates of the benefits of non-cancer risk reductions. However, this section describes some of those effects.

Both animal and human studies demonstrate that TCE exposure can result in either autoimmune/immune enhancement responses or immunosuppression. There is also evidence of both systemic and localized hypersensitivity resulting in skin sensitization and autoimmune hepatitis. Overall, immunotoxicity in the form of both autoimmunity and immune suppression following TCE exposure are supported by the weight of evidence (EPA 2020e).

Several studies have demonstrated liver toxicity in both animals and humans exposed to TCE. In addition to increased liver size and other effects seen in animals, There is human evidence for hepatitis accompanying immune-related generalized skin diseases, jaundice, hepatomegaly, hepatosplenomegaly, and liver failure in TCE-exposed workers. A case study published in 2012 reported TCE hypersensitivity-induced liver damage (EPA 2020e).

Kidney toxicity has been found to be related to exposure to TCE. Studies in both humans and animals have shown changes in the proximal tubules of the kidney following exposure to TCE and occupational studies have shown increased levels of kidney damage (proximal tubules) and end-stage renal disease in TCE-exposed workers. Human studies reported increased excretion of urinary proteins among TCE-exposed workers when compared to unexposed controls (EPA 2020e).

Evidence exists to associate TCE with reproductive effects. Most human studies support an association between TCE exposure and alterations in sperm density and quality, as well as changes in sexual drive or function and serum endocrine levels. Fewer epidemiological studies exist linking decreased incidence of fecundability (time-to-pregnancy) and menstrual cycle disturbances in women with TCE exposures (EPA 2020e).

Neurotoxicity related to TCE exposure has been demonstrated in animal and human studies under both acute and chronic exposure conditions. Fewer and more limited epidemiological studies are suggestive of TCE exposure being associated with delayed motor function, and changes in auditory, visual, and cognitive function or performance, and neurodevelopmental abnormalities. Human studies have consistently reported vestibular system-related symptoms such as headaches, dizziness, and nausea following TCE exposure. And, several newer epidemiological studies have found an association between TCE exposure and neurodegenerative disorders such as Amyotrophic Lateral Sclerosis and Parkinson's disease (EPA 2020e).

As for human developmental neurotoxicity, the available studies collectively suggest that the developing brain is susceptible to TCE toxicity. These studies have reported an association with TCE exposure and CNS congenital or postnatal effects such as delayed newborn reflexes, impaired learning or memory, aggressive behavior, hearing impairment, speech impairment, encephalopathy, impaired executive and motor function and attention deficit (EPA 2020e).

As discussed in EPA's risk evaluation (EPA 2020e), there is positive overall evidence that TCE may produce congenital heart defects (CHDs) in humans (based on positive evidence from epidemiology studies, ambiguous evidence from animal toxicity studies, and stronger positive evidence from mechanistic studies).

CHDs are the most common birth defect, affecting approximately 1% of all births in the U.S. (CDC 2022a). CHDs impact the structure and functioning of an infant's heart. There are several different types of CHDs, with treatments and outlooks varying from mild to severe. According to the CDC, about 97 percent of infants born with a non-critical CHD will survive to one year of age and 95 percent will survive to 18 years of age (CDC 2022a). About 1 in 4 babies with a CHD have a critical CHD that requires one or more surgeries in the first year of life to repair the heart or blood vessels (CDC 2022b). About 75 percent of infants born with a critical CHD will survive to one year of age and 69 percent will survive to 18 years of age (CDC 2022a).

Some individuals with CHD may develop health problems into adulthood such as irregular heartbeats, increased risk of infection in the heart muscle, or weakness in the heart. Adults with CHDs will require routine examinations with a cardiologist and some may require additional surgeries (CDC 2022b). In addition, the co-occurrence of other physical, developmental, or cognitive disabilities increases for individuals with heart defects (CDC 2022a).

Arth, Tinker et al. (2017) estimated a mean annual cost of $41,166 (2013$) (median $14,552) for CHD-associated hospitalizations. For critical CHDs, mean and median costs were estimated at $79,011 and $29,886 (2013$), respectively. In addition to hospitalization costs, individuals with CHDs will likely incur healthcare costs associated with physician visits and outpatient care. They are also more likely to require specialized healthcare such as medications, physical or speech therapy, or treatment for developmental or behavioral problems (Chen, Riehle-Colarusso et al. 2018). Additional social costs may include caregiver burden and mental health services (McClung, Glidewell et al. 2018), as well as non-market costs such as pain and suffering and CHD-related mortality. As previously noted, the severity of specific types of CHDs and associated costs will vary depending on the type of heart defect.

As shown in Table 8-36, EPA estimates that there are approximately 1,162 pregnant workers and ONUs annually that may potentially benefit from a reduced risk of CHD resulting from reduced TCE exposure. The number of pregnant workers is estimated by multiplying the total number of workers and ONUs (see section 6.2) by a pregnancy rate. The pregnancy rate is estimated as the product of (1) the percentage of workers and ONUs that are women of childbearing age (15-44 years), using the Bureau of Labor Statistics' Current Population Survey Annual Social and Economic Supplement (U.S. Census Bureau 2010-2022) and (2) the pregnancy rate among women of childbearing age (87.4 pregnancies per 1,000 women aged 15-44 years; Maddow-Zimet and Kost 2021). The percentage of workers and ONUs that are women of childbearing age is assumed to vary by use category, whereas the pregnancy rate among women of childbearing age is assumed to be constant across use categories. Note that the estimated number of pregnant women exposed may not be representative of the population of susceptible fetuses and a single exposure of a chemical within a critical window of fetal development may produce adverse effects (EPA 2020e) thus, it is not possible to estimate how many pregnant women might be exposed during that critical window.

Table 8-36: Estimated Annual Number of Pregnant Workers and ONUs

Use Category	Number of Workers and ONUs	Estimated Pregnancy Rate[1]	Annual Number of Pregnant Workers and ONUs
Laboratory Use	2,510	1.33%	33.4
Manufacturing	208	1.33%	2.8
Import/Repackage	27	1.33%	0.4
Battery and Synthetic Paper Processing Aid	75	1.33%	1.0
HFC Manufacturing	56	1.33%	0.7
Intermediate in HCl Production	784	1.33%	10.4
Fluoroelastomer Manufacture	50	1.33%	0.7
Open-Top Vapor Degreasing	3,500	1.33%	46.6
Enclosed Vapor Degreasing	70	1.33%	0.9
Conveyorized Vapor Degreasing	80	1.33%	1.1
Web Vapor Degreasing	10	1.33%	0.1
Batch Cold Cleaning	520	1.33%	6.9
Disposal to Wastewater	13,302	1.15%	153.3
Incorporation Into Formulation, Mixture, or Reaction Product	588	1.33%	7.8
Mold Release	415	1.33%	5.5
Liquid Cleaners and Degreasers	17,720	1.33%	235.8
Aerosol Spray Cleaning/Degreasing	6,548	2.45%	160.6
Lubricants and Greases	1,827	1.33%	24.3
Adhesives, Sealants, Paints and Coatings	904	1.33%	12.0
Spot Removers	18,675	2.45%	457.9
Film Cleaner	-	-	-
Pepper Spray	-	-	-
Total	**67,869**	-	**1,162**

[1] Estimated as the product of the percentage of workers and ONUs that are women of childbearing age (15-44 years), using the BLS CPS ASES microdata (U.S. Census Bureau 2010-2022) and the pregnancy rate among women of childbearing age (87.4 pregnancies per 1,000 women aged 15-44 years; Maddow-Zimet and Kost 2021). For the aerosol spray cleaning/degreasing and spot remover uses, the percentages of workers and ONUs that are women of childbearing age are assumed to be equal to those estimated for individuals in the services industry in the CPS ASES data (28%). The percentage for the Disposal to Wastewater use is assumed to be equal to that estimate for individuals in the transportation and utilities industry (13%). All other uses are assumed to follow the percentage for the manufacturing industry (15%).

To the extent that the rule prohibiting certain conditions of use reduces the amount of TCE in drinking water systems thereby exposures to populations using those drinking water sources, there could be potential health-related benefits related to improved drinking water quality that EPA was unable to quantify in this economic analysis.

Public drinking water supplies are subject to a legally enforceable maximum contaminant level (MCL) for TCE established by EPA (U.S. EPA, 2018). An MCL for drinking water is the highest level of a contaminant allowed in drinking water. The MCL is based on the MCL Goal (MCLG), which is the level of a contaminant in drinking water below which there is no known or expected risk to human health. EPA sets the MCL as close to the MCLG as possible, with consideration for the best available treatment technologies and costs. For TCE, the non-enforceable MCLG is 0 and the enforceable MCL is 0.005 mg/L (or 5 ug/L). Pursuant to the MCL, public drinking water supplies are tested and treated for TCE.

TCE has been measured at concentrations above the MCL in some drinking water systems. In support for EPA's second Six-Year Review (SYR2) of NPDWRs, EPA developed a national contaminant occurrence assessment (EPA, 2010). For TCE, the report showed that average concentrations exceeded the MCL for 25 out of 50,432 systems (0.050 percent) serving approximately 410,000 people (or 0.181 percent of 227 million people) (National Primary Drinking Water Regulations; Announcement of the Results of EPA's Review of Existing Drinking Water Standards and Request for Public Comment and/or Information on Related Issues, 2010). These results are based on a subset of monitoring data provided in response to the SYR information collection request, and they do not necessarily reflect MCL violations, which are based on annual average concentrations at entry points. There were 191 MCL violations for TCE between 1998 and 2005, ranging from 12 to 31 annually. Further, for contaminants that have an MCL above the MCLG such as TCE, there may be incremental health benefits from reducing TCE concentrations even where they are below the MCL. TCE was detected with average concentration above the quantitation limit at 310 to 388 of 50,432 systems serving an approximate population of 12 to 13 million people (or 5.2 to 5.7 percent of 227 million people).[21]

The final rule's prohibition of certain conditions of use of TCE has the potential to reduce the concentration of TCE in source waters used by public drinking water systems. To the extent that this improvement in source water quality leads to decreased concentrations of TCE in finished drinking water, there could be health-related benefits from reduced ingestion, dermal absorption, or inhalation of TCE (e.g., during showering and bathing). Due to uncertainties regarding ground or surface water contamination, transport, water treatment technologies, and occurrence at potentially affected public water systems and their intake sources, these benefits are not quantified.

[21] Systems with TCE detections were widely distributed and located in most of the states providing data. A few large systems (serving 500,000 or more people) accounted for almost half of the exposed population (National Primary Drinking Water Regulations; Announcement of the Results of EPA's Review of Existing Drinking Water Standards and Request for Public Comment and/or Information on Related Issues, 2010).

9. Comparison of Costs and Benefits and Monetized Net Benefits

This chapter presents estimates for the quantified net benefits of the regulatory options. Quantified net benefits are estimated by subtracting the total annualized quantified cost of the regulatory options (see Chapter 7) from the total annualized quantified benefits (see Chapter 8). Total quantified costs reflect costs of compliance with the regulatory options, including requirements for prohibition and WCPP compliance, for those uses where costs could be estimated. Total quantified benefits reflect the benefits of reduced risk for kidney, liver and non-Hodgkin lymphoma cancer.

Table 9-1 presents the undiscounted stream of annual costs, benefits, and net benefits over the 20-year analytical timeframe. Note that year "0" costs are the initial costs and year "1" costs are recurring costs incurred in the first year. The vapor degreasing and batch cold cleaning uses account for about 85 percent of the annualized costs under Option 1 and a slightly smaller share of the costs Under Option 2. Thus, the trends observed over time for the Options largely reflect the costs attributable to these uses. Thus, the annual cost savings in out years are attributable to lower operating costs for TCE vapor degreasing alternatives. Likewise, the cost increases observed in years 6 and 9 reflect the end of the vapor degreasing 6(g) exemptions. However, the generally higher costs under Option 2 are largely attributable to in the inclusion of the use of TCE as an intermediate in HCl manufacture under Option 2.

Table 9-4 and Table 9-5 present the net benefits by use category estimated using a 3 percent discount rate using the low and high benefits estimates, respectively. Table 9-6 and Table 9-7 present the net benefits by use category estimated using a 7 percent discount rate using the low and high benefits estimates, respectively. Table 9-8 summarizes the four net benefits estimates that were estimated. Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products in these net benefits tables. These costs and benefits are aggregated under the use categories for the formulated products so that benefits and costs are comparable. This is why the costs and benefits presented in these tables are larger for the use categories for the formulated products compared to values in the cost and benefits summary tables in Chapter 7 and 8 (total costs and benefits across all use categories are the same).

Note that as discussed in Chapter 7, section 7.11, there are additional unquantified costs that affect all options. Similarly, Chapter 8 notes that there are also unquantified benefits. Therefore, it is not clear whether the monetized net benefits presented in the tables below under- or over-estimate the true social net benefits of the regulatory options.

In addition to analyzing the net benefits, EPA is required to consider the cost effectiveness of the options. Cost effectiveness is a method of comparing certain actions in terms of the expense per item of interest or goal. A goal of this regulatory action is to prevent cancer cases resulting from exposure to TCE. The final rule costs $15.4 million per potential cancer case avoided while the alternative option costs $18.6 million per potential cancer case avoided using annualized costs for the 2 percent discount rate and cancer cases avoided from one year of reduced exposure under the policy options (the average across the 20-year analytical timeframe). Thus, Option 1 has a lower cost per cancer case avoided compared to Option 2, making it the most cost-effective of the two options considered.

Table 9-1: 20-Year Stream of Annual Undiscounted Costs, Benefits, and Net Benefits (millions, 2022$)

Year	Costs		Benefits				Net Benefits			
			Low Estimate		High Estimate		Low Estimate		High Estimate	
	Option 1 (Final Rule)	Option 2 (Alternative)	Option 1 (Final Rule)	Option 2 (Alternative)	Option 1 (Final Rule)	Option 2 (Alternative)	Option 1 (Final Rule)	Option 2 (Alternative)	Option 1 (Final Rule)	Option 2 (Alternative)
0	$1,314.0	$1,324.4	$0	0	0	0	($1,314)	($1,324)	($1,314)	($1,324)
1	($10.6)	$3.8	$24	$0	$24	$25	$35	($4)	($14)	($28)
2	($10.3)	$4.0	$24	$0	$24	$25	$34	($4)	($14)	($29)
3	($13.6)	$0.4	$24	$0	$25	$25	$38	($0)	($11)	($25)
4	($13.6)	$0.4	$24	$0	$25	$25	$38	($0)	($11)	($25)
5	($13.6)	$0.4	$24	$0	$25	$25	$38	($0)	($11)	($25)
6	$5.3	$19.4	$24	$0	$25	$25	$19	($19)	($30)	($44)
7	($14.2)	($0.1)	$24	$0	$25	$25	$38	$0	($10)	($25)
8	($14.2)	($0.1)	$24	$0	$25	$25	$38	$0	($10)	($25)
9	($7.9)	$6.2	$24	$0	$25	$25	$32	($6)	($17)	($31)
10	($14.4)	($0.4)	$24	$0	$25	$25	$39	$0	($10)	($24)
11	($14.4)	($0.4)	$24	$0	$25	$25	$39	$0	($10)	($24)
12	($14.4)	($0.4)	$24	$0	$25	$25	$39	$0	($10)	($24)
13	($14.4)	($0.4)	$24	$0	$25	$25	$39	$0	($10)	($24)
14	($14.4)	($0.4)	$24	$0	$25	$25	$39	$0	($10)	($24)
15	($14.4)	($0.4)	$24	$0	$25	$25	$39	$0	($10)	($24)
16	($14.4)	($0.4)	$24	$0	$25	$25	$39	$0	($10)	($24)
17	($14.4)	($0.4)	$24	$0	$25	$25	$39	$0	($10)	($24)
18	($14.4)	($0.4)	$24	$0	$25	$25	$39	$0	($10)	($24)
19	($14.4)	($0.4)	$24	$0	$25	$25	$39	$0	($10)	($24)
20	($14.4)	($0.4)	$24	$0	$25	$25	$39	$0	($10)	($24)

Table 9-2: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (Low Benefits Estimate, 2 Percent Discount Rate, 2022$)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2

Table 9-2: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (Low Benefits Estimate, 2 Percent Discount Rate, 2022$)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Laboratory Use	$1,020,962	$1,020,962	-	-	($1,020,962)	($1,020,962)
Manufacturing	$257,925	$496,593	$9,955	$11,144	($247,970)	($485,449)
Battery and Synthetic Paper Processing Aid	$271,592	$311,972	$55,169	$56,344	($216,423)	($255,629)
HFC Manufacturing	$36,605	$71,153	$1,349	$1,510	($35,256)	($69,644)
Intermediate in HCl Production	-	$1,916,912	-	$42,384	-	($1,874,528)
Fluoroelastomer Manufacture	$181,062	$207,982	$37,513	$37,564	($143,549)	($170,418)
Open-Top Vapor Degreasing	$45,445,026	$45,493,389	$6,580,750	$6,594,356	($38,864,276)	($38,899,033)
Enclosed Vapor Degreasing	$917,124	$921,179	$2,875	$3,012	($914,249)	($918,167)
Conveyorized Vapor Degreasing	$1,037,791	$1,037,791	$195,973	$195,973	($841,818)	($841,818)
Web Vapor Degreasing	$129,724	$129,724	$6,236	$6,236	($123,488)	($123,488)
Batch Cold Cleaning	$6,745,641	$6,745,641	$610,659	$610,659	($6,134,983)	($6,134,983)
Disposal to Wastewater	$7,077,581	$18,630,260	$860,405	$859,919	($6,217,177)	($17,770,341)
Energized Electrical Cleaners (EEC)	$575,451	$575,451	$79,514	$79,714	($495,937)	($495,737)
Mold Release[1]	$52,573	$52,573	$392,326	$396,232	$339,753	$343,659
Liquid Cleaners and Degreasers[1]	$75,756	$75,756	$2,227,169	$2,226,780	$2,151,412	$2,151,023
Aerosol Spray Cleaning/Degreasing[1]	$99,119	$99,119	$6,249,562	$6,249,548	$6,150,443	$6,150,429
Lubricants and Greases[1]	$28,124	$28,124	$1,839,215	$1,837,103	$1,811,092	$1,808,979
Adhesives, Sealants, Paints and Coatings[1]	$60,332	$60,332	$857,989	$857,419	$797,657	$797,087
Spot Removers[1]	$38,715	$38,715	$2,848,077	$2,847,688	$2,809,362	$2,808,972
Pepper Spray[1]	$3,754	$3,754	$924	$493	($2,830)	($3,261)
Total	**$64,054,859**	**$77,917,383**	**$22,855,659**	**$22,914,077**	**($41,199,199)**	**($55,003,306)**

[1]Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products. These costs and benefits are aggregated under the use categories for the formulated products here so that benefits and costs are comparable. This is why the costs and benefits presented in this table are larger for the use categories for the formulated products compared to values in the cost and benefits summary tables in Chapter 7 and 8.

Table 9-3: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (High Benefits Estimate, 2 Percent Discount Rate, 2022$)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2

Table 9-3: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (High Benefits Estimate, 2 Percent Discount Rate, 2022$)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Laboratory Use	$1,020,962	$1,020,962	-	-	($1,020,962)	($1,020,962)
Manufacturing	$257,925	$496,593	$10,091	$11,296	($247,835)	($485,297)
Battery and Synthetic Paper Processing Aid	$271,592	$311,972	$55,921	$57,112	($215,671)	($254,861)
HFC Manufacturing	$36,605	$71,153	$1,367	$1,531	($35,238)	($69,623)
Intermediate in HCl Production	-	$1,916,912	-	$42,962	-	($1,873,950)
Fluoroelastomer Manufacture	$181,062	$207,982	$38,024	$38,076	($143,038)	($169,906)
Open-Top Vapor Degreasing	$45,445,026	$45,493,389	$6,670,446	$6,684,237	($38,774,581)	($38,809,152)
Enclosed Vapor Degreasing	$917,124	$921,179	$2,914	$3,053	($914,210)	($918,126)
Conveyorized Vapor Degreasing	$1,037,791	$1,037,791	$198,644	$198,644	($839,147)	($839,147)
Web Vapor Degreasing	$129,724	$129,724	$6,321	$6,321	($123,403)	($123,403)
Batch Cold Cleaning	$6,745,641	$6,745,641	$618,982	$618,982	($6,126,659)	($6,126,659)
Disposal to Wastewater	$7,077,581	$18,630,260	$872,142	$871,650	($6,205,439)	($17,758,610)
Energized Electrical Cleaners (EEC)	$575,451	$575,451	$80,618	$80,820	($494,833)	($494,630)
Mold Release[1]	$52,573	$52,573	$397,674	$401,632	$345,101	$349,059
Liquid Cleaners and Degreasers[1]	$75,756	$75,756	$2,257,525	$2,257,131	$2,181,769	$2,181,374
Aerosol Spray Cleaning/Degreasing[1]	$99,119	$99,119	$6,336,370	$6,336,356	$6,237,251	$6,237,237
Lubricants and Greases[1]	$28,124	$28,124	$1,864,284	$1,862,143	$1,836,160	$1,834,019
Adhesives, Sealants, Paints and Coatings[1]	$60,332	$60,332	$869,683	$869,106	$809,351	$808,773
Spot Removers[1]	$38,715	$38,715	$2,887,638	$2,887,244	$2,848,923	$2,848,528
Pepper Spray[1]	$3,754	$3,754	$936	$500	($2,818)	($3,254)
Total	**$64,054,859**	**$77,917,383**	**$23,169,579**	**$23,228,794**	**($40,885,279)**	**($54,688,590)**

[1]Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products. These costs and benefits are aggregated under the use categories for the formulated products here so that benefits and costs are comparable. This is why the costs and benefits presented in this table are larger for the use categories for the formulated products compared to values in the cost and benefits summary tables in Chapter 7 and 8.

Table 9-4: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (Low Benefits Estimate, 3 Percent Discount Rate, 2022$)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2

Table 9-4: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (Low Benefits Estimate, 3 Percent Discount Rate, 2022$)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Laboratory Use	$1,019,851	$1,019,851	-	-	($1,019,851)	($1,019,851)
Manufacturing	$257,227	$495,780	$7,952	$8,902	($249,275)	($486,878)
Battery and Synthetic Paper Processing Aid	$270,832	$313,678	$47,589	$45,005	($223,243)	($268,673)
HFC Manufacturing	$38,271	$74,458	$1,130	$1,264	($37,141)	($73,193)
Intermediate in HCl Production	-	$1,913,754	-	$33,854	-	($1,879,899)
Fluoroelastomer Manufacture	$180,554	$209,118	$29,960	$30,005	($150,594)	($179,114)
Open-Top Vapor Degreasing	$51,402,026	$51,454,277	$5,255,545	$5,267,311	($46,146,482)	($46,186,966)
Enclosed Vapor Degreasing	$1,011,662	$1,016,091	$2,288	$2,406	($1,009,374)	($1,013,685)
Conveyorized Vapor Degreasing	$1,175,495	$1,175,495	$156,535	$156,535	($1,018,959)	($1,018,959)
Web Vapor Degreasing	$146,937	$146,937	$4,981	$4,981	($141,955)	($141,955)
Batch Cold Cleaning	$7,640,714	$7,640,714	$487,770	$487,770	($7,152,944)	($7,152,944)
Disposal to Wastewater	$7,076,676	$18,606,842	$687,113	$686,726	($6,389,562)	($17,920,116)
Energized Electrical Cleaners (EEC)	$622,687	$622,687	$63,278	$63,450	($559,409)	($559,237)
Mold Release[1]	$57,453	$57,453	$313,375	$316,494	$255,921	$259,041
Liquid Cleaners and Degreasers[1]	$82,789	$82,789	$1,778,975	$1,778,664	$1,696,185	$1,695,875
Aerosol Spray Cleaning/Degreasing[1]	$108,321	$108,321	$4,973,971	$4,973,960	$4,865,650	$4,865,639
Lubricants and Greases[1]	$30,735	$30,735	$1,469,093	$1,467,406	$1,438,358	$1,436,671
Adhesives, Sealants, Paints and Coatings[1]	$65,933	$65,933	$685,328	$684,873	$619,395	$618,940
Spot Removers[1]	$42,309	$42,309	$2,266,751	$2,266,440	$2,224,442	$2,224,131
Pepper Spray[1]	$4,103	$4,103	$738	$394	($3,365)	($3,709)
Total	**$71,234,573**	**$85,081,323**	**$18,232,371**	**$18,276,440**	**($53,002,202)**	**($66,804,883)**

[1]Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products. These costs and benefits are aggregated under the use categories for the formulated products here so that benefits and costs are comparable. This is why the costs and benefits presented in this table are larger for the use categories for the formulated products compared to values in the cost and benefits summary tables in Chapter 7 and 8.

Table 9-5: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (High Benefits Estimate, 3 Percent Discount Rate, 2022$)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2

Table 9-5: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (High Benefits Estimate, 3 Percent Discount Rate, 2022$)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Laboratory Use	$1,019,851	$1,019,851	-	-	($1,019,851)	($1,019,851)
Manufacturing	$257,227	$495,780	$8,065	$9,029	($249,161)	($486,751)
Battery and Synthetic Paper Processing Aid	$270,832	$313,678	$48,270	$45,649	($222,561)	($268,028)
HFC Manufacturing	$38,271	$74,458	$1,146	$1,283	($37,125)	($73,175)
Intermediate in HCl Production	-	$1,913,754	-	$34,339	-	($1,879,415)
Fluoroelastomer Manufacture	$180,554	$209,118	$30,389	$30,434	($150,166)	($178,684)
Open-Top Vapor Degreasing	$51,402,026	$51,454,277	$5,330,782	$5,342,718	($46,071,244)	($46,111,560)
Enclosed Vapor Degreasing	$1,011,662	$1,016,091	$2,321	$2,440	($1,009,341)	($1,013,650)
Conveyorized Vapor Degreasing	$1,175,495	$1,175,495	$158,776	$158,776	($1,016,718)	($1,016,718)
Web Vapor Degreasing	$146,937	$146,937	$5,053	$5,053	($141,884)	($141,884)
Batch Cold Cleaning	$7,640,714	$7,640,714	$494,753	$494,753	($7,145,961)	($7,145,961)
Disposal to Wastewater	$7,076,676	$18,606,842	$696,596	$696,203	($6,380,080)	($17,910,639)
Energized Electrical Cleaners (EEC)	$622,687	$622,687	$64,170	$64,345	($558,516)	($558,342)
Mold Release[1]	$57,453	$57,453	$317,861	$321,025	$260,408	$263,572
Liquid Cleaners and Degreasers[1]	$82,789	$82,789	$1,804,442	$1,804,127	$1,721,653	$1,721,338
Aerosol Spray Cleaning/Degreasing[1]	$108,321	$108,321	$5,044,106	$5,044,095	$4,935,786	$4,935,774
Lubricants and Greases[1]	$30,735	$30,735	$1,490,124	$1,488,413	$1,459,390	$1,457,678
Adhesives, Sealants, Paints and Coatings[1]	$65,933	$65,933	$695,139	$694,677	$629,206	$628,744
Spot Removers[1]	$42,309	$42,309	$2,298,713	$2,298,397	$2,256,403	$2,256,088
Pepper Spray[1]	$4,103	$4,103	$748	$399	($3,354)	($3,703)
Total	**$71,234,573**	**$85,081,323**	**$18,491,456**	**$18,536,156**	**($52,743,118)**	**($66,545,167)**

[1]Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products. These costs and benefits are aggregated under the use categories for the formulated products here so that benefits and costs are comparable. This is why the costs and benefits presented in this table are larger for the use categories for the formulated products compared to values in the cost and benefits summary tables in Chapter 7 and 8.

Table 9-6: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (Low Benefits Estimate, 7 Percent Discount Rate, 2022$)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2

Table 9-6: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (Low Benefits Estimate, 7 Percent Discount Rate, 2022$)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Laboratory Use	$1,015,018	$1,015,018	-	-	($1,015,018)	($1,015,018)
Manufacturing	$254,189	$492,243	$3,805	$4,260	($250,384)	($487,983)
Battery and Synthetic Paper Processing Aid	$267,524	$321,094	$22,296	$21,535	($245,227)	($299,559)
HFC Manufacturing	$44,392	$86,691	$635	$711	($43,757)	($85,980)
Intermediate in HCl Production	-	$1,900,018	-	$16,199	-	($1,883,819)
Fluoroelastomer Manufacture	$178,349	$214,063	$14,329	$14,357	($164,021)	($199,706)
Open-Top Vapor Degreasing	$77,266,553	$77,335,094	$2,512,991	$2,520,450	($74,753,562)	($74,814,643)
Enclosed Vapor Degreasing	$1,409,320	$1,415,334	$1,079	$1,151	($1,408,241)	($1,414,183)
Conveyorized Vapor Degreasing	$1,774,397	$1,774,397	$74,903	$74,903	($1,699,494)	($1,699,494)
Web Vapor Degreasing	$221,800	$221,800	$2,384	$2,384	($219,416)	($219,416)
Batch Cold Cleaning	$11,533,580	$11,533,580	$233,402	$233,402	($11,300,178)	($11,300,178)
Disposal to Wastewater	$7,072,738	$18,504,991	$329,139	$328,953	($6,743,599)	($18,176,037)
Energized Electrical Cleaners (EEC)	$820,958	$820,958	$30,304	$30,414	($790,654)	($790,544)
Mold Release[1]	$78,680	$78,680	$149,952	$151,445	$71,272	$72,765
Liquid Cleaners and Degreasers[1]	$113,376	$113,376	$851,254	$851,105	$737,878	$737,729
Aerosol Spray Cleaning/Degreasing[1]	$148,340	$148,340	$2,384,335	$2,384,330	$2,235,995	$2,235,989
Lubricants and Greases[1]	$42,090	$42,090	$702,973	$702,165	$660,883	$660,076
Adhesives, Sealants, Paints and Coatings[1]	$90,292	$90,292	$327,935	$327,717	$237,643	$237,425
Spot Removers[1]	$57,941	$57,941	$1,086,597	$1,086,449	$1,028,657	$1,028,508
Pepper Spray[1]	$5,618	$5,618	$353	$188	($5,265)	($5,430)
Total	**$102,395,154**	**$116,171,618**	**$8,728,666**	**$8,752,119**	**($93,666,488)**	**($107,419,499)**

[1]Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products. These costs and benefits are aggregated under the use categories for the formulated products here so that benefits and costs are comparable. This is why the costs and benefits presented in this table are larger for the use categories for the formulated products compared to values in the cost and benefits summary tables in Chapter 7 and 8.

Table 9-7: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (High Benefits Estimate, 7 Percent Discount Rate, 2022$)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2

Table 9-7: Total 20-Year Annualized Net Benefits by Use Category and Regulatory Option (High Benefits Estimate, 7 Percent Discount Rate, 2022$)

Use Category	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Laboratory Use	$1,015,018	$1,015,018	-	-	($1,015,018)	($1,015,018)
Manufacturing	$254,189	$492,243	$3,867	$4,329	($250,322)	($487,914)
Battery and Synthetic Paper Processing Aid	$267,524	$321,094	$22,658	$21,884	($244,866)	($299,210)
HFC Manufacturing	$44,392	$86,691	$645	$723	($43,747)	($85,969)
Intermediate in HCl Production	-	$1,900,018	-	$16,462	-	($1,883,557)
Fluoroelastomer Manufacture	$178,349	$214,063	$14,561	$14,590	($163,788)	($199,473)
Open-Top Vapor Degreasing	$77,266,553	$77,335,094	$2,553,722	$2,561,302	($74,712,831)	($74,773,791)
Enclosed Vapor Degreasing	$1,409,320	$1,415,334	$1,096	$1,170	($1,408,223)	($1,414,164)
Conveyorized Vapor Degreasing	$1,774,397	$1,774,397	$76,117	$76,117	($1,698,279)	($1,698,279)
Web Vapor Degreasing	$221,800	$221,800	$2,422	$2,422	($219,377)	($219,377)
Batch Cold Cleaning	$11,533,580	$11,533,580	$237,185	$237,185	($11,296,395)	($11,296,395)
Disposal to Wastewater	$7,072,738	$18,504,991	$334,474	$334,285	($6,738,264)	($18,170,706)
Energized Electrical Cleaners (EEC)	$820,958	$820,958	$30,773	$30,884	($790,185)	($790,074)
Mold Release[1]	$78,680	$78,680	$152,383	$153,900	$73,703	$75,220
Liquid Cleaners and Degreasers[1]	$113,376	$113,376	$865,051	$864,900	$751,675	$751,524
Aerosol Spray Cleaning/Degreasing[1]	$148,340	$148,340	$2,421,164	$2,421,159	$2,272,824	$2,272,819
Lubricants and Greases[1]	$42,090	$42,090	$714,367	$713,546	$672,277	$671,457
Adhesives, Sealants, Paints and Coatings[1]	$90,292	$90,292	$333,250	$333,029	$242,958	$242,736
Spot Removers[1]	$57,941	$57,941	$1,103,380	$1,103,229	$1,045,440	$1,045,289
Pepper Spray[1]	$5,618	$5,618	$359	$191	($5,259)	($5,427)
Total	**$102,395,154**	**$116,171,618**	**$8,867,475**	**$8,891,308**	**($93,527,680)**	**($107,280,310)**

[1]Note that costs and benefits for import/repackage and incorporation into formulation, mixture, or reaction product are accounted for under the use categories for the formulated products. These costs and benefits are aggregated under the use categories for the formulated products here so that benefits and costs are comparable. This is why the costs and benefits presented in this table are larger for the use categories for the formulated products compared to values in the cost and benefits summary tables in Chapter 7 and 8.

Table 9-8: Total 20-Year Annualized Net Benefits by Regulatory Option, (Millions, 2022$)

Estimate	Costs		Benefits		Net Benefits	
	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2	Option 1 (Final Rule)	Option 2
Low Benefits, 2 Percent Discount Rate	$64	$78	$23	$23	($41)	($55)
High Benefits, 2 Percent Discount Rate	$64	$78	$23	$23	($41)	($55)
Low Benefits, 3 Percent Discount Rate	$71	$85	$18	$18	($53)	($67)
High Benefits, 3 Percent Discount Rate	$71	$85	$18	$19	($53)	($67)
Low Benefits, 7 Percent Discount Rate	$102	$116	$9	$9	($94)	($107)
High Benefits, 7 Percent Discount Rate	$102	$116	$9	$9	($94)	($107)

10. Economic Impact Analyses

In addition to the cost analysis presented in Chapter 7, several other types of impacts are important to consider in evaluating the effects of a regulation. This chapter presents the incremental impact of the rule on:

- The environmental health risk or safety risk to children due to the regulation, as required by Executive Order 13045–Protection of Children from Environmental Health & Safety Risks (Section 10.1);
- Small Entities, as required by the Regulatory Flexibility Act (RFA) of 1980, amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 (Section 10.2);
- Employment Impact Analysis (Section 10.3);
- Paperwork burden, as required by the Paperwork Reduction Act (Section 10.4);
- State and Local Governments, as required by the Unfunded Mandates Reform Act (Section 10.5);
- Environmental Justice, as required by Executive Order 12898–Environmental Justice (Section 10.6);
- Impacts on Technological Innovation and the National Economy (Section 10.7);
- Federalism, as required by Executive Order 13132 (Section 10.8); and
- Tribal Governments, as required by Executive Order 13175 (Section 10.9).

10.1 Protection of Children from Environmental Health Risks and Safety Risks

Executive Order 13045 applies if the regulatory action is a significant regulatory action under section 3(f)(1) of Executive Order 12866 and concerns an environmental health risk or safety risk that may disproportionately affect children. Although this action concerns an environmental health risk or safety risk that may disproportionately affect children, it is not subject to Executive Order 13045 because it is not a significant regulatory action under section 3(f)(1) of Executive Order 12866 (costs are less than $200 million).

10.2 Small Entity Impacts

This section addresses the potential impacts of the final rule on small entities. Figure 10-1 provides an overview of the approach used for the small business analysis. As indicated in the figure, two different approaches are used depending on whether specific individual entities affected are known.

The following use categories do not include any affected small businesses according to SBA's small business thresholds (SBA 2023):

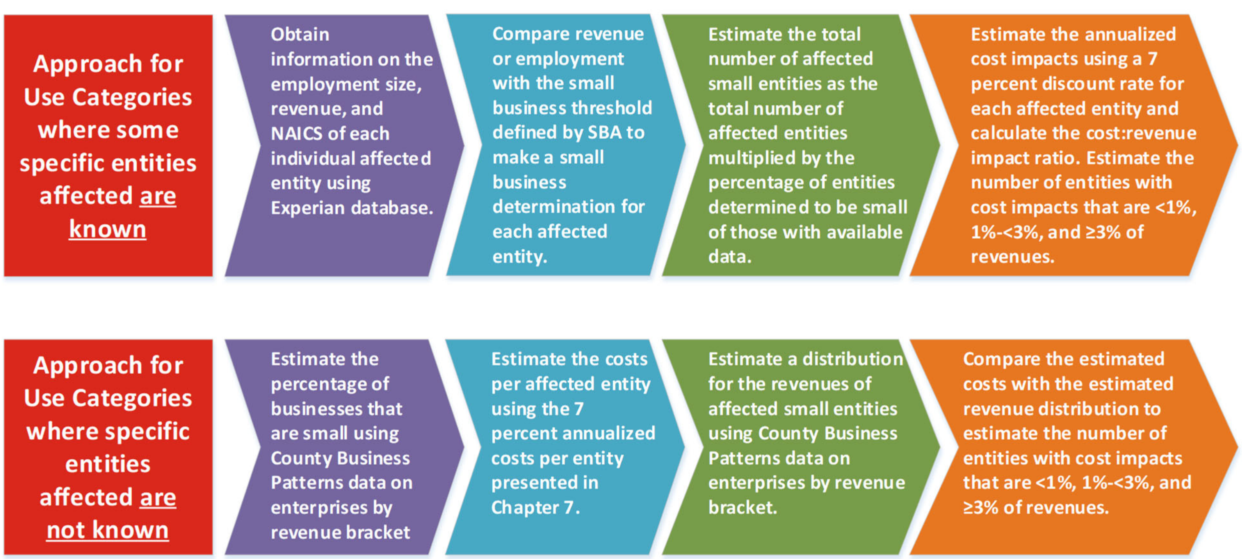
- Manufacturing
- HFC Manufacturing
- Fluoroelastomer Manufacture

With the exception of EEC users, no incremental costs beyond the cost of rule familiarization are estimated for users of TCE products, who are assumed to switch to TCE-free alternatives with similar costs and efficacy under the rule. As noted in section 7.12.2, there may be some applications where TCE is more effective, reducing labor time and wait time, and this analysis was unable to quantify these costs. For example, there may be some safety-critical applications where alternatives would need to undergo extensive safety reviews and testing before they could replace the TCE products. The impact of a prohibition of TCE for these uses could potentially result in important negative impacts of the rule, but EPA is unable to quantify any of these potential impacts, so cost impacts to potentially affected small businesses could not be estimated.

Data on the NAICS, employment, and revenue for entities with potential impacts was retrieved from the Dun and Bradstreet Hoovers database (Dun & Bradstreet 2022) and the Experian Business Target IQ database (Experian 2023). These data were compared against SBA's small business thresholds (SBA 2023) to determine which entities were small. For affected vapor degreasing firms, where only a subset of the affected entities could be identified (i.e., those that appear in the NEI data), EPA estimated that 72 percent of vapor degreasing firms were small, based on the 86 firms with sufficient data available in the Dun and Bradstreet Hoovers database (Dun & Bradstreet 2022) to make a small business determination.

Except for the vapor degreasing, batch cold cleaning uses, and other users of products that contain TCE, each individual affected entity was identified in the Dun and Bradstreet Hoovers database (Dun & Bradstreet 2022), which includes the employment and revenue data necessary to make the small business determination (see Table 3-2, above, for the full list of affected entities identified in the Dun and Bradstreet Hoovers database). The percentage of vapor degreasing and batch cold cleaning facilities that are owned by small firms was estimated from the 90 facilities with sufficient information on their parent company for making a small business determination in the Dun and Bradstreet Hoovers database (Dun & Bradstreet 2022) and the Experian Business Target IQ database (Experian 2023). The revenue distribution for these firms is estimated as the revenues for the 71 small firms for which revenue data was available in the Dun and Bradstreet Hoovers database (Dun & Bradstreet 2022) or the Experian Business Target IQ database (Experian 2023). U.S. Census Bureau (2021) county business patterns data by enterprise receipt size is used to estimate the number of small entities in the use categories without known individual affected entities. Since the U.S. Census Bureau (2021) reflects 2017 receipts, they were inflated to 2022$ using the GDP deflator (U.S. Bureau of Economic Analysis 2023c).

Figure 10-1: Overview of small business analysis approach, which differs depending on whether the specific entities affected are known



10.2.1 Regulatory Requirement for Small Business Analysis

The Regulatory Flexibility Act (RFA) of 1980, amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996, requires regulators to assess the effects of regulations on small entities including businesses, nonprofit organizations, and governments. In some instances, agencies are also required to examine regulatory alternatives that may reduce adverse economic effects on significantly impacted small entities. The RFA requires agencies to prepare an initial and final regulatory flexibility analysis for each rule unless the Agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. The RFA, however, does not specifically define "a significant economic impact on a substantial number" of small entities. Sections 603 and 604 of the RFA require that regulatory flexibility analyses identify the types and numbers of small entities to which the rule would apply, describe the rule requirements to which small entities would be subject, and describe any regulatory alternatives, including exemptions and deferral, which would lessen the rule's burden on small entities. Under the Regulatory Flexibility Act (RFA), the definition of a "small business" is determined by the U.S. Small Business Administration's regulations at 13 CFR 121.201 (which create small business size standards using either a sales or employment threshold, depending on the nature of the industry), unless an agency establishes an alternate definition.

To fulfill the requirements of the RFA, this analysis addresses two basic questions regarding the rule: (1) the number and type of small entities potentially affected, and (2) the extent of the rule's potential economic impact on those entities as measured by the cost-to-revenue ratio. This ratio is a good measure of entities' ability to afford the costs attributable to a regulatory requirement because comparing compliance costs to revenues or expenses provides a reasonable indication of the magnitude of the regulatory burden relative to a commonly available measure of economic activity. Where regulatory costs represent a small fraction of a typical entity's revenues or expenses, the financial impacts of the regulation on such entities may be considered as not significant.

10.2.2 Estimated Number of Affected Small Entities

As noted above, the number of small entities with cost impacts is estimated using either Experian (2023) or U.S. Census Bureau (2021) data, depending on whether the individual affected entities are known.[22]

10.2.2 (A) Use Categories with Some Known Individual Affected Entities

Table 10-1 presents the estimated total number of affected entities and the estimated number of affected entities defined as small businesses for the use categories where Experian (2023) data for known affected entities were used to make the small business determinations.[23]

[22] Dun & Bradstreet (2022) data on numbers of employees and revenues were used when entities could not be identified in the Experian data.

[23] Dun & Bradstreet (2022) data on numbers of employees and revenues were used when entities could not be identified in the Experian data.

Table 10-1: Number of Affected Small Entities for Use Categories Estimated from Individual Affected Entities

Use Category	NAICS	Number of Affected Facilities (including large businesses)	Number of Small Firms with Estimated Impacts
Laboratory Use	561990	251	25
Manufacturing	-	2	-
Import/Repackage	424690, 424950	9	5
Battery and Synthetic Paper Processing Aid	326291	3	1
HFC Manufacturing	-	2	-
Fluoroelastomer Manufacture	-	2	-
Open-Top Vapor Degreasing	333415, 333515, 333612, 333912, 333914, 333921, 333922, 333923, 333924, 333991, 333992, 333993, 333994, 333995, 333996, 333997, 333999, 334416, 334417, 334418, 334419, 334512, 334513, 334515, 335110, 335121, 335122, 335129, 335311, 335312, 335313, 335314, 335921, 335991, 336310, 336320, 336330, 336340, 336350, 336360, 336370, 336390, 336411, 336412, 336413, 336415, 336510, 337127, 339113, 339114, 339910, 339993, 339999, 488190, 811212, 811310	350	276
Enclosed Vapor Degreasing	331210, 331221, 331222, 332721, 332722, 332911, 332912, 332913, 332919, 332991, 332992, 332993, 332994, 332996, 332999	7	6
Conveyorized Vapor Degreasing	331210, 331221, 331222, 331410, 331420, 331491, 331492, 332111, 332112, 332114, 332117, 332119, 332215, 332216, 332710, 332721, 332722	8	6
Web Vapor Degreasing	331110	1	1
Batch Cold Cleaning	324110, 325612, 325992, 327420, 331110, 331210, 332119, 332721, 332811, 332812, 332994, 332999, 334511, 336111, 336214, 336412, 336414, 336415, 336611, 339991, 423510, 493190, 811219, 812332	52	41
Incorporation Into Formulation, Mixture, or Reaction Product	333249, 423830, 325612, 424690, 424690, 424690, 325612, 325120, 424690, 339993, 423840, 325180, 424690, 561499, 325612, 424690	28	16
Notes: See section 6.2 for a description of how the estimated number of affected entities were estimated.			

10.2.2 (B) Use Categories without Known Individual Affected Entities

U.S. Census Bureau (2021) county business patterns data by enterprise receipt size is used to estimate the number of small entities in the use categories without known individual affected entities. Since the U.S. Census Bureau (2021) reflects 2017 receipts, they were inflated to 2022$ using the GDP deflator (U.S. Bureau of Economic Analysis 2023c). See Table 3-1, above, for the numbers of firms above and below SBA's small business revenue thresholds (SBA 2023) for the NAICS in these use categories.

The percentage of firms that are small entities shown in Table 10-2 is calculated from the share of firms in each affected NAICS that are defined as small (see the total number of firms and the number of small firms by NAICS in Table 3-1). The number of affected small firms is calculated by multiplying the total number of affected firms by the percentage that are small.

Table 10-2: Number of Affected Firms and Small Firms Estimated from Census Data

Use Category	Small Entity NAICS	Number of Affected Firms	Percent Small	Number of Affected Small Firms
Disposal and Recycling	562211, 562920	739	2%	17
Energized Electrical Cleaners	811213, 811219, 811310, 811411, 811490	668	97%	651
Mold Release	326211, 326212, 332919, 335220, 336320, 336390, 812332	17	90%	15
Liquid Cleaners and Degreasers	313230, 333514, 334310, 441110, 441120, 451110, 811111, 811112, 811113, 811118, 811121, 811122, 811191, 811198, 811211, 811212, 811213, 811219, 811310, 811411, 811490	11,815	98%	11,574
Aerosol Spray Cleaning/Degreasing	313230, 333514, 334310, 441110, 441120, 451110, 811111, 811112, 811113, 811118, 811121, 811122, 811191, 811198, 811211, 811212, 811213, 811219, 811310, 811411, 811490	3,698	98%	3,626
Lubricants and Greases	332321, 332322, 332323, 332410, 332420, 332431, 332439, 332510, 332613, 332618, 332710, 332721, 332722, 332911, 332912, 332913, 332919, 332991, 332992, 332993, 332994, 332996, 332999, 333111, 333112, 333120, 333131, 333132, 333241, 333242, 333243, 333244, 333249, 333314, 333316, 333318, 333413, 333414, 333415, 333511, 333514, 333515, 333517, 333519, 333611, 333612, 333613, 333618, 333912, 333914, 333921, 333922, 333923, 333924, 333991, 333992, 333993, 333994, 333995, 333996, 333997, 333999, 336111, 336112, 336120, 336211, 336212, 336213, 336214, 336310, 336320, 336330, 336340, 336350, 336360, 336370, 336390, 336411, 336412, 336413, 336414, 336415, 336419, 336510, 336611, 336612, 336991, 336992, 336999, 337124	345	96%	332
Adhesives, Sealants, Paints and Coatings	313210, 313320, 321992, 322220, 324199, 325510, 325520, 325998, 326140, 326150, 326211, 326212, 326220, 326299, 331523, 332321, 332812, 332813, 332993, 332994, 332999, 333515, 333914, 334417, 334511, 335312, 335931, 336211, 336213, 336350, 336360, 336390, 336411, 336415, 336611, 337110, 337121, 337122, 337211, 339113, 339920, 339991, 481111, 928110	65	89%	58
Spot Removers	561740, 812310, 812320	4,980	99%	4,949

10.2.3 Estimated Cost and Small Business Impacts

Table 10-3 presents the estimated average costs per entity and the range for estimated small business revenues.

The cost impacts for laboratory use and battery and synthetic paper processing aid are estimated from the per-facility and per-worker/ONU WCPP compliance unit costs (see section 7.8, 7.9, and 7.10). The numbers of affected workers and ONUs are estimated as the lesser of the total number of employees at the affected firm and the numbers of workers and ONUs estimated to be affected in Chapter 6.

The cost impacts for the vapor degreasing use categories and batch cold cleaning are described above in section 7.7 and summarized in Table 7-41.

Costs for the incorporation into formulation, mixture, or reaction product use category reflect a reformulation cost of $64,966 per product (see Table 7-9).

Firms that are not subject to WCPP requirements are assumed to incur an initial managerial labor burden of one hour for rule familiarization. The wage rate for the Disposal to Wastewater use category is the transportation and public utilities sector wage rate ($91.13). The wage rate for the Aerosol Spray Cleaning/Degreasing and Spot Removers use categories is the service sector wages ($95.71). The manufacturing sector wage was used for other use categories for firms who use TCE products that will be prohibited ($94.74). Assuming a minimum revenue equal to the loaded annual wages for one full-time employee, the cost impacts are all estimated to be less than one percent of firm revenues.

Table 10-3: Per Firm Cost Impacts for Small Businesses

Use Category	Estimated Average per Facility Costs (2022$ 7% Annualized Costs)	Range for estimated small business revenues (thousands, 2022$)	Notes
Laboratory Use	$4,044	$408	WCPP costs
Manufacturing	-	-	No affected small entities
Import/Repackage	$25	$11,700 - $186,070	Rule familiarization and downstream notification costs
Battery and Synthetic Paper Processing Aid	$89,175	$45,490	WCPP costs
HFC Manufacturing	-	-	No affected small entities
Fluoroelastomer Manufacture	-	-	No affected small entities
Vapor Degreasing and Batch Cold Cleaning uses	$129,916	$315 - $1,188,030	Costs of switching to alternative cleaning methods.
Disposal and Recycling	$9,571	$1,578 - $47,000	WCPP costs
Energized Electrical Cleaners	$1,222	$24,480	One year of prescriptive control costs followed by prohibition costs
Incorporation Into Formulation, Mixture, or Reaction Product	$2,371 - $61,637	$3,100 - $770,000	Costs of reformulation, plus the costs of compliance with WCPP requirements for one energized electric cleaning facility
Mold Release	$8.17	$197	Rule Familiarization Costs
Liquid Cleaners and Degreasers	$8.17	$197	Rule Familiarization Costs
Aerosol Spray Cleaning/Degreasing	$8.26	$199	Rule Familiarization Costs
Lubricants and Greases	$8.17	$197	Rule Familiarization Costs
Adhesives, Sealants, Paints and Coatings	$8.17	$197	Rule Familiarization Costs
Spot Removers	$8.26	$199	Rule Familiarization Costs

10.2.4 Summary of Estimated Small Business Impacts

Table 10-4 presents a summary of the estimated small business impacts. Except for the vapor degreasing and batch cold cleaning uses, the cost-revenue impact ratios are all less than 1% of revenues. The cost impact is estimated to be between $8 to $129,944.

Table 10-4: Summary of Small Business Impacts

Use Category	Number of Small Firms	Average Cost Per Small Firm (2022$, 7% Discount Rate)	Number and Percent of Firms by Cost-Revenue Impact Threshold		
			<1%	1-3%	>3%
Laboratory Use	25	$4,044	25 (100%)	-	-
Import/Repackage	5	$25	5 (100%)	-	-
Battery and Synthetic Paper Processing Aid	1	$89,175	1 (100%)	-	-
Vapor Degreasing and Batch Cold Cleaning Uses	330	$129,845	-	-	330 (100%)
Incorporation Into Formulation, Mixture, or Reaction Product	16	$2,371 - $61,637	16 (100%)	-	-
Disposal to Wastewater	17	$9,571	17 (100%)	-	-
Energized Electrical Cleaners	651	$1,222	651 (100%)	-	-
Mold Release	15	$8	15 (100%)	-	-
Liquid Cleaners and Degreasers	11,574	$8	11,574 (100%)	-	-
Aerosol Spray Cleaning/Degreasing	3,626	$8	3,626 (100%)	-	-
Lubricants and Greases	332	$8	332 (100%)	-	-
Adhesives, Sealants, Paints and Coatings	58	$8	58 (100%)	-	-
Spot Removers	4,949	$8	4,949 (100%)	-	-
Total	**21,599**	**$8 - $129,845**	**21,269 (98.5%)**	**-**	**330 (1.5%)**

10.3 Employment Effects

Employment impacts of environmental regulations include a mix of potential declines and gains in different sectors of the economy over time. Impacts on employment can vary according to labor market conditions and may differ across occupations, industries, and regions. Isolating employment impacts of regulation is difficult as such impacts are a challenge to disentangle from effects on employment caused by a wide variety of ongoing concurrent economic changes.

In the long run, environmental regulation is expected to cause a shift of employment among employers rather than affect the general employment level (Arrow, Cropper et al. 1996; Hafstead and Williams III 2020). However, even if employment impacts are mitigated by long-run market adjustments to full employment, many regulatory actions have transitional effects in the short run (OMB 2015; Walker 2013). These movements of workers in and out of jobs in response to environmental regulation are potentially important distributional impacts of interest to policy makers. Of particular concern is the potential for transitional job losses experienced by workers operating in declining industries, exhibiting low migration rates, or living in communities or regions where unemployment rates are high.

Compliance with environmental regulation can result in increased demand for the inputs or factors (including labor) used in the production of environmental protection. However, the regulated sector generally relies on revenues generated by other market outputs to cover the costs of supplying increased environmental quality. This can lead to reduced demand for labor and other factors of production used to produce the market output. Employment impacts, both positive and negative, in sectors upstream and downstream from the regulated sector, or in sectors producing substitute or complimentary products, may also occur.

10.3.1 Baseline Employment

Facilities using consumer/commercial products containing TCE are not expected to experience any cost impacts associated with switching to TCE-free alternatives, since alternative products with similar efficacy and cost are already available (see Chapter 5).

There are potential employment impacts for other uses of TCE, described below in section 10.3.2. Table 10-5 presents a summary of the affected sites and industry statistics for the affected sectors.

Table 10-5: Industry Statistics for Sectors Affected by WCPP Requirements and Summary of Employment at Affected Facilities

Use Category	Industry Statistics[1]							Affected Facilities[2]	
	Number of Firms	Number of Establish-ments	Employment			Annual Payroll Per Employee (thousands 2022$)	Preliminary Receipts (thousands, 2022$)	Facilities	Employees at Affected Facilities
			Total	Per Estab-lishment	10-Year Percent Change				
Laboratory Use	17,847	23,245	2,545,199	109	7%	$77	$634,679,217	251	27,483
Manufacturing	1,636	3,632	210,111	58	3%	$115	$232,920,060	2	208
Battery and Synthetic Paper Processing Aid	1,533	1,805	90,600	50	21%	$73	$44,041,900	3	151
HFC Manufacturing	814	1,118	67,038	60	5%	$106	$51,355,626	2	120
Intermediate in HCl Production	2,729	4,467	286,579	64	8%	$118	$918,626,279	28	1,796
Fluoroelastomer Manufacture	1,157	1,383	74,656	54	15%	$55	$21,016,883	2	108
Open-Top Vapor Degreasing	59,284	65,164	2,304,480	35	10%	$75	$1,065,060,269	350	12,378
Enclosed Vapor Degreasing	10,711	11,530	439,446	38	14%	$66	$146,218,750	7	267
Conveyorized Vapor Degreasing	26,603	27,735	612,528	22	13%	$62	$208,880,429	8	177
Web Vapor Degreasing	369	522	93,552	179	-2%	$89	$109,616,435	1	179
Batch Cold Cleaning	27,259	34,493	1,351,749	39	6%	$87	$1,384,392,899	52	2,038

[1]Industry Statistics are from Table 3-1 and 2009 U.S. Statistics of U.S. Business data (U.S. Census Bureau 2012), aggregated according to use category.
[2]Employees at affected sites are estimated as either the number of facilities multiplied by the average employment per establishment (Table 3-1) or the estimated number of workers and ONUs from Table 6-20, whichever is greater.

10.3.2 Potential Employment Impacts of the Rule

As noted above, facilities using consumer/commercial products containing TCE are not expected to experience any cost impacts associated with switching to TCE-free alternatives, since alternative products with similar efficacy and cost are already available (see Chapter 5). Similarly, EPA believes that the producers of these products will reformulate them using TCE-free alternatives and importers and repackagers of these products will import or repackage TCE-free alternatives. Thus, EPA expects minimal employment impacts from eliminating TCE from consumer/commercial products because there are adequate substitutes and little to no changes in equipment or processes necessary. Many current suppliers of TCE products also provide TCE-free alternatives and therefore the effect on their businesses will likely be limited.

Table 10-5, above, also summarizes the number of potentially affected employees at facilities where there are potential employment impacts. For several of these uses, a workplace chemical protection plan (WCPP) is required until the use of TCE is phased out. The costs of WCPP compliance can be substantial and the estimated annualized costs range from about $44,000 to $7 million at these facilities. Given these costs, affected facilities may opt to comply with the proposed rule by closing or shifting operations abroad where TCE use is not regulated or reduce their capacity.[24] While EPA believes these facilities will likely be able to comply with the WCPP, some unknown number of facilities may close or move operations abroad.

In the event that some facilities choose not to switch or are unable to switch to an alternative to TCE, they may close and workers may experience job loss, at least temporarily. While it may not be an option for small businesses, larger employers may shift workers to other facilities. Finding alternative work may be more challenging for older workers or workers with specialized skills that are not in demand elsewhere, or workers in communities with limited job opportunities. Dislocated employees as a result of any capacity reductions or closures may find new jobs, temporarily enter unemployment, or leave the labor force. Employment declines in the local communities where these plants are located, if the capacity reductions or closures are permanent, may result in negative spillovers to the local economy. While the literature is evolving, a recent update and review of published estimates of such 'local multipliers' in the economics literature suggests that an additional 0.5 jobs may be eliminated in the metropolitan region per direct job lost (Osman and Kemeny 2021).

Upstream impacts on facilities that use TCE might include impacts on workers at firms that may be developing alternatives or substitutes to TCE. For example, there may be increased temporary employment associated with reformulating TCE-free alternatives and converting production processes to use TCE substitute technologies. In general, EPA expects these impacts to be small as most uses and users have existing clear alternatives to TCE.

There are multiple regulated uses with the potential for downstream impacts. These include laboratory use, manufacturing, HFC manufacturing, intermediate in HCl production, fluoroelastomer manufacture, vapor degreasing, and cold cleaning. Facility closure, shifting production abroad, or downtime while converting to TCE-free alternative processes could all result in downstream impacts from supply chain disruptions, including potential employment impacts.

Turning to a nationwide perspective, job impacts (both positive and negative) in the local labor market do not tell the full story. In the long run environmental regulation is expected to cause a shift of employment among employers and not affect the general employment level. In general, in periods of low unemployment, workers experiencing job loss are more easily able to transition to other jobs and

[24] Facilities could also comply by switching to a TCE alternative, but employment impacts would not be expected from switching to a TCE alternative.

industries. The transitional impacts described above are nonetheless important for the employees and communities in which they are felt.

Finally, EPA acknowledges that employment impacts, both positive and negative, are possible in indirectly affected sectors upstream and downstream from the regulated sector, or in sectors producing substitute or complimentary products. This might include gains at upstream facilities that manufacture the equipment necessary for conversions to an alternative technology.

In conclusion, while EPA does not have data to quantify employment impacts of the final rule, most workers currently using TCE are expected to continue employment while shifting away from TCE use and towards alternatives. However, EPA acknowledges that transitional employment impacts may be experienced by some workers at facilities that opt to close or shift operations abroad instead of complying with requirements at the facilities currently using TCE.

10.4 Paperwork Burden Analysis

This section presents a summary of the burden and associated costs for the respondents associated with the recordkeeping and reporting requirements of the final action. The detailed paperwork burden analysis is presented in the information collection request (ICR) supporting statement for this rulemaking. It provides the average annual burden and cost estimates for the next three years of the program.

The paperwork burden and associated costs include the activity types listed below. Note that not all entities would incur burden or costs from these activities because they may already be meeting the requirements under as part of their usual business practices.

- Rule familiarization
    - The 1,009 facilities complying with WCPP requirements and the 668 firms complying with prescriptive control requirements are assumed to incur an initial cost of $284 for a 3-hour burden associated with rule familiarization. This results in an annual average burden and cost of 1,677 hours and $158,864.
    - The 21,393 facilities complying with prohibition requirements are assumed to incur an initial cost of $95 for a 1-hour burden associated with rule familiarization. This results in an annual average burden and cost of 7,131 hours and $678,520.
- Downstream notification
    - Each person who processes or distributes in commerce TCE or TCE-containing products for any use must, prior to or concurrent with the shipment, notify companies to whom TCE is shipped, in writing, of the restrictions on its use. It is assumed that the two manufacturers accomplish this by modifying the SDS to note the restrictions. The burden associated with the downstream notification requirements, including the related recordkeeping, is 2 hours, with an associated labor cost of $189. This results in an annual average burden and cost of 7.3 hours and $695. Shipment records are assumed to be kept as part of ordinary business practices, and therefore no incremental burden is estimated for this requirement.
- Dermal Protection
    - Under the final rule, facilities required to comply with dermal controls include those facilities complying with the rule through a WCPP or prescriptive controls. These facilities would be required to develop a dermal protection control program (estimated 5 initial hours per facility).

  - EPA estimates that 1,677 respondents will incur a total average annual cost of $199,720 for dermal protection over the first three years of the rule from an average annual total time burden of 2,800 hours.

- Respiratory Protection

  - Under the final rule, the 1,009 facilities complying with the rule through an WCPP would be required to develop exposure control plans, monitor exposure levels, maintain records of this monitoring, provide employees with information about how they can access the exposure control plans, exposure monitoring records, PPE program implementation documentation, and respirator program documentation, and obtain an acknowledgment from the employee that they have received the information. The estimated costs and burdens are as follows:

    - The estimated burden and costs for the respiratory exposure monitoring plan and conducting exposure monitoring (generating the exposure monitoring results) are presented below in Table 10-7 (labor costs) and Table 10-10 (non-labor costs).

    - The estimated burden and costs for recordkeeping related to respiratory exposure monitoring are presented below in Table 10-8.

  - The estimated burden and costs for notifications related to exposure monitoring (notifying potentially exposed workers; providing them with access to exposure control plans, exposure monitoring records, PPE program implementation documentation, and respirator program documentation; obtaining an acknowledgment that they have received this information) are presented below in Table 10-9.

- Information related to proposed phase outs

  - Under the final rule, 2 facilities complying with the rule through a phase-out for processing TCE as an intermediate to manufacture HFC-134a would be required to maintain records that document appropriate reduction or attempts at reduction of use of TCE. Documentation related to production volumes would be considered usual business records.

  - The burden and cost of recordkeeping related to demonstrating that the end use is in rocket booster nozzle production for Federal agencies or their contractors, and records that demonstrate that a final pre-launch test of rocket booster nozzles without using TCE was completed using an alternative to TCE in the production of rocket booster nozzles for Federal agencies and their contractors are described in the economic analysis of the final rule.

  - EPA estimates that 23,070 respondents will incur an average annual total cost of $8 million over the first three years of the rule from an average annual total time burden of 38,625 hours (1.67 hours and $345 per respondent).

Table 10-11 presents the summary of the average annual burden hours and costs per facility over the first three years, as well as the three-year total burden hours and costs associated with the primary option. See Chapter 7 for a more detailed description of how the time burden and wage rates were estimated. The burden and cost estimates provided reflect the figures provided in the accompanying Information Collection Request (ICR) for the rule.

Table 10-6: Paperwork Burden and Cost Associated with Rule Familiarization, Downstream Notification, and Dermal Exposure Control

Activity	Number of Respondents	Average Annual Burden Per Respondent	Average Annual Total Burden	Average Annual Total Cost
Rule Familiarization (WCPP or prescriptive control firms)[1]	1,677	1	1,677	$158,864
Rule Familiarization (Prohibition firms)[2]	21,393	0.33	7,131	$678,520
Downstream Notification (SDS)[3]	11	0.67	7	$695
Develop Exposure Control Program[1]	1,677	1.67	2,800	$199,720

[1,4]A wage of $71.32 was used to calculate the labor cost (see Certified Industrial Hygienist wage in Table 7-4).

[2]A wage of $95.15 was used to calculate the labor cost (weighted average of sector-specific Managerial wages; see Table 7-4).

[3]A wage of $94.74 was used to calculate the labor cost (see Manufacturing/Managerial wage in Table 7-4).

Table 10-7: Paperwork Burden and Labor Cost Associated with Respiratory Monitoring

Threshold	Number of Respondents	Number of Workers	Annual Per Respondent Burden (excludes burden estimated on a per-worker basis)	Annual Per-Worker Labor Burden	Average Annual Total Burden	Average Annual Total Cost
Respondents with three years of WCPP						
<Action Level (1 event in first year)	764.54	8,588.4	2.0	0.6	6,682.1	$384,776
Between Action Level and ECEL (2 events per year)	50.68	255.5	6.0	3.6	1,223.8	$70,558
1 to <10 times the ECEL (4 events per year)	135.39	851.9	6.0	7.2	6,945.7	$397,123
10 to <25 times the ECEL (4 events per year)	19.32	150.5	6.0	7.2	1,199.4	$68,487
25 to <50 times the ECEL (4 events per year)	14.92	134.6	6.0	7.2	1,058.5	$60,396
50 to <1,000 times the ECEL (4 events per year)	21.89	234.2	6.0	7.2	1,817.7	$103,630
1,000 to <10,000 times the ECEL (4 events per year)	-	-	6.0	7.2	-	$0
Respondents with two years of WCPP						
<Action Level (1 event in first year)	-	-	2.0	0.60	-	$0
Between Action Level and ECEL (2 events per year)	-	-	4.0	2.40	-	$0
1 to <10 times the ECEL (4 events per year)	0.08	9.5	4.0	4.80	46.0	$2,613
10 to <25 times the ECEL (4 events per year)	0.62	18.1	4.0	4.80	89.2	$5,069
25 to <50 times the ECEL (4 events per year)	0.78	13.6	4.0	4.80	68.3	$3,888
50 to <1,000 times the ECEL (4 events per year)	0.52	8.8	4.0	4.80	44.5	$2,534
1,000 to <10,000 times the ECEL (4 events per year)	-	-	4.0	4.80	-	$0
All Respondents	**1,009**	**10,265**	**-**	**-**	**19,175**	**$1,099,072**

A blended wage for a Certified Industrial Hygienist and Technical Specialist was used to calculate the labor cost (see wage rates in Table 7-4). The wages were weighted according to the labor mix presented in Table 7-52.

Table 10-8: Paperwork Burden and Labor Cost Associated with Respiratory Recordkeeping

Threshold	Number of Respondents	Number of Workers	Annual Per Respondent Burden (excludes burden estimated on a per-worker basis)	Annual Per-Worker Labor Burden	Average Annual Total Burden	Average Annual Total Cost
Respondents with three years of WCPP						
<Action Level (1 event in first year)	764.54	8,588.4	2.7	0.06	2,554.1	$152,365
Between Action Level and ECEL (2 events per year)	50.68	255.5	8.0	0.33	489.7	$29,269
1 to <10 times the ECEL (4 events per year)	135.39	851.9	16.0	0.67	2,737.0	$163,209
10 to <25 times the ECEL (4 events per year)	19.32	150.5	16.0	0.67	409.9	$24,389
25 to <50 times the ECEL (4 events per year)	14.92	134.6	16.0	0.67	328.9	$19,533
50 to <1,000 times the ECEL (4 events per year)	21.89	234.2	16.0	0.67	507.2	$30,056
1,000 to <10,000 times the ECEL (4 events per year)	-	-	16.0	0.67	-	$0
Respondents with one year of WCPP						
<Action Level (1 event in first year)	-	-	2.0	0.06	-	$0
Between Action Level and ECEL (2 events per year)	-	-	5.3	0.22	-	$0
1 to <10 times the ECEL (4 events per year)	0.08	9.52	10.7	0.44	5.0	$289
10 to <25 times the ECEL (4 events per year)	0.62	18.06	10.7	0.44	14.6	$850
25 to <50 times the ECEL (4 events per year)	0.78	13.58	10.7	0.44	14.3	$842
50 to <1,000 times the ECEL (4 events per year)	0.52	8.84	10.7	0.44	9.4	$556
1,000 to <10,000 times the ECEL (4 events per year)	-	-	10.7	0.44	-	$0
All Respondents	**1,009**	**10,265**	**-**	**-**	**7,070**	**$421,359**

A wage of $94.74 was used to calculate the labor cost (see Manufacturing/Managerial wage in Table 7-4).

Table 10-9: Paperwork Burden and Labor Cost Associated with Respiratory Notification

Threshold	Number of Respondents	Number of Workers	Annual Per Respondent Burden (excludes burden estimated on a per-worker basis)	Annual Per-Worker Labor Burden	Average Annual Total Burden	Average Annual Total Cost
Respondents with three years of WCPP						
<Action Level (1 event in first year)	764.54	8,588.4	-	0.03	257.7	$14,622
Between Action Level and ECEL (2 events per year)	50.68	255.5	-	0.17	43.4	$2,465
1 to <10 times the ECEL (4 events per year)	135.39	851.9	-	0.33	281.1	$15,953
10 to <25 times the ECEL (4 events per year)	19.32	150.5	-	0.33	49.7	$2,818
25 to <50 times the ECEL (4 events per year)	14.92	134.6	-	0.33	44.4	$2,520
50 to <1,000 times the ECEL (4 events per year)	21.89	234.2	-	0.33	77.3	$4,386
1,000 to <10,000 times the ECEL (4 events per year)	-	-	-	0.33	-	$0
Respondents with one year of WCPP						
<Action Level (1 event in first year)	-	-	-	0.03	-	-
Between Action Level and ECEL (2 events per year)	-	-	-	0.11	-	-
1 to <10 times the ECEL (4 events per year)	0.08	9.52	-	0.22	2.1	$119
10 to <25 times the ECEL (4 events per year)	0.62	18.06	-	0.22	4.0	$225
25 to <50 times the ECEL (4 events per year)	0.78	13.58	-	0.22	3.0	$170
50 to <1,000 times the ECEL (4 events per year)	0.52	8.84	-	0.22	1.9	$110
1,000 to <10,000 times the ECEL (4 events per year)	-	-	-	0.22	-	-
All Respondents	**1,009**	**10,265**	**-**	**-**	**765**	**$43,388**
A wage of $94.74 was used to calculate the labor cost (see Manufacturing/Managerial wage in Table 7-4).						

Table 10-10: Paperwork Non-Labor Cost Associated with Respiratory Monitoring

Threshold	Number of Respondents	Number of Workers	Annual Per Respondent Non-Labor Costs (excludes costs estimated on a per-worker basis)	Annual Per-Worker Non-Labor Cost	Average Annual Per-Respondent Cost	Average Annual Total Cost
Respondents with three years of WCPP						
<Action Level (1 event in first year)	764.54	8,588.4		$362	$4,066	$3,109,001
Between Action Level and ECEL (2 events per year)	50.68	255.5		$724	$3,650	$184,968
1 to <10 times the ECEL (4 events per year)	135.39	851.9		$1,448	$9,111	$1,233,479
10 to <25 times the ECEL (4 events per year)	19.32	150.5		$1,448	$11,278	$217,895
25 to <50 times the ECEL (4 events per year)	14.92	134.6		$1,448	$13,061	$194,872
50 to <1,000 times the ECEL (4 events per year)	21.89	234.2		$1,448	$15,493	$339,136
1,000 to <10,000 times the ECEL (4 events per year)	-	-		$1,448	-	-
Respondents with one year of WCPP						
<Action Level (1 event in first year)	-	-		$362	-	-
Between Action Level and ECEL (2 events per year)	-	-		$724	-	-
1 to <10 times the ECEL (4 events per year)	0.08	9.52		$1,448	$172,312	$13,785
10 to <25 times the ECEL (4 events per year)	0.62	18.06		$1,448	$42,179	$26,151
25 to <50 times the ECEL (4 events per year)	0.78	13.58		$1,448	$25,210	$19,664
50 to <1,000 times the ECEL (4 events per year)	0.52	8.84		$1,448	$24,616	$12,800
1,000 to <10,000 times the ECEL (4 events per year)	-	-		$1,448	-	-
All Respondents	**1,009**	**10,265**		**-**	**$320,976**	**$5,351,750**
See Table 7-52.						

Table 10-11: Summary of Three-Year Average Incremental Burden Hours and Costs for Primary Option

Activity	Number of Respondents	Average Annual Responses Per Respondent	Average Annual Burden Per Respondent	Average Annual Total Labor Burden	Average Annual Total Labor Costs (2022$)	Average Annual Total Non-Labor Costs (2022$)	Average Annual Total Costs (2022$)
Agency Burden	-	-	-	-	-	-	-
Rule Familiarization (WCPP or prescriptive control firms)	1,677	0.33	1.00	1,677	$158,864		$158,864
Rule Familiarization (prohibition firms)	21,393	0.33	0.33	7,131	$678,520		$678,520
Downstream Notification (SDS)	11	1	0.67	7.3	$695		$695
Develop Exposure Control Program	1,677	1	1.67	2,800	$199,720		$199,720
Respiratory Monitoring	1,009	1.12	19.01	19,175	$1,099,072	$5,351,750	$6,450,822
Respiratory Recordkeeping	1,009	1.12	7.01	7,070	$421,359		$421,359
Respiratory Notifications	1,009	1.12	0.76	765	$43,388		$43,388
All Activities	**23,070**	**-**	**1.67[1]**	**38,625**	**$2,601,617**	**$5,351,750**	**$7,953,367**

[1]0.33 for respondents complying with rule familiarization only and 18.78 for respondents with burdens beyond rule familiarization

10.5 Unfunded Mandates Reform Act (UMRA)

Title II of the Unfunded Mandates Reform Act of 1995, Pub. L. 104-4, establishes requirements for Federal agencies to assess the effects of their regulatory actions on State, local, and Tribal governments, and the private sector. Under section 202 of the UMRA, EPA generally must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with "Federal mandates" that might result in expenditures by State, local, and Tribal governments, in the aggregate, or by the private sector, of $100 million or more (when adjusted annually for inflation) in any one year. The rule is not expected to affect state, local, or Tribal governments because the rule affects entities that use TCE and the use of TCE by government entities is minimal. In addition, the cost of the rule to the private sector does not exceed the inflation-adjusted UMRA threshold of $100 million.

10.6 Executive Order 12898 – Environmental Justice Impacts

EPA's "Technical Guidance for Assessing Environmental Justice in Regulatory Analysis[25]" provides recommendations that encourage analysts to conduct the highest quality analysis feasible, recognizing that data limitations, time and resource constraints, and analytic challenges will vary by media and

[25] https://www.epa.gov/sites/default/files/2016-06/documents/ejtg_5_6_16_v5.1.pdf

circumstance (EPA 2016b). This analysis presents information about the facilities, workforce, and communities potentially affected by the regulatory options under current conditions before the rule goes into effect. It draws on publicly available data provided by EPA and U.S. Census, including the Toxics Release Inventory (TRI), Chemical Data Reporting (CDR), National Emissions Inventory (NEI), the American Community Survey (ACS), and the Quarterly Workforce Indicators (QWI).

The purpose of this analysis is to characterize the baseline conditions faced by communities and workers[26] affected by the regulation to identify the potential for disproportionate impacts on minority and low-income populations. To examine the populations surrounding the facilities reviewed in this analysis, EPA includes estimates that reflect population-weighted averages across Census block groups within 1, 3, and 5 miles of each facility. These calculations follow the buffering methodology used to create EPA's EJSCREEN buffer reports (EPA 2019b).[27]

In Section 10.6.1, the EPA characterizes the average demographic characteristics of communities near all identified trichloroethylene facilities compared to national and rural averages. For the purposes of this analysis, EPA considers a facility to be in a rural community if 50 percent or more of the population estimated to live within 3 miles of the facility is not located in an urban block group. The baseline characterization across all facilities establishes typical demographics near these facilities and provides a useful point of departure for examining specific subsets of facilities of special interest.

The analysis then explores the characteristics of communities near facilities associated with several COUs. These uses include manufacturing of TCE (Section 10.6.2), use of TCE as an intermediate in the manufacture of HFCs (Section 10.6.3), use as a process solvent in the manufacture of battery separators Section 10.6.4), use in vapor degreasing (Section 10.6.5), use in vapor degreasing of narrow tubes (Section 10.6.6), and use as a synthetic paper processing aid (Section 10.6.7). These COUs were selected for a number of reasons; these are described in the respective analyses for each of the uses. The analysis also presents an assessment of worker demographics for each of these COUs.

EPA also presents information on the number of facilities that may pose potential risk to individuals living in close proximity to facilities releasing toxic chemicals according to TRI data from 2020 for each of the uses covered. This shows whether TCE facilities are in areas with clustering of TRI sites. However, assessing cumulative impacts on communities requires understanding what is being emitted and what risks these facilities pose, which does not exactly correspond to facility counts.

Data from EJSCREEN, EPA's environmental justice mapping and screening tool, are also presented. Specifically, two environmental indicators from EJSCREEN are included: the air toxics cancer risk and the air toxics respiratory hazard index, averaged across the geographic areas for facilities of interest. In this analysis, the national average air toxics respiratory hazard index is 0.3, and the average air toxics respiratory hazard index is 20 for the air toxics cancer risk (EPA 2018a, 2018b). These indices are

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[26] Throughout this section, the term workers also includes ONUs.

[27] A distance buffer is drawn around each facility, and the algorithm estimates the fraction of the Census block group population that is inside the buffer using Census block population counts. Census blocks offer higher resolution information on where residents live, and using each block's internal point (i.e., centroid) defined by the Census Bureau, the entire block population is included when this internal point falls inside the distance buffer. Block population counts that are within the buffer are aggregated to a block group-by-buffer level. This population fraction is used to calculate final population-weighted averages across all block groups intersecting the buffer. For a more detailed explanation of this buffer methodology, see Appendix B of the EJSCREEN Technical Documentation.

developed as part of EPA's Air Toxics Screening Assessment. (https://www.epa.gov/AirToxScreen). The respiratory hazard index is the sum of hazard indices for those air toxics with reference concentrations based on respiratory endpoints, where each hazard index (HI) is the ratio of exposure concentration in the air to the health-based reference concentration set by EPA. A hazard index of 1 or lower means air toxics are unlikely to cause adverse noncancer health effects over a lifetime of exposure. However, an HI greater than 1 doesn't necessarily mean adverse effects are likely. The cancer risk is an estimate of the lifetime cancer risk from inhalation of air toxics (meaning the risk of developing cancer due to inhalation exposure to each air toxic compound over a normal lifetime of 70 years), as risk per lifetime per million people. The Air Toxics Screening Assessment results are most meaningful when viewed at the state or national level. These results alone are not sufficient to draw conclusions about local concentrations and risk (EPA 2017h). Results are presented to indicate where potential risks from air toxics could potentially exceed the national average.

The benefits chapter (Chapter 8) does not discuss the sociodemographic characteristics of the affected workers and non-workers. While EPA lacks information on the characteristics of the workers in the specific regulated facilities, this analysis provides sociodemographic information on workers in the affected industries and locations as a proxy for the likely characteristics of affected workers. It also provides information on the sociodemographic characteristics of nearby communities and the general population.

This analysis characterizes baseline conditions, so it does not provide information about the relative merits of the alternative regulatory options. As discussed in Chapter 1, EPA found unreasonable risk for numerous uses of TCE. The regulatory options considered prohibit the manufacture (including import), processing, distribution in commerce, industrial and commercial use, and disposal of TCE in the short term for most of these uses. The risk evaluation did not evaluate potential unreasonable risk to the general population for TCE. However, EPA separately conducted a screening approach to assess whether there may be potential risks to the general population from ambient air and water pathways. The screening approach was developed in order to allow EPA to determine—with confidence—situations which present no unreasonable risk to fenceline communities or where further investigation would be needed to develop a more-refined estimate of risk. Both a single-year (2019) and multi-year (2015-2020) analysis was used to identify facilities in the fenceline screening approach. The fenceline technical support memos for the ambient air pathway and the water pathway provide the Agency with a quantitative assessment of exposure (EPA 2022d, 2023c). The results from applying this screening approach did not allow EPA to rule out unreasonable risk to fenceline communities. This EJ analysis includes those facilities in the fenceline screening approach within their relevant COU if they had reported TCE to the 2020 TRI and characterizes the demographics of populations nearby the facilities and of workers within those facilities.

Data limitations prevent EPA from conducting a more comprehensive EJ analysis that would identify the incremental impacts of the regulatory options and assess the extent to which they mitigate or exacerbate any disproportionate impacts in communities with environmental justice concerns. Uncertainties include the sociodemographic characteristics of the specific individuals affected by the use categories and the substitute technologies and practices that would be adopted at regulated entities in response to the rule. While the final rule is anticipated to eliminate unreasonable risks from exposure to TCE, EPA is not able to quantify the distribution of the change in risk across affected workers, communities, or demographic groups. EPA is also unable to quantify the changes in risks to workers, communities, and demographic groups from non-TCE-using technologies or practices that firms may adopt in response to the regulation to determine whether any such changes could pose environmental justice concerns.

10.6.1 All Identified Trichloroethylene Facilities

EPA used data from CDR, TRI, and NEI to identify approximately 2,600 facilities reporting the manufacture (including import) of TCE and/or emissions and releases of TCE. Table 10-12 presents average information on communities surrounding all identified facilities likely to be affected by the regulation compared to both the overall national average and the national average for rural areas. The analysis uses socioeconomic and demographic data from the American Community Survey 1-year data release for 2020. The values in the last three columns reflect population-weighted averages across the Census block groups within a 1-, 3-, and 5- mile radius of each facility. The table presents rural in addition to overall national statistics for comparison because 1,421 of the 2,615 facilities are located in rural communities.

Table 10-12: Demographics of Communities Within 1-, 3-, and 5-mile Radii of Trichloroethylene Facilities, Population Weighted Averages

Demographic	National	Urban	Rural	1Mile Average	3 Mile Average	5 Mile Average
Median Household Income	$64,994	$71,293	$51,878	$74,374	$77,378	$77,984
White	70.4%	66.5%	87.6%	63.0%	62.5%	62.7%
Black	12.6%	14.2%	5.8%	13.1%	14.1%	15.0%
American Indian	0.8%	0.6%	1.7%	0.6%	0.6%	0.6%
Asian	5.6%	6.6%	1.2%	8.9%	8.9%	8.3%
Pacific Islander	0.2%	0.2%	0.1%	0.2%	0.2%	0.2%
Other	5.1%	6.1%	0.8%	8.3%	7.8%	7.5%
2 or More Races	5.2%	5.7%	2.8%	5.9%	5.8%	5.7%
Hispanic	18.2%	21.7%	2.4%	23.2%	23.1%	22.4%
2x Poverty Line	29.8%	30.6%	26.0%	33.7%	31.6%	31.0%
Below Poverty Line	12.8%	13.6%	9.6%	15.7%	14.3%	13.9%
NATA Cancer Risk	20	-	-	30	30	31
NATA Respiratory Hazard Score	0.3	-	-	0.4	0.4	0.4
Total Population	-	-	-	**8,558,151**	**55,806,017**	**106,394,429**

Table 10-12 indicates that in general, communities within 1, 3, and 5 miles of TCE facilities affected by this regulation have a much higher share of Hispanic and Asian persons, as well as persons of another race at the national or national rural level. The share of Black persons living in these communities is similar to the overall national average within 1-mile of TCE facilities but higher than the rural national average and higher than the overall national average for communities within 3- and 5-miles of TCE facilities. Median household incomes are higher in communities surrounding TCE facilities on average compared to the national average, while poverty rates are higher in communities within a 1-, 3-, and 5-mile radius of such facilities. Both the NATA Cancer Risk and Nata Respiratory Hazard Score are above the national average.

10.6.2 TCE Manufacture

Three facilities manufacture TCE. Two TCE manufacturing facilities are owned by Occidental Chemical Holding Corporation, and one facility is owned by Westlake[28] (Westlake 2016). Under the rule, these facilities will be required to implement a Workplace Chemical Protection Program (WCPP) including dermal protections to manufacture for certain ongoing uses followed by a prohibition of the use of TCE.

[28] Axiall is listed as a manufacturer under the 2020 CDR, however, it was acquired by Westlake in 2016.

Table 10-13 presents average information on communities surrounding the three facilities manufacturing TCE. The analysis uses socioeconomic and demographic data from the American Community Survey 1-year data release for 2020. The values in the last three columns reflect population-weighted averages across the Census block groups within 1-, 3- and 5- miles of each facility. The table presents rural data in addition to overall national statistics for comparison. because facilities are located in both urban and rural communities. For the purposes of this analysis, EPA considers a facility to be in a rural community if 50 percent or more of the population estimated to live within 3 miles of the facility is not located in an urban block group.

Table 10-13: Demographics of Communities Within 1-, 3-, and 5-mile Radii of Facilities Manufacturing TCE

Demographic	National	Rural	1 Mile Average	3 Mile Average	5 Mile Average
Median Household Income	$64,994	$51,878	$44,608	$73,651	64,821
White	70.4%	87.60%	76.3%	82.2%	78.7%
Black	12.6%	5.80%	22.6%	8.0%	11.2%
American Indian	0.8%	1.70%	0.0%	0.5%	0.6%
Asian	5.6%	1.20%	0.4%	1.2%	1.5%
Pacific Islander	0.2%	0.10%	0.0%	0.1%	0.1%
Other	5.1%	0.80%	0.0%	3.3%	2.9%
2 or More Races	5.2%	2.80%	0.7%	4.8%	5.1%
Hispanic	18.2%	2.40%	0.0%	18.3%	23.8%
2x Poverty Line	29.8%	26.00%	31.0%	29.5%	33.0%
Below Poverty Line	12.8%	9.60%	8.2%	11.6%	13.8%
NATA Cancer Risk	20	-	63	81	61
NATA Respiratory Hazard Score	0.3	-	0.6	0.56	0.47
Total Population	-	-	**14**	**20,178**	**161,305**

The median household income of communities within 1 mile of the facilities are generally lower than all the national averages, higher in communities within 3 miles of the facilities and close to the national average in communities around 5 miles of the facilities. The percent of individuals living at greater than two times below the poverty line is higher than the national averages in communities surrounding the TCE manufacturing communities.

To evaluate potential risk posed by the clustering of these facilities, EPA also summarize the NATA Cancer Risk, which is 3-4x greater than the national average, and the NATA Respiratory Hazard Score, which is greater than the national average.

Table 10-14 presents the density of other TRI facilities located within a 1-, 3- and 5-mile radius of the 3 TCE manufacturing facilities. These facilities could contribute to cumulative environmental risks in these communities, assuming that individuals living in closer proximity are more likely to be exposed to toxic releases by these TRI facilities. Occidental Chemical Holding Corporation has 66 facilities within 5 miles of its LaPorte, TX plant but only 8 within 5 miles of its Wichita, KS plant. Axiall Corporation has 20 other TRI facilities within 5 miles of its facility in Westlake, LA. This information suggests that these facilities are in areas with evidence of clustering of Toxic Releases Inventory sites. To evaluate potential for risk posed by the clustering of these facilities, we also summarize the NATA Cancer Risk, which is 3-4x greater than the national average, and the NATA Respiratory Hazard Score, which is greater than the national average.

Table 10-14: Total Number of Other TRI Facilities Within 1, 3 and 5 Miles of Facilities Manufacturing TCE

Facility Name	Location	Other TRI Facilities Within 1 Mile	Other TRI Facilities Within 3 Miles	Other TRI Facilities Within 5 Miles
OCCIDENTAL CHEMICAL HOLDING CORP	LaPorte, TX	8	38	66
OCCIDENTAL CHEMICAL HOLDING CORP	Wichita, KS	2	2	8
AXIALL CORPORATION	Westlake, LA	4	12	20

Table 10-15 shows the demographics of communities near the Occidental Holding Corporation in Wichita, KS. This facility is in a rural area and there appears to not be a population living within 1 mile of the facility. Within a 3-mile radius of the facility, the median household income is higher than both the national and national rural medians but falls below the national median for communities within 5 miles. The communities within a 5-mile radius have a higher than (national and rural) average level of poverty.

The community has a higher proportion of White population than the national average although is similar to the national rural average. Other demographic groups generally fall close to or below the national and national rural averages except for Other which is higher. Both the NATA Cancer Risk and NATA Respiratory Hazard score exceed the national average.

Table 10-15: Community Demographics Near Occidental Chemical Holding Corp., Wichita, KS

Demographic	National	Rural	1 mile	3 miles	5 miles
Median Household Income	$64,994	$51,878	-	$80,500	$60,169
White	70.4%	87.60%	-	85.1%	86.2%
Black	12.6%	5.80%	-	1.8%	2.9%
American Indian	0.8%	1.70%	-	0.7%	1.0%
Asian	5.6%	1.20%	-	2.2%	2.3%
Pacific Islander	0.2%	0.10%	-	0.4%	0.1%
2 or more races	5.1%	0.80%	-	1.5%	1.3%
Other	5.2%	2.80%	-	8.4%	6.1%
Hispanic	18.2%	2.40%	-	6.8%	11.6%
2x Below Poverty Level	29.8%	26.00%	-	19.4%	32.4%
Below Poverty Level	12.8%	9.60%	-	5.7%	14.2%
NATA Cancer	20	-	-	28	26
NATA Respiratory	0.3	-	-	0.35	0.33
Total Population	-	-	-	**3,260**	**37,929**

Table 10-16 shows that the communities surrounding the Westlake facility in Westlake, LA have lower median household incomes than the national or national urban medians and a greater proportion of the populations fall below the poverty level than the national or national rural averages.

These communities have a higher proportion of both White and Black population than the national or national urban averages but below the averages for other race and ethnic groups. NATA cancer risk within 1 mile of the Westlake facility is 3x the national average, and the NATA cancer risk within 3 miles is much higher at 130, or over 6x higher the national average. This finding suggests that communities living near the Westlake facility are exposed to high concentrations of air toxics in the baseline.

Both the NATA Cancer Risk and NATA Respiratory Hazard score exceed the national average. The scores within the 3-mile radius are the highest where the cancer score exceeds the national average by 6x.

Table 10-16: Community Demographics Near Westlake facility, Westlake, LA

Demographic	National	Urban	1 mile	3 miles	5 miles
Median Household Income	$64,994	$71,293	$44,608	$63,729	$57,387
White	70.4%	66.5%	76.3%	81.2%	73.3%
Black	12.6%	14.2%	22.6%	14.6%	21.6%
American Indian	0.8%	0.6%	0.0%	0.5%	0.4%
Asian	5.6%	6.6%	0.4%	0.9%	2.0%
Pacific Islander	0.2%	0.2%	0.0%	0.0%	0.0%
2 or more races	5.1%	6.1%	0.0%	1.5%	1.0%
Other	5.2%	5.7%	0.7%	1.2%	1.7%
Hispanic	18.2%	21.7%	0.0%	3.2%	4.5%
2x Below Poverty Level	29.8%	30.6%	31.0%	30.8%	34.9%
Below Poverty Level	12.8%	13.6%	8.2%	11.7%	15.0%
NATA Cancer	20		63	130	65
NATA Respiratory	0.3		0.6	0.82	0.55
Total Population			**14**	**9,889**	**52,909**

Facilities manufacturing TCE fall under a single NAICs sector: Industrial and Miscellaneous Chemicals. Table 10-17 breaks down the data for workers for counties with a TCE manufacturing facility. Data are taken from the Census' QWI data averages indicator values for four quarters of 2020 (U.S. Census Bureau 2022). Worker populations for the TCE manufacturing facilities in Harris County have a higher percentage of Hispanic and Asian workers than the national average for workers in the Industrial and Miscellaneous Chemicals sector as well as workers at the national level. The percentage of Black workers is higher for Calcasieu Parish, LA than for both the average for workers in the industrial and miscellaneous chemicals sector and at the national level.

Table 10-17: Characteristics of General Worker Populations at National Level and Sector Worker Populations in Areas Nearby Facilities Manufacturing TCE

Region	Employees in Industry	Percent Local Employees in Industry	Percent Asian	Percent Black	Percent Pacific Islander	Percent Hispanic	Percent Native American	Percent 2 of More Races	Percent White
National	326,569,308		5.6%	12.6%	0.2%	18.2%	0.8%	5.2%	70.4%
Urban	266,435,744		6.6%	14.2%	0.2%	21.7%	0.6%	5.7%	66.5%
Rural	60,133,564		1.2%	5.8%	0.1%	2.4%	1.7%	2.8%	87.6%
Industrial and Miscellaneous Chemicals									
National			4.2%	10.9%	0.1%	9.9%	0.6%	1.2%	82.9%
Harris County, TX	12,220	0.6%	7.3%	11.2%	0.1%	19.4%	0.5%	1.3%	79.4%
Sedgwick County, KS	-	-	-	-	-	-	-	-	-
Calcasieu Parish, LA	3,270	4.6%	1.9%	15.4%		2.0%	0.6%	0.7%	81.5%

10.6.3 Use of TCE as an Intermediate in the Manufacture of HFCs

Use in processing as a reactant/intermediate for the manufacture of HFCs (specifically HFC-134a) involves only two facilities and is the highest volume use of TCE. Under this rule, this use will be phased out over time and be subject to a WCPP prior to being banned. Because of the small number of facilities impacted, the significant volume of TCE in this use, and the gradual phase down of the use of TCE prior to a prohibition, EPA examined the populations surrounding the specific facilities involved in this use.

Table 10-18 presents average information on communities surrounding the two facilities using TCE as an intermediate in the manufacture of HFCs. The rule requires these facilities to implement a WCPP including dermal protections for up to 8 years under the rule and for up to 9 years under the alternative option, followed by a prohibition of the use of TCE. The EPA used socioeconomic and demographic data from the American Community Survey 1-year data release for 2020. The values in the last three columns reflect population-weighted averages across the Census block groups within 1, 3 and 5 miles of each facility. The table presents rural in addition to overall national statistics for comparison because both facilities are located in rural communities. Both the NATA Cancer Risk and NATA Respiratory Hazard score exceed the national average. The cancer risk score exceeds the national average by over 5x. Communities near these facilities also have higher poverty rates than the national and rural average at all distance bandwidths. In particular, communities within 1 mile of these facilities have poverty rates of twice the national rural average at 20% below the federal poverty line.

Table 10-18: Demographics of Communities Within 1-, 3-, and 5-mile Radii of Facilities Using TCE to Manufacture HFCs, Population-Weighted Averages

Demographic	National	Rural	1 Mile Average	3 Mile Average	5 Mile Average
Median Household Income	$64,994	$51,878	$54,545	$55,495	$64,636
White	70.4%	87.60%	22.8%	56.4%	67.7%
Black	12.6%	5.80%	76.2%	41.6%	29.5%
American Indian	0.8%	1.70%	0.0%	0.1%	0.1%
Asian	5.6%	1.20%	0.1%	0.1%	0.1%
Pacific Islander	0.2%	0.10%	0.0%	0.0%	0.0%
Other	5.1%	0.80%	0.0%	0.3%	0.5%
2 or More Races	5.2%	2.80%	0.9%	1.5%	2.0%
Hispanic	18.2%	2.40%	2.4%	2.1%	3.6%
2x Poverty Line	29.8%	26.00%	45.2%	36.3%	31.7%
Below Poverty Line	12.8%	9.60%	20.2%	15.6%	13.8%
NATA Cancer Risk	20	-	120	120	109
NATA Respiratory Hazard Score	0.3	-	1.3	1.3	1.1
Total Population	-	-	**309**	**7,040**	**14,505**

Table 10-19 presents the density of other TRI facilities located within 1-, 3- and 5-mile distances of the two HFC manufacturing facilities. These facilities could contribute to cumulative environmental risks in these communities, assuming that individuals living in closer proximity are more likely to be exposed to toxic releases by these TRI facilities. Arkema, Inc. has 11 TRI facilities within 5 miles while Mexichem Fluor, Inc. has nearly double that with 21 TRI facilities within 5 miles. This information suggests that these facilities are in areas with clustering of Toxic Releases Inventory sites.

Table 10-19: Total Number of Other TRI Facilities Within 1, 3 and 5 Miles of Facilities Using TCE to Manufacture HFCs

Facility Name	Location	Other TRI Facilities Within 1 Mile	Other TRI Facilities Within 3 Miles	Other TRI Facilities Within 5 Miles
Arkema, Inc.	Calvert City, KY	5	11	11
Mexichem Fluor, Inc.	St. Gabriel, LA	4	14	21

The following tables provide profiles of communities surrounding each facility using TCE to manufacture HFCs, again focusing on populations located within 1, 3 and 5 miles. For comparison, the tables provide the national and state averages either overall or for rural areas, depending on whether the facility is located in an urban or rural area.

Table 10-20: Community Demographics Near Mexichem Fluor, St. Gabriel, LA

Demographic	National	Rural	1 mile	3 miles	5 miles
Median Household Income	$64,994	$51,878	$54,613	$52,868	$67,954
White	70.4%	87.60%	21.5%	29.7%	45%
Black	12.6%	5.80%	77.5%	68.5%	51%
American Indian	0.8%	1.70%	0.0%	0.0%	0%
Asian	5.6%	1.20%	0.1%	0.1%	0%
Pacific Islander	0.2%	0.10%	0.0%	0.0%	0%
2 or more races	5.1%	0.80%	0.0%	0.3%	1%
Other	5.2%	2.80%	0.8%	1.4%	2%
Hispanic	18.2%	2.40%	2.4%	2.0%	4%
2x Below Poverty Level	29.8%	26.00%	45.3%	38.4%	33%
Below Poverty Level	12.8%	9.60%	20.3%	16.9%	15%
NATA Cancer	20	-	200	200	180
NATA Respiratory	0.3	-	0.6	0.61	0.59
Total Population	-	-	**304**	**4,252**	**8,287**

Table 10-20 shows that the communities surrounding the Mexichem Fluor facility in St. Gabriel, LA are majority Black with a much higher percentage than the national and rural averages and have a much lower proportion of other races with both the nation and national rural averages. Average median household incomes are below the national average at the 1- and 3- mile radius but are above the rural median. However, the communities surrounding this facility face a higher poverty percentage than the national or rural averages. Both the NATA Cancer Risk and NATA Respiratory Hazard score exceed the national average in the areas surrounding the Mexichem Fluor facility. The cancer risk score exceeds the national average by over 10x in the 1- and 3- mile radius areas.

The demographics for communities surrounding the Arkema facility in Calvert City, KY are shown in Table 10-21. These communities have a higher proportion of White populations than both the national and national rural averages. Median household incomes in surrounding communities are higher than the rural national average and lower than the national average for communities within 1 and 3 miles of the facility. Poverty levels around the facility are higher than the national and national rural levels. Both the NATA Cancer Risk and NATA Respiratory Hazard score exceed the national average in the areas surrounding the Arkema facility. The cancer risk score exceeds the national average by over 6x in the 1- and 3- mile radius areas.

Table 10-21: Community Demographics Near Arkema, Calvert City, KY

Demographic	National	Rural	1 mile	3 miles	5 miles
Median Household Income	$64,994	$51,878	$50,440	$59,502	$60,215
White	70.4%	87.60%	96.1%	97.1%	97%
Black	12.6%	5.80%	0.0%	0.5%	0%
American Indian	0.8%	1.70%	0.0%	0.2%	0%
Asian	5.6%	1.20%	0.0%	0.2%	0%
Pacific Islander	0.2%	0.10%	0.0%	0.0%	0%
2 or more races	5.1%	0.80%	0.4%	0.3%	0%
Other	5.2%	2.80%	3.5%	1.7%	2%
Hispanic	18.2%	2.40%	2.7%	2.3%	3%
2x Below Poverty Level	29.8%	26.00%	39.9%	33.0%	31%
Below Poverty Level	12.8%	9.60%	14.8%	13.5%	12%
NATA Cancer	20	-	120	120	109
NATA Respiratory	0.3	-	1.3	1.3	1.1
Total Population	-	-	5	2,788	6,218

Facilities using TCE to manufacture HFCs fall under a single NAICs sector, Basic Chemical Manufacturing. Table 10-22 breaks down the data for workers for counties with a facility using TCE to manufacture HFCs. Data are taken from the Census' QWI data averages indicator values for four quarters of 2020 (U.S. Census Bureau 2022). The table indicates that nationally, workers who are White are somewhat overrepresented in the Basic Chemical Manufacturing industry compared to their representation in the overall workforce. Chemical workers in communities with facilities using TCE to manufacture HFCs are more likely to be Black than Basic Manufacturing Chemical workers nationally and workers nationally.

Table 10-22: Characteristics of General Worker Populations at National Level and Sector Worker Populations in Areas Nearby Facilities Manufacturing HFCs Using TCE

Region	Employees in Industry	Percent Asian	Percent Black	Percent Pacific Islander	Percent Hispanic	Percent Native American	Two Percent or More Races	Percent white
National	326,569,308	5.6%	12.6%	0.2%	18.2%	0.8%	5.2%	70.4%
Rural	60,133,564	1.2%	5.8%	0.1%	2.4%	1.7%	2.8%	87.6%
Basic Chemical Manufacturing								
National		4.2%	10.9%	0.1%	9.9%	0.6%	1.2%	82.9%
Marshall County, KY	1,390	0.5%	5.3%	0.0%	0.8%	-	0.5%	93.6%
Iberville Parish, LA	2,306	1.3%	18.9%		2.6%	0.1%	0.7%	79.0%

10.6.4 Battery Separator Manufacturers

Few facilities use TCE as a process solvent in battery (separator) manufacture. EPA is aware that separators are fundamental components in batteries that provide the necessary separation between the internal anode and cathode components that make batteries work, and that a restriction on TCE use for the production of battery separators would critically impact the U.S. battery manufacturing supply chain and impede the expansion of domestic battery production capacity. Thus, under the final rule, a 6(g) exemption allows the continued use of TCE for this use for up to 15 years after which time this use will be prohibited. Facilities using TCE during the exemption timeframe must implement a WCPP. Because of the small number of facilities impacted, the importance of the use, and the delayed prohibition, this analysis examines the populations surrounding the specific facilities involved in this use.

Table 10-23 presents average information on communities surrounding the two facilities identified as using TCE as a process solvent to manufacture battery separators. The analysis uses socioeconomic and demographic data from the American Community Survey 1-year data release for 2020. The values in the last three columns reflect population-weighted averages across the Census block groups within a 1-, 3- and 5- mile radius of each facility. The table presents both urban and rural demographics in addition to overall national statistics for comparison because half the facilities are located in urban areas and half are in rural areas. For the purposes of this analysis, EPA considers a facility to be in a rural community if 50 percent or more of the population estimated to live within 3 miles of the facility is not located in an urban block group. Both the NATA Cancer Risk and NATA Respiratory Hazard score exceed the national average in the areas surrounding these facilities.

Table 10-23: Demographics of Communities Within 1, 3, and 5 miles of Facilities Using TCE as a Process Solvent for Manufacturing Battery Separators, Population Weighted Averages

Demographic	National	Urban	Rural	1 Mile Average	3 Mile Average	5 Mile Average
Median Household Income	$64,994	$71,293	$51,878	$51,131	$53,131	$55,922
White	70.4%	66.5%	87.6%	88.4%	92.1%	92.7%
Black	12.6%	14.2%	5.8%	0.0%	0.3%	0.5%
American Indian	0.8%	0.6%	1.7%	0.7%	0.4%	0.7%
Asian	5.6%	6.6%	1.2%	1.6%	1.4%	1.1%
Pacific Islander	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%
Other	5.1%	6.1%	0.8%	1.4%	1.9%	1.5%
2 or More Races	5.2%	5.7%	2.8%	7.7%	3.8%	3.5%
Hispanic	18.2%	21.7%	2.4%	14.9%	7.4%	5.7%
2x Poverty Line	29.8%	30.6%	26.0%	41.3%	37.6%	35.5%
Below Poverty Line	12.8%	13.6%	9.6%	13.1%	15.3%	14.1%
NATA Cancer Risk	20		-	30	30	30
NATA Respiratory Hazard Score	0.3		-	0.4	0.4	0.4
Total Population	-		-	**7,382**	**28,539**	**42,906**

Table 10-23 indicates that communities within 1 mile of the facilities have a median household income below the national, urban, and rural median household incomes. These communities also have a greater proportion of the community below the poverty level than those at the national and urban levels. A higher percentage of White persons reside in this area compared with the national, urban, and rural averages. Communities within the 3- and 5-mile radius of these facilities have median household incomes that exceed the rural median income but are still below national and urban levels. These facilities have a higher share of White persons in the surrounding communities than the national or national rural averages. Populations of Hispanic, other, and two or more races also exceed the rural average in these areas.

The following tables provide characteristics of communities surrounding each facility within a 1-, 3- and 5- mile radius. For comparison, the tables provide the national averages overall and for either rural or urban areas, depending on whether the facility is located in a rural or urban area.

Communities surrounding the Entek International, LLC facility in Lebanon, OR have median household incomes below the national and urban averages, as shown in Table 10-24. These communities also have a larger percentage of the population below the poverty level than the national or urban levels.

The communities surrounding this facility have a greater percentage of White in the populations in all three distances from the facility compared to the national and urban averages. Additionally, within the 3- and 5-mile radius, the populations have a greater percentage of American Indians than the national average although the facility is not within 5 miles of tribal lands. Both the NATA Cancer Risk and NATA Respiratory Hazard score exceed the national average in the areas surrounding this facility.

Table 10-24: Community Demographics Near Battery Manufacturer Entek International, LLC., Lebanon, OR

Demographic	National	Urban	1 mile	3 miles	5 miles
Median Household Income	$64,994	$71,293	$49,636	$49,037	$53,043
White	70.4%	66.5%	88.0%	91.4%	91.07%
Black	12.6%	14.2%	0.0%	0.3%	0.31%
American Indian	0.8%	0.6%	1.0%	0.5%	1.01%
Asian	5.6%	6.6%	1.0%	0.8%	0.78%
Pacific Islander	0.2%	0.2%	0.0%	0.1%	0.06%
2 or more races	5.1%	6.1%	2.0%	1.9%	1.74%
Other	5.2%	5.7%	8.0%	5.1%	5.02%
Hispanic	18.2%	21.7%	16.0%	9.2%	8.06%
2x Below Poverty Level	29.8%	30.6%	43.0%	41.3%	38.18%
Below Poverty Level	12.8%	13.6%	14.0%	16.8%	15.17%
NATA Cancer	20	-	30	29	28
NATA Respiratory	0.3	-	0.41	0.40	0.40
Total Population	-	-	**6,669**	**19,994**	**24,800**

Table 10-25 indicates that the communities surrounding the facility in Piney Flats, TN, is also predominately White with the percentage population higher than the national and national rural averages.

The population of Asians within a 1-mile radius of this facility is higher than the rural and national averages.

Median household income for communities surrounding this facility fall below the national average at the 5-mile radius. Additionally, poverty levels in these communities are at higher percentage of the population than the national and rural levels. The NATA Cancer Risk score exceeds the national average in the areas surrounding this facility.

Table 10-25: Community Demographics Near Battery Manufacturer Microporous, LLC., Piney Flats, TN

Demographic	National	Rural	1 mile	3 miles	5 miles
Median Household Income	$64,994	$51,878	$66,120	$66,854	$60,053
White	70.40%	87.60%	91.0%	91%	94.97%
Black	12.60%	5.80%	0.0%	0%	0.73%
American Indian	0.80%	1.70%	0.0%	0%	0.34%
Asian	5.60%	1.20%	7.0%	7%	1.55%
Pacific Islander	0.20%	0.10%	0.0%	0%	0.00%
2 or more races	5.10%	0.80%	1.0%	1%	1.10%
Other	5.20%	2.80%	1.0%	1%	1.30%
Hispanic	18.20%	2.40%	3.0%	3%	2.55%
2x Below Poverty Level	29.80%	26.00%	20.0%	20%	31.77%
Below Poverty Level	12.80%	9.60%	6.0%	6%	12.57%
NATA Cancer	20	-	30	20	20
NATA Respiratory	0.3	-	0.3	0.3	0.3
Total Population	-	-	**683**	**8,546**	**18,104**

Table 10-26 presents the density of other TRI facilities located within 1-, 3- and 5-mile distances of the four facilities using TCE to manufacture battery separators. These facilities could contribute to aggregate environmental risks in these communities, assuming that individuals living in closer proximity are more likely to be exposed to toxic releases by these facilities.

Table 10-26: Total Number of Other TRI Facilities Within 1, 3 and 5 Miles of Facilities Using TCE in Battery Manufacture

Facility Name	Location	Other TRI Facilities Within 1 Mile	Other TRI Facilities Within 3 Miles	Other TRI Facilities Within 5 Miles
ENTEK INTERNATIONAL LLC	LEBANON, OR	1	1	1
MICROPOROUS LLC	PINEY FLATS, TN	4	4	4

Facilities using TCE to manufacture batteries fall under two NAICs sectors, Plastics Product Manufacturing and Rubber Product Manufacturing. Table 10-27 shows the characteristics of workers within the counties and nationally in the sectors using TCE to manufacture battery separators and workers in the general population. Data are taken from the Census' QWI data averages indicator values for four quarters of 2020 (U.S. Census Bureau 2022). In general, these facilities tend to have worker populations that have a greater percentage of Whites when compared to national averages for all workers and for workers within their industry sector.

Table 10-27: Characteristics of General Worker Populations at National Level and Sector Worker Populations in Areas Nearby Facilities Using TCE to Manufacture Batteries

Region	Employees in Industry	Percent Local Employees in Industry	Percent Asian	Percent Black	Percent Pacific Islander	Percent Hispanic	Percent Native American	Two Percent or More Races	Percent White
National	326,569,308		5.6%	12.6%	0.2%	18.2%	0.8%	5.2%	70.4%
Urban	266,435,744		6.6%	14.2%	0.2%	21.7%	0.6%	5.7%	66.5%
Rural	60,133,564		1.2%	5.8%	0.1%	2.4%	1.7%	2.8%	87.6%
Plastics Product Manufacturing									
National			5.6%	12.1%	0.3%	18.3%	1.0%	1.6%	79.5%
Linn County	311	0.8%	0.0%	0.0%	0.0%	5.1%	1.6%	2.3%	94.9%
Rubber Product Manufacturing									
National			3.4%	15.9%	0.1%	10.5%	1.0%	1.4%	78.2%
Sullivan County	175	0.30%	2.9%	2.9%	0.0%	3.4%	0.0%	0.0%	92.6%

10.6.5 Vapor Degreasing

The second largest use of TCE is degreasing applications including vapor degreasing with TCE. Vapor degreasing is a cleaning process used in a variety of industries by many different size businesses to clean parts. This sector was chosen for more detailed analysis because of the likelihood of multiple facilities being located in close proximity to each other.

Using data from the NEI, this analysis identified 108 specific facilities that may be performing vapor degreasing activities. These facilities fall under a total of 24 separate industry sectors and are located throughout the country. Ninety-five of the facilities are in urban areas and 13 are in rural areas. Table 10-28 presents the average demographics for all the identified vapor degreasing facilities.

On average, the median household income for communities surrounding vapor degreasing facilities is higher than the average national, rural, and urban median income. However, these communities also have a higher percentage of population below the poverty level compared to national and rural levels. Both the NATA Cancer Risk and NATA Respiratory Hazard score exceed the national average in the areas surrounding these facilities.

Table 10-28: Demographics of Communities Within 1-, 3-, and 5-mile Radii of TCE Vapor Degreasing Facilities, Population-Weighted averages

Demographic	National	Rural	1 Mile Average	3 Mile Average	5 Mile Average
Median Household Income	$64,994	$51,878	$75,764	$76,095	$76,849
White	70.40%	87.60%	65.9%	64.6%	63.7%
Black	12.60%	5.80%	12.2%	14.2%	15.3%
American Indian	0.80%	1.70%	0.4%	0.4%	0.5%
Asian	5.60%	1.20%	5.4%	6.2%	6.7%
Pacific Islander	0.20%	0.10%	0.1%	0.1%	0.1%
Other	5.10%	0.80%	9.9%	8.6%	8.1%
2 or More Races	5.20%	2.80%	6.2%	5.8%	5.6%
Hispanic	18.20%	2.40%	26.7%	23.9%	22.9%
2x Poverty Line	29.80%	26.00%	32.5%	30.7%	30.4%
Below Poverty Line	12.80%	9.60%	15.3%	14.2%	14.0%
NATA Cancer Risk	20	-	30.4	29.9	30.1
NATA Respiratory Hazard Score	0.3	-	0.42	0.42	0.42
Total Population	-	-	1,309,000	11,107,207	27,325,961

These facilities also have higher percentages of Black populations within 3 and 5 miles of facilities compared to the national and rural averages. However, this percentage is only higher in comparison to the urban average within a 5-mile radius. Hispanic populations are a greater percentage of the population within a 1-, 3-, and 5-mile radius of these facilities, as are people of Two or more races and Other races. Asian individuals are also a greater percentage of the population within these buffers when compared to rural population, but they are a similar proportion to the national average across all distance bandwidths.

Among the vapor degreasers identified, a sub-group of 25 facilities that are in close proximity to each other were also examined. It is possible that the proximity of these facilities could mean that nearby communities experience aggregate exposures to TCE from multiple facilities. These facilities are in 5 counties in metropolitan Chicago surrounding Cook County, Illinois, and so they are in an urban area.

These counties are known as the Collar Counties and include DuPage, Kane, Lake, McHenry, and Will counties. Facilities within Cook County were also included. Table 10-29 shows average demographics surrounding the 25 facilities in this area. Both the NATA Cancer Risk and NATA Respiratory Hazard score exceed the national average in the areas surrounding these facilities.

Table 10-29: Demographics of Communities Within 1-, 3-, and 5-mile Radii of Chicago Metropolitan TCE Vapor Degreasing Facilities, Population-Weighted Averages

Demographic	National	Urban	1 Mile Average	3 Mile Average	5 Mile Average
Median Household Income	$64,994	$71,293	$88,866	$84,804	$83,971
White	70.40%	66.5%	65.4%	64.5%	62.9%
Black	12.60%	14.2%	10.6%	12.5%	13.7%
American Indian	0.80%	0.6%	0.4%	0.3%	0.3%
Asian	5.60%	6.6%	5.4%	6.4%	7.2%
Pacific Islander	0.20%	0.2%	0.1%	0.1%	0.0%
Other	5.10%	6.1%	11.8%	10.0%	10.0%
2 or More Races	5.20%	5.7%	6.3%	6.1%	5.7%
Hispanic	18.20%	21.7%	33.4%	29.1%	27.9%
2x Poverty Line	29.80%	30.6%	26.7%	27.2%	27.7%
Below Poverty Line	12.80%	13.6%	11.7%	12.2%	12.5%
NATA Cancer Risk	20	-	32.1	31.3	31.8
NATA Respiratory Hazard Score	0.3	-	0.48	0.48	0.48
Total Population	-	-	659,514	5,444,583	13,090,324

The average median household income of the communities surrounding the vapor degreasing facilities in the Chicago metropolitan area is higher than the national and national urban levels. Additionally, these communities do not have a higher percentage of the population below the poverty level. The communities near these facilities do have higher percentages of Hispanic populations and people of Other races compared to both the national and urban averages. In addition, the percentage of Black persons within a 5-mile radius is higher than the national level but less than the urban population. The Asian populations within a 3- and 5-mile radius of these vapor degreasing facilities are higher than the national average and higher than the urban average within a 5-mile radius.

Table 10-30 presents the density of other TRI facilities located within 1-, 3- and 5-mile distances of the 2 chemical manufacturing facilities. These facilities could contribute to cumulative environmental exposures and risks in these communities, assuming that individuals living in closer proximity are more likely to be exposed to toxic releases by these TRI facilities.

Table 10-30: Total Number of Other TRI Facilities Within 1, 3 and 5 Miles of Chicago Metropolitan TCE Vapor Degreasing Facilities

Facility	Location	1 Mile	3 Miles	5 Miles
Castle Metal Finishing Corp	Schiller Park, IL	3	17	47
Streamwood Plating Co	Streamwood, IL	1	5	12
Amilan Distributors Inc	Bensenville, IL	2	35	69
Berteau-Lowell Plating Plating Inc	Chicago, IL	1	14	28
Able Electro-Polishing Co	Chicago, IL	5	24	53
Hu-Friedy Manufacturing Co LLC	Chicago, IL	1	6	26
Clybourn Metal Finishing Co	Chicago, IL	2	15	25
Light Logic of IL dba Framburg	Bellwood, IL	3	18	31
Dial Tool Co	Addison, IL	2	14	34
MJ Celco	Schiller Park, IL	5	18	39
Wauconda Tool & Engineering	Algonquin, IL	1	2	7
Head Manufacturing Inc	South Elgin, IL	1	5	10
Hasse & Wrede North America	North Aurora, IL	1	2	14
Millennium Polishers Inc	Melrose Park, IL	5	22	41
Autotrol Corp	Crystal Lake, IL	4	5	10
Milton Industires Inc	Chicago, IL	3	9	33
Union Special Corp	Huntley, IL	1	2	3
American/Jebco Corp	Franklin Park, IL	8	27	54
TWR Service Corp	Schaumburg, IL	1	7	15
Smalley Steel Ring Co	Lake Zurich, IL	3	3	3
Dixon Valve	Westmont, IL	0	0	7
General Machinery & Manufacturing Co	Chicago, IL	0	10	30
Craftsman Plating & Tinning Corp	Chicago, IL	0	7	20
Bycap Inc	Chicago, IL	0	4	15
Watlow Electric Mfg Co	Richmond, IL	0	1	2

Amilan Distributors, Inc., involved in Coating, Engraving, Heat Treating, and Allied Activities, has 69 facilities within 5 miles of its Bensenville, IL facility and 20 facilities (80%) of the facilities have 10 or more TRI facilities within 5 miles. Because of the proximity of facilities to each other, it is possible that some of the TRI facilities could be in close proximity to multiple vapor degreasing facilities. This information suggests that these vapor degreasing facilities are in areas where there is there is evidence of clustering of TRI sites. However, to be able to assess cumulative impacts on communities, it is important to understand what is being emitted and what risks these facilities pose, which may not exactly correspond with counts of TRI facilities.

Table 10-30 shows the characteristics of workers within the counties and nationally in the sectors using TCE in vapor degreasing in the Chicago metropolitan area. The table presents simple averages across all surveyed individuals in the affected county.

Employment at facilities within the Coating, Engraving, Heat Treating, and Allied Activities sector is generally similar to the national averages for the sector across demographic groups. However, the Hispanic population is overrepresented. Compared to the distribution of general workers at the national level, White and Hispanic workers in this sector are overrepresented.

Compared to general workers nationally, both White and Hispanic workers are overrepresented in the Electric Lighting Equipment Manufacturing sector. For this sector specifically, White and Hispanic workers are overrepresented in both Cook and McHenry counties while Asian workers are overrepresented in DuPage County.

White workers are overrepresented in the Forging and Stamping sector compared to general workers nationally. In addition, Hispanic and Asian workers in facilities using TCE for vapor degreasing in the Forging and Stamping sector are overrepresented compared to the national distribution of workers in that sector in both Cook and DuPage counties, while Black employees are overrepresented in Cook County and White workers are overrepresented in DuPage County when compared to the national averages for that sector.

Asian and White employees in facilities using TCE in vapor degreasing in the Industrial Machinery Manufacturing sector are overrepresented compared to general workers nationally. However, at facilities in the Chicago metropolitan area, only White workers are overrepresented in this sector compared to both the national sector average and general workers.

At the national level, the worker population in the sector Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing for Whites is greater than the national or urban general worker population. In addition, these facilities also have a higher percentage of Hispanic workers when compared to both the national average for the sector and to the national general worker population.

White and Hispanic workers are overrepresented in the Medical Equipment and Supplies Manufacturing sector compared to the percentages of general workers at the national and national urban levels. However, for the specific facilities using TCE in vapor degreasing in the Chicago metropolitan area within this sector, Asian and Hispanic workers are overrepresented compared to distribution of these populations within the sector nationally and White workers are overrepresented compared to general workers at the national and national urban level.

Nationally, White and Asian workers in the Navigational, Measuring, Electromedical, and Control Instruments Manufacturing sector are overrepresented when compared to the general worker population nationally and the national urban population. For the vapor degreasing facilities within this sector in the Chicago metropolitan area, White and Hispanic workers are overrepresented compared to the percentage of these workers in the sector nationally. Additionally, White workers in these facilities are overrepresented compared to the national average for general workers.

Asian, White, and Hispanic workers within the Other Fabricated Metal Product Manufacturing sector in facilities using TCE in vapor degreasing are overrepresented compared to the national average within that sector as well as the population distributions for general workers at both the national and national urban levels.

Within the Other Miscellaneous Manufacturing sector, facilities using TCE for vapor degreasing employ a larger percentage of Asian, Black, and Hispanic workers than the national average for that sector and Asian and Hispanic are overrepresented compared to the national average for general workers.

Facilities that use TCE for vapor degreasing in the Semiconductor and Other Electronic Component Manufacturing in the Chicago metropolitan area employ a higher percentage of Asian and Hispanic workers compared to both the national average of workers withing that industry sector and nationally for general workers.

Facilities using TCE in vapor degreasers in the Spring and Wire Product Manufacturing sector employ a greater percentage of White and Hispanic workers both the national average for that sector and the national average for general workers.

Table 10-31: Characteristics of General Worker Populations at National Level and Sector Worker Populations in Areas Nearby Chicago Metropolitan TCE Vapor Degreasing Facilities

Region	Employees in Industry	Percent Local Employees in Industry	Percent Asian	Percent Black	Percent Pacific Islander	Percent Hispanic	Percent Native American	Two Percent or More Races	Percent White
National	326,569,308		5.6%	12.6%	0.2%	18.2%	0.8%	5.2%	70.4%
Urban	266,435,744		6.6%	14.2%	0.2%	21.7%	0.6%	5.7%	66.5%
Rural	60,133,564		1.2%	5.8%	0.1%	2.4%	1.7%	2.8%	87.6%
Coating, Engraving, Heat Treating, and Allied Activities									
National			4.6%	10.5%	0.3%	22.8%	1.1%	1.7%	81.8%
Cook County	3,687	0.2%	4.6%	10.3%	0.3%	45.4%	1.2%	1.8%	81.8%
DuPage County	1,043	0.2%	5.6%	7.6%	0.4%	41.6%	1.7%	1.5%	83.1%
Electric Lighting Equipment Manufacturing									
National			7.7%	8.6%	0.2%	22.8%	0.9%	1.6%	80.8%
Cook County	1,776	0.1%	6.5%	7.4%	0.2%	47.4%	1.7%	1.5%	82.7%
McHenry County	576	0.7%	2.8%	2.1%		21.7%		1.0%	93.6%
Forging and Stamping									
National			4.4%	8.0%	0.2%	16.9%	0.7%	1.3%	85.3%
Cook County	4,165	0.2%	7.2%	10.6%	0.3%	35.6%	0.9%	1.2%	79.9%
DuPage County	788	0.1%	5.5%	4.7%		35.3%	0.8%	1.4%	87.3%
Industrial Machinery Manufacturing									
National			11.3%	4.4%	0.2%	10.4%	0.6%	1.5%	81.9%
McHenry County	167	0.2%	4.8%		0.0%	8.4%		2.4%	91.0%
Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing									
National			6.1%	4.0%	0.2%	13.7%	0.8%	1.3%	87.6%
Cook County	6,870	0.3%	6.5%	4.6%	0.2%	26.0%	0.9%	1.2%	86.6%
DuPage County	4,520	0.8%	6.0%	4.4%	0.3%	30.9%	0.9%	1.4%	87.0%

Table 10-31: Characteristics of General Worker Populations at National Level and Sector Worker Populations in Areas Nearby Chicago Metropolitan TCE Vapor Degreasing Facilities

Region	Employees in Industry	Percent Local Employees in Industry	Percent Asian	Percent Black	Percent Pacific Islander	Percent Hispanic	Percent Native American	Two Percent or More Races	Percent White
Kane County	1,324	0.7%	6.2%	3.7%	0.2%	25.4%	1.3%	1.4%	87.3%
Medical Equipment and Supplies Manufacturing									
National			13.4%	8.2%	0.3%	16.5%	0.9%	1.8%	75.4%
Cook County	2,811	0.1%	17.6%	6.3%	0.2%	27.3%	0.9%	1.4%	73.6%
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing									
National			15.1%	6.1%	0.2%	10.8%	0.6%	1.8%	76.1%
McHenry County	320	0.4%	3.1%	1.3%	0.0%	16.3%	-	-	94.4%
Other Fabricated Metal Product Manufacturing									
National			4.7%	8.5%	0.2%	14.2%	0.9%	1.4%	84.4%
Cook County	5,611	0.3%	6.5%	8.4%	0.3%	39.5%	1.3%	1.4%	82.1%
Kane County	1,095	0.6%	12.0%	7.1%		32.1%	1.1%	1.1%	78.7%
Other Miscellaneous Manufacturing									
National			6.2%	6.8%	0.2%	17.0%	1.0%	1.7%	84.0%
Cook County	6,893	0.3%	7.8%	10.1%	0.3%	30.4%	0.9%	1.6%	79.3%
Semiconductor and Other Electronic Component Manufacturing									
National			23.9%	5.4%	0.2%	13.2%	0.8%	1.8%	67.8%
Cook County	2,745	0.1%	32.5%	5.2%	0.1%	25.1%	1.1%	1.4%	59.7%
Spring and Wire Product Manufacturing									
National			5.4%	7.6%	0.2%	18.6%	0.9%	1.5%	84.2%
Lake County	1,136	0.4%	5.5%	5.8%	0.4%	39.3%	0.7%	1.4%	86.1%

10.6.6 Vapor Degreasing of Narrow Tubes

EPA identified five specific facilities that use vapor degreasing to clean narrow tubes for aerospace and/or medical device use. These facilities were chosen for more detailed analysis because of a 7-year TSCA section 6(g) exemption on prohibition for these uses. Under the rule, these facilities will be required to implement a WCPP including dermal protections to manufacture for certain ongoing uses followed by a prohibition of the use of TCE. They are Salem Tube Inc., Superior Tube Co., Summerhill High Precision Tube, Handytube Corp., and Ametek Specialty Metal Product.. Under the rule, these facilities will be required to implement a Workplace Chemical Protection Program (WCPP) including dermal protections to manufacture for certain ongoing uses followed by a prohibition of the use of TCE. Table 10-32 presents average information on communities surrounding the five facilities. TCE. The analysis uses socioeconomic and demographic data from the American Community Survey 1-year data release for 2020. The values in the last three columns reflect population-weighted averages across the Census block groups within 1-, 3- and 5-miles of each facility. The table presents rural and urban data in addition to overall national statistics for comparison. because facilities are located in both urban and rural communities. For the purposes of this analysis, EPA considers a facility to be in a rural community if 50 percent or more of the population estimated to live within 3-miles of the facility is not located in an urban block group.

Table 10-32: Demographics of Communities Within 1-, 3-, and 5-mile Radii of Facilities Vapor Degreasing of Narrow Tubes

Demographic	National	Urban	Rural	1 Mile Average	3 Mile Average	5 Mile Average
Median Household Income	$64,994	$71,293	$51,878	78,889	90,539	88,878
White	70.4%	66.5%	87.6%	79.3%	79.6%	78.1%
Black	12.6%	14.2%	5.8%	12.3%	10.5%	11.2%
American Indian	0.8%	0.6%	1.7%	0.1%	0.1%	0.2%
Asian	5.6%	6.6%	1.2%	4.0%	4.7%	5.6%
Pacific Islander	0.2%	0.2%	0.1%	0.0%	0.0%	0.0%
Other	5.1%	6.1%	0.8%	0.7%	1.9%	1.6%
2 or More Races	5.2%	5.7%	2.8%	3.5%	3.1%	3.2%
Hispanic	18.2%	21.7%	2.4%	3.9%	6.1%	5.8%
2x Poverty Line	29.8%	30.6%	26.0%	18.4%	18.2%	19.8%
Below Poverty Line	12.8%	13.6%	9.6%	8.0%	8.6%	8.6%
NATA Cancer Risk	20	-	-	30	26	25
NATA Respiratory Hazard Score	0.3	-	-	0.3	0.3	0.3
Total Population	-	-	-	17,277	125,309	322,205

The median household income of communities within 1-, 3-, and 5-miles of the facilities are higher than all of the national averagesand the percent of individuals with incomes less than two the poverty line is below than all the national averages in communities surrounding the narrow tube vapor degreasing facilities. EPA also summarized the NATA Cancer Risk, which is greater than the national average and the NATA Respiratory Hazard Score, which the same as the national average in areas at a 1-, 3-, and 5-mile radius from the facility.

Table 10-33 presents the density of other TRI facilities located within a 1-, 3- and 5-mile radius of the 5 narrow tube facilities. These facilities could contribute to cumulative environmental risks in these communities, if individuals living in closer proximity are more likely to be exposed to toxic releases by these TRI facilities. Ametek Specialty Metal Product has 19 facilities within 5 miles of its Wallingford, CT plant but only 8 within 5 miles of its Wichita, KS plant. Axiall Corporation has 20 other TRI facilities within 5 miles of its facility in Westlake, LA. This information suggests that these facilities are in areas with evidence of clustering of Toxic Releases Inventory sites. To evaluate potential for risk posed by the clustering of these facilities, we also summarize the NATA Cancer Risk, which is 3-4x greater than the national average, and the NATA Respiratory Hazard Score, which is greater than the national average.

Table 10-33: Total Number of Other TRI Facilities Within 1, 3 and 5 Miles of Facilities Manufacturing TCE

Facility Name	Location	Other TRI Facilities Within 1 Mile	Other TRI Facilities Within 3 Miles	Other TRI Facilities Within 5 Miles
Salem Tube Inc.	Greenville, PA	3	3	4
Superior Tube Co.	Collegeville, PA	1	3	6
Summerhill High Precision Tube	Scottdale, PA	1	1	2
Ametek Specialty Metal Product	Wallingford, CT	5	11	19
Handytube Corp.	Camden, PA	-	1	2

Table 10-34 shows the demographics of communities near the Salem Tube Corporation in Greenville, PA. This facility is in a rural area. Within a 1-,3-, and 5-mile radius of the facility, the median household income is higher than both the national and national rural medians. The communities within a 3- and 5-mile radius have a higher than (national and rural) average level of poverty.

The surrounding communities have a higher proportion of White population than the national average although it is more similar to the national rural average, particularly at the 1-mile radius. Other demographic groups generally below the national and national rural averages except for Other which is higher at the 1-mile radius. Both the NATA Cancer Risk and NATA Respiratory Hazard score are equal to or lower than the national average.

Table 10-34: Community Demographics Near Salem Tube, Inc., Greenville, PA

Demographic	National	Rural	1 mile	3 miles	5 miles
Median Household Income	$64,994	$51,878	103,868	66,981	54,125
White	70.4%	87.6%	89.5%	93.8%	95.8%
Black	12.6%	5.8%	1.9%	1.7%	1.4%
American Indian	0.8%	1.7%	0.0%	0.0%	0.1%
Asian	5.6%	1.2%	1.0%	1.1%	0.7%
Pacific Islander	0.2%	0.1%	0.0%	0.0%	0.0%
2 or more races	5.1%	0.8%	0.4%	1.0%	0.4%
Other	5.2%	2.8%	7.1%	2.4%	1.6%
Hispanic	18.2%	2.4%	1.0%	1.6%	1.5%
2x Below Poverty Level	29.8%	26.0%	21.9%	32.3%	34.8%
Below Poverty Level	12.8%	9.6%	11.5%	14.0%	14.2%
NATA Cancer	20	-	20	20	20
NATA Respiratory	0.3	-	0.3	0.3	0.2
Total Population	-	-	1,085	4,490	15,212

Table 10-35 shows that the communities surrounding the Superior Tube Co. in Collegeville, PA have higher median household incomes than the national or national urban medians and a greater proportion of the populations at the 1-mile radius fall below the poverty level than the national or national rural averages.

These communities have a higher proportion of White and Asian populations than the national and urban averages. The NATA cancer risk score is higher than the national average while the NATA Respiratory Hazard score is the same as the national average.

Table 10-35: Community Demographics Near Superior Tube, Co., Collegeville, PA

Demographic	National	Urban	1 mile	3 miles	5 miles
Median Household Income	$64,994	$71,293	$112,865	$126,601	$118,110
White	70.4%	66.5%	80.3%	79.2%	80.7%
Black	12.6%	14.2%	9.0%	10.3%	6.9%
American Indian	0.8%	0.6%	0.1%	0.1%	0.0%
Asian	5.6%	6.6%	8.6%	7.0%	9.3%
Pacific Islander	0.2%	0.2%	0.0%	0.0%	0.0%
2 or more races	5.1%	6.1%	0.2%	1.4%	1.0%
Other	5.2%	5.7%	1.8%	2.0%	2.1%
Hispanic	18.2%	21.7%	4.6%	4.6%	4.3%
2x Below Poverty Level	29.8%	30.6%	10.1%	7.8%	9.9%
Below Poverty Level	12.8%	13.6%	5.6%	3.1%	3.9%
NATA Cancer	20	-	30	30	30
NATA Respiratory	0.3	-	0.3	0.3	0.3
Total Population	-	-	4,210	41,378	108,007

Table 10-36 shows the demographics of communities near the Summerdale Precision Tube, Scottdale, PA. This facility is in an urban area. Within a 1-,3-, and 5-mile radius of the facility, the median household income is lower than both the national and national urban medians. These communities also have a lower than (national and urban) average level of poverty.

These communities have a higher proportion of White populations than the national and urban averages. The NATA cancer risk score is 2x higher than the national average at the 1-mile radius and exceeds the national average at both the 3- and 5-mile radii while the NATA Respiratory Hazard score exceeds the national average at the 1- and 3-mile radii but is equal at the 5-mile radius.

Table 10-36: Community Demographics Near Summerhill Hill Precision Tube, Scottdale, PA

Demographic	National	Urban	1 mile	3 miles	5 miles
Median Household Income	$64,994	$71,293	$53,525	$57,795	$53,733
White	70.4%	66.5%	97.4%	97.2%	96.7%
Black	12.6%	14.2%	0.9%	1.3%	1.2%
American Indian	0.8%	0.6%	0.0%	0.0%	0.0%
Asian	5.6%	6.6%	0.2%	0.3%	0.3%
Pacific Islander	0.2%	0.2%	0.0%	0.0%	0.0%
2 or more races	5.1%	6.1%	0.0%	0.0%	0.2%
Other	5.2%	5.7%	1.5%	1.2%	1.6%
Hispanic	18.2%	21.7%	0.1%	0.1%	0.3%
2x Below Poverty Level	29.8%	30.6%	26.6%	26.8%	29.4%
Below Poverty Level	12.8%	13.6%	12.6%	10.9%	11.0%
NATA Cancer	20	-	43	37	33
NATA Respiratory	0.3	-	0.4	0.4	0.3
Total Population	-	-	5,192	12,092	26,226

Table 10-37 shows the demographics of communities near the Ametek Specialty Metal Products, Wallingford, CT facility. The median household income for areas surrounding the facility have a higher median income than both the national and national urban medians. These communities also have a lower than (national and urban) average level of poverty.

The surrounding communities have a higher proportion of White populations and lower proportion of other demographic groups than the national and urban averages. NATA cancer risk is the same or close to the national average at the 1-, 3-, and 5-mile radius and exceeds the national average at both the 3- and 5-mile radii while the NATA Respiratory Hazard score is lower than the national average for the surrounding areas.

Table 10-37: Community Demographics Near Ametek Specialty Metal Products, Wallingford, CT

Demographic	National	Urban	1 mile	3 miles	5 miles
Median Household Income	64,994	71,293	85,528	86,583	94,947
White	70.4%	66.5%	86.9%	86.8%	84.1%
Black	12.6%	14.2%	1.4%	2.4%	4.8%
American Indian	0.8%	0.6%	0.0%	0.0%	0.0%
Asian	5.6%	6.6%	4.0%	4.5%	5.7%
Pacific Islander	0.2%	0.2%	0.0%	0.1%	0.1%
2 or more races	5.1%	6.1%	0.2%	3.3%	2.7%
Other	5.2%	5.7%	7.5%	2.8%	2.7%
Hispanic	18.2%	21.7%	9.9%	10.4%	8.0%
2x Below Poverty Level	29.8%	30.6%	8.7%	17.4%	14.8%
Below Poverty Level	12.8%	13.6%	3.8%	9.1%	6.9%
NATA Cancer	20	-	20	20	21
NATA Respiratory	0.3	-	0.2	0.2	0.2
Total Population	-	-	1,868	39,581	93,710

Table 10-38 shows the demographics of communities near the Handytube, Wallingford, CT facility. The median household income for areas surrounding the facility have a higher median income than the national medial at the 1- and 3-mile radius, but less at the 5-mile radius. The national urban median, however, is higher than the median household income for all three distances around the facility. both the national and national urban medians. In the 5-mile radius around the facility, the communities have a higher-than-average level of poverty The communities also have a lower than (national and urban) average percentage of population below the poverty level and below 2x the poverty level.

The surrounding communities also a higher percentage of Black populations than the national and national urban level. The NATA cancer risk score is the same as the national average at the 1-, 3-, and 5-mile radius while the NATA Respiratory Hazard score is lower than the national average for those same surrounding areas.

Table 10-38: Community Demographics Near Handytube Corp., Camden, PA

Demographic	National	Urban	1 mile	3 miles	5 miles
Median Household Income	$64,994	$71,293	$68,550	$66,784	$62,447
White	70.4%	66.5%	54.2%	60.1%	57.7%
Black	12.6%	14.2%	33.6%	27.9%	30.0%
American Indian	0.8%	0.6%	0.4%	0.4%	0.8%
Asian	5.6%	6.6%	4.8%	3.9%	3.3%
Pacific Islander	0.2%	0.2%	0.0%	0.0%	0.0%
2 or more races	5.1%	6.1%	2.3%	1.7%	1.9%
Other	5.2%	5.7%	4.7%	6.0%	6.2%
Hispanic	18.2%	21.7%	5.8%	5.4%	8.0%
2x Below Poverty Level	29.8%	30.6%	19.8%	26.8%	32.5%
Below Poverty Level	12.8%	13.6%	6.1%	12.9%	14.9%
NATA Cancer	20	-	20	20	20
NATA Respiratory	0.3	-	0.2	0.2	0.2
Total Population	-	-	4,924	27,767	79,051

Facilities using TCE to manufacture narrow tubes fall under two NAICs sectors, Steel Product Manufacturing from Purchased Steel and Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding. Table 10-39 breaks down the data for workers for counties with a facility using TCE to manufacture narrow tubes. Data are taken from the Census' QWI data averages indicator values for four quarters of 2020 (U.S. Census Bureau 2022). Data for two of the counties in which facilities are located are not included because data was not sufficient to provide results. This includes the county which contains the facility operating in the Steel Product Manufacturing from Purchased Steel and Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding sector. The table indicates that nationally, workers who are White are somewhat overrepresented in the Steel Product Manufacturing from Purchased Steel from Purchased Steel industry compared to their representation in the overall workforce. Black workers in Steel Product Manufacturing from Purchased Steel sector in Montgomery County are overrepresented when compared to the national workforce in both that sector and overall.

Table 10-39: Characteristics of General Worker Populations at National Level and Sector Worker Populations in Areas Nearby Facilities Vapor Degreasing of Narrow Tubes

Region	Employees in Industry	Percent Local Employees in Industry	Percent Asian	Percent Black	Percent Pacific Islander	Percent Hispanic	Percent Native American	Percent 2 or More Races	Percent White
National	326,569,308	-	5.6%	12.6%	0.2%	18.2%	0.8%	5.2%	70.4%
Urban	266,435,744	-	6.6%	14.2%	0.2%	21.7%	0.6%	5.7%	66.5%
Rural	60,133,564	-	1.2%	5.8%	0.1%	2.4%	1.7%	2.8%	87.6%
Steel Product Manufacturing from Purchased Steel									
National	-	-	2.7%	10.2%	0.1%	14.0%	1.0%	1.3%	84.6%
Mercer County	702	1.9%	-	4.8%	0.0%	1.3%	-	0.7%	94.0%
Montgomery County	1,021	0.2%	6.1%	14.1%	0.0%	8.7%	-	1.3%	77.8%
Westmoreland County	167	0.1%	-	4.8%	0.0%	0.0%	-	-	93.4%
Data for some counties may not appear due to an insufficient number of observations. Some percentages may not sum to 100% due to rounding.									

10.6.7 Processing Use of TCE in the Manufacture of Specialty Paper

PPG Industries, Inc. is the sole company using TCE as a processing aid in the manufacture of synthetic paper. Under the rule, this facility will be required to implement a Workplace Chemical Protection Program (WCPP) including dermal protections to manufacture for certain ongoing uses followed by a prohibition of the use of TCE. Table 10-40 presents average information on communities surrounding the facility. The analysis uses socioeconomic and demographic data from the American Community Survey 1-year data release for 2020. The values in the last three columns reflect population-weighted averages across the Census block groups within 1-, 3- and 5- miles of the facility. The table presents urban data in addition to overall national statistics for comparison because the facility is located in a an urban community.

Table 10-40: Demographics of Communities Within 1-, 3-, and 5-mile Radii of PPG Industries, Inc.

Demographic	National	Urban	1 Mile Average	3 Mile Average	5 Mile Average
Median Household Income	$64,994	$71,293	$40,432	$52,822	$58,021
White	70.4%	66.5%	88.5%	90.5%	88.2%
Black	12.6%	14.2%	7.2%	6.6%	7.9%
American Indian	0.8%	0.6%	0.2%	0.2%	0.2%
Asian	5.6%	6.6%	0.0%	0.3%	0.9%
Pacific Islander	0.2%	0.2%	0.0%	0.0%	0.0%
Other	5.1%	6.1%	0.5%	0.3%	0.3%
2 or More Races	5.2%	5.7%	3.6%	2.0%	2.5%
Hispanic	18.2%	21.7%	1.9%	1.7%	1.3%
2x Poverty Line	29.8%	30.6%	52.9%	37.2%	32.5%
Below Poverty Line	12.8%	13.6%	24.7%	14.9%	12.7%
NATA Cancer Risk	20	-	21	23	23
NATA Respiratory Hazard Score	0.3	-	0.3	0.3	0.3
Total Population	-	-	3,152	36,144	83,640

The median household income of communities within 1-,3-, and 5-miles of the facility are lower than the national averages. The percent of individuals living at greater than two times below the poverty line is also higher than the national averages in the communities surrounding the synthetic paper manufacturing facility. The NATA Cancer Risk is similar to the national average and the NATA Respiratory Hazard Score is the same as the national average.

Table 10-41 presents the density of other TRI facilities located within a 1-, 3- and 5-mile radius of the PPG Industries, Inc. facility. These TRI facilities could contribute to cumulative environmental risks in these communities, assuming that individuals living in closer proximity are more likely to be exposed to toxic releases by these TRI facilities. There are 7 facilities within 5 miles of the Barberton, OH plant, 4 within 3 miles, and only one additional facility within 1 mile of the plant. This information suggests that the PPG Industry, Inc. facility is in an area with evidence of some clustering of Toxic Releases Inventory sites.

Table 10-41: Total Number of Other TRI Facilities Within 1, 3 and 5 Miles of Facilities Manufacturing TCE

Facility Name	Location	Other TRI Facilities Within 1 Mile	Other TRI Facilities Within 3 Miles	Other TRI Facilities Within 5 Miles
PPG Industries, Inc.	Barberton, OH	1	4	7

The PPG facility manufacturing synthetic paper falls under NAICs 325180: Other Basic Inorganic Chemical Manufacturing. 5 breaks down the data for workers in the county for the synthetic paper manufacturing facility. Table 10-42 breaks down the data for workers for counties nearby PPG, they only facility using TCE in manufacturing synthetic paper. Data are taken from the Census' QWI data averages indicator values for four quarters of 2020 (U.S. Census Bureau 2022). Worker populations for the TCE manufacturing facilities in Summit County have a lower percentage of Asian and Hispanic workers than the national average for all workers as well as those workers nationally in the basic chemical manufacturing sector. The percentage of White workers is higher than the average for all workers at the national and national urban level. in the industrial and miscellaneous chemicals sector and at the national level. The percentage of Black workers is higher than the national average for workers in the same industry sector and the national average for all workers, but is slightly lower than the percentage for all urban workers.

Table 10-42: Characteristics of General Worker Populations at National Level and Sector Worker Populations in Areas Nearby Facilities Manufacturing Synthetic Paper

Region	Employees in Industry	Percent Local Employees in Industry	Percent Asian	Percent Black	Percent Pacific Islander	Percent Hispanic	Percent Native American	Percent 2 of More Races	Percent White
National	326,569,308		5.6%	12.6%	0.2%	18.2%	0.8%	5.2%	70.4%
Urban	266,435,744		6.6%	14.2%	0.2%	21.7%	0.6%	5.7%	66.5%
Basic Chemical Manufacturing									
National	134,658		4.3%	10.8%	0.1%	10.3%	0.6%	1.3%	82.9%
Summit County, OH	305	0.1%	2.3%	13.8%	0.0%	2.0%	0.0%	1.3%	82.6%

10.6.8 Conclusions

To briefly summarize the findings of this analysis, this baseline characterization suggests that workers in affected industries and regions, as well as residents of nearby communities, are often more likely people of color than the general population in affected geographic areas. However, battery separator manufacturing facilities are often located near communities with larger percent White populations. Although one of those facilities identified has a higher percent American Indian population nearby, the facility is not within 5 miles of tribal lands. Further, the data suggest that there are differentials in many other demographics when compared to national averages in communities surrounding most facilities subject to this regulation. These include both race and ethnicity as well as income. Most facilities are in areas where there is a high density of other TRI facilities, which could mean there is a cumulative risk to populations in the surrounding areas. Also, almost all facilities are in areas where both the NATA Cancer Risk and NATA Respiratory Hazard Scores are greater than the national average, with the highest NATA Cancer score of any facility investigated in this EJ analysis at 10x the national average.

10.7 Impacts on Technological Innovation and the National Economy

With respect to the anticipated effects of this rule on the national economy, as described in the preamble, EPA considered the number of businesses and workers that would be affected and the costs and benefits to those businesses and workers and did not find that there would be a measurable impact on the national economy. Guidance issued by the Office of Management and Budget indicates that the economic impact of a regulation on the national economy becomes measurable only if the economic impact of the regulation reaches 0.25 percent to 0.5 percent of Gross Domestic Product (GDP) (See Memorandum from Sally Katzen, "Guidance for Implementing Title II of [UMRA]," March 31, 1995). Given the current real GDP, this is equivalent to a cost of $50 billion to $101 billion (U.S. Bureau of Economic Analysis 2023b). Therefore, EPA has concluded that this rule is highly unlikely to have any measurable effect on the national economy.

With respect to this rule's effect on technological innovation, EPA expects this rule to spur innovation, not hinder it. A prohibition or significant restriction on the manufacture, processing, and distribution in commerce of TCE for uses covered in this final rule is likely to increase demand for chemical substitutes. This rulemaking involves environmental monitoring or measurement, specifically for occupational inhalation exposures to TCE. Consistent with the Agency's Performance Based Measurement System (PBMS), EPA does not require the use of specific, prescribed analytic methods. Rather, the Agency plans to allow the use of any method that meets the prescribed performance criteria. The PBMS approach is intended to be more flexible and cost-effective for the regulated community; it is also intended to encourage innovation in analytical technology and improved data quality. EPA is not precluding the use of any method, whether it constitutes a voluntary consensus standard or not, as long as it meets the performance criteria specified. Some examples of methods which might meet the criteria are included in appendix A of the ECEL memo.

10.8 Executive Order 13132 – Federalism

Executive Order 13132, entitled *Federalism* (64 FR 43255, August 10, 1999), directs federal agencies to consider whether a rule has federalism implications (i.e., whether it has substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132). The EPA has concluded that this action has federalism implications because regulation under TSCA section 6(a) may preempt state law. The Agency consulted with state and local officials early in the process of developing the proposed action to permit them to have meaningful and timely input into its development. EPA met with State and local officials early in the process of developing the proposed and final regulatory actions in order to receive meaningful and timely input into its development. Consultation occurred from July 22, 2021 until October 22, 2021. This included a background presentation on September 9, 2021, and a consultation meeting on July 22, 2021. EPA invited the following national organizations representing state and local elected officials to a meeting on May 13, 2021 in Washington DC: National Governors Association; National Conference of State Legislatures, Council of State Governments, National League of Cities, U.S. Conference of Mayors, National Association of Counties, International City/County Management Association, National Association of Towns and Townships, County Executives of America, and Environmental Council of States.

10.9 Executive Order 13175 – Tribal Implications

Executive Order 13175, entitled *Consultation and Coordination with Indian Tribal Governments* (59 FR 22951, November 6, 2000), directs federal agencies to consider whether a rule has tribal implications (i.e., whether it has substantial direct effects on tribal governments, on the relationship between the Federal government and the Indian tribes, or on the distribution of power and responsibilities between the Federal government and Indian tribes). This rulemaking would not have substantial direct effects on tribal government because TCE is not manufactured, processed, or distributed in commerce by tribes and would not impose substantial direct compliance costs on tribal governments. Thus, Executive Order 13175 does not apply to this action. EPA nevertheless consulted with tribal officials during the development of this action, consistent with the EPA Policy on Consultation and Coordination with Indian Tribes. EPA held a tribal consultation from May 17, 2021 to August 20, 2021, with meetings on June 15, 2021, and July 8, 2021. EPA risk managers briefed tribal officials on the Agency's risk management considerations and tribal officials raised no related issues or concerns to EPA during, or in follow-up-to those meetings.

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Appendix A - Chemical Ranking Procedure and Calculations

A chemical ranking procedure was developed as a proxy for market share percentage of the chemicals used in products. This procedure provides a coarse estimate of 1) market share percentage of chemicals used within the current marketplace, and 2) the anticipated market share percentage of alternative chemicals if methylene chloride were restricted for a certain product category.

The use of a chemical ranking procedure as a proxy for market share of the chemicals used in products, builds in an assumption that the greater solvent effectiveness, greater number of customer product reviews, greater customer ratings, lower VOC content, lower product flammability, and lower price are associated with greater market share. This may not be the case for all product categories, and additional research using industry-specific sources would be necessary to obtain enhanced market share information for each product category and ingredient.

An Internet search was conducted to find products within a product category that met the following two conditions: 1) were available for sale on-line, and 2) had customer review and rating information available on-line. These products would provide the basis for this chemical ranking procedure.

For some product categories, there were no customer reviews for products with COCs and/or alternative products. For these cases, these products were included in our evaluation and were given the lowest possible score "0" for both customer reviews and customer ratings.

The individual chemical ingredient names and concentrations for these products were identified by reviewing the product Safety Data Sheets. The chemical ranking procedure was limited to solvent ingredients only. Other product ingredients such as propellants, evaporation barriers, colorants, and surfactants were excluded from this chemical ranking procedure.

The concentration of a solvent ingredient in a product was multiplied by the sum of ratings for the following factors: product price, solvent VOC exempt status, number of customer reviews of the product, number of customer ratings of the product, product HSP distance to the target contaminant, and product fire safety. The rating scale used was from "0" the least desirable rating, to "5" the most desirable rating. If a solvent ingredient was used in more than one product, then the results for the solvent were summed to represent the cumulative market share for the particular solvent. The following paragraphs provide a description for each factor.

Product Price

The pricing information was accessed from publicly available websites. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce.

The price range for products containing methylene chloride was determined. The price for individual products containing alternative chemicals was compared to the price range of the products containing methylene chloride. The higher the rating, the more desirable the product price containing alternative solvents. Exhibit A-1 shows the rating scale based upon this comparison.

Exhibit A-1: Product Price - Rating Scale

Rating	Description
5	Within or below the price range of products containing a Chemical of Concern (1-BP, DCM, NMP, TCE, PCE)
4	< 25% above price range of products containing a Chemical of Concern
3	25 to 50% above price range of products containing a Chemical of Concern
2	51 to 75% above price range of products containing a Chemical of Concern
1	76 to 100% above price range of products containing a Chemical of Concern
0	Greater than 100% above price range of products containing a Chemical of Concern

Solvent VOC Exempt Status

The individual solvents were given a rating of "5" if they have VOC exempt status from the U.S. EPA and were given a rating of "0" if they did not have VOC exempt status.

Customer Reviews of the Product

The number of customer reviews of the product was determined from online sources. The retailer providing the highest number of customer reviews for a particular product was used for the chemical ranking procedure. In general, the higher the number of customer reviews the higher the likelihood that the product is widely sold and used. Exhibit A-2 shows the rating scale based upon the number of product customer reviews.

Exhibit A-2: Customer Reviews - Rating Scale

Rating	Number of Customer Reviews
5	Greater than 5,000 reviews
4	3,001 to 5,000 reviews
3	1,001 to 3,000 reviews
2	501 to 1,000 reviews
1	11 to 500 reviews
0	0 to 10 reviews

Customer Ratings of the Product

The average number of stars provided by customer reviews of the product was determined from online sources. The typical customer rating scale is "0" to "5" stars, where "0" is the lowest rating and "5" is the highest rating based upon customer satisfaction with the product. Exhibit A-3 shows the rating scale based upon the average customer rating for a product.

Exhibit A-3: Customer Ratings - Rating Scale

Rating	Customer Rating
5	4.7 to 5.0 stars
4	4.3 to 4.6 stars
3	3.7 to 4.2 stars
2	3.3 to 3.6 stars
1	3.0 to 3.2 stars
0	Less than 3 stars

HSP Distance to Contaminant

The HSP theory can be used to predict which solvents will be able to quickly dissolve and/or soften the target. HSP values are based on the principle that "like dissolves like," meaning that the closer the contaminant and the solvent are in three-dimensional solubility space, the greater the likelihood that the solvent will be effective. Therefore, with all other factors being equal, the lower the HSP distance between the solvent and contaminant the more effective the solvent will be and ultimately reduce the removal time of the contaminant. Exhibit A-4 shows the rating scale based upon the HSP distance between the solvent and contaminant.

The calculation of the HSP distance to contaminant is a time -consuming process. Due to limited project resources this calculation was conducted for some but not all product categories. For product categories with no HSP distance calculations, the HSP distance factor was not included in the chemical ranking process.

Exhibit A-4: HSP Distance to Contaminant- Rating Scale

Rating	HSP Distance
5	Less than 3.0
4	3.0 to 6.9
3	7.0 to 9.9
2	10.0 to 12.9
1	13.0 to 15.0
0	Greater than 15.0

Fire Safety

The fire safety rating is based upon the product flammability rating and the presence/absence of evaporation barrier additives in the product. The product flammability rating was determined by either the rating provided on the product label, or the flash point temperature provided in the product Safety Data Sheet. Under the Federal Hazardous Substances Act label requirements, the Consumer Product Safety Commission classifies a liquid with a flash point less than 20 °F as "Extremely Flammable"; greater than 20 °F and less than 100 °F as "Flammable";

and 100 °F to 150 °F as "Combustible." Exhibit A-5 shows the rating scale based upon the product flammability rating and the presence/absence of evaporation barrier additives.

Exhibit A-5: Fire Safety - Rating Scale

Rating	Fire Safety
5	"Non-flammable" product rating
4	"Combustible" product rating or Evaporation Barrier used in the product
1	"Flammable" product rating and no Evaporation Barrier used in the product
0	"Extremely flammable" product rating and no Evaporation Barrier used in the product

The details of the chemical ranking procedure for determining the market share percentage for brake cleaners is provided as an example of this procedure. Exhibit A-6 shows the chemical ranking procedure applied to the brake cleaning products. Note that total points for a given solvent are summed across products assessed. In addition, this procedure may undervalue the aqueous option as the HSP value and the price for the aqueous option are both shown as zero. The degreasing mechanism is not reflected in the HSP system. Similarly, the cost savings from adoption of an aqueous system are not reflected here because no cost per ounce was calculated for the aqueous system.

Exhibit A-6: Chemical Ranking Procedure for Brake Cleaning Products

Chemical	Product	Concentration in Product	Price	VOC	Customer Reviews	Customer Ratings	HSP Distance to brake contaminant	Fire Safety	Total Points	% Before Restriction	% After Restriction
acetone	CRC Brakleen Non-Chlorinated 05054	85%	5	5	2	5	3	0	17.0		
acetone	3M 08180	65%	4	5	1	4	4	0	11.7		
acetone	3M 08179	80%	3	5	1	4	3	0	12.8		
							acetone subtotal		**41.5**	31%	47%
perc	CRC Brakleen 05089	95%	5	5	5	5	3	5	26.6		
perc	Berryman 5C-4	13%	5	5	0	5	4	5	3.0		
							perc subtotal		**29.6**	22%	
DCM	Berryman 5C-4	65%	5	5	0	5	4	5	15.6	12%	
heptane, branched, cyclic, and linear	3M 08880	55%	5	0	1	4	5	0	8.3	6%	9%
xylene	3M 08880	23%	5	0	1	4	5	0	3.4		
xylene	3M 08180	5%	4	0	1	4	4	0	0.6		
							xylene subtotal		**4.0**	3%	4%
toluene	Berryman 5C-4	20%	5	0	0	5	4	5	3.8	3%	4%
2-methyl hexane	3M 08180	8%	4	0	1	4	4	0	1.0	1%	1%

Exhibit A-6: Chemical Ranking Procedure for Brake Cleaning Products

Chemical	Product	Concentration in Product	Price	VOC	Customer Reviews	Customer Ratings	HSP Distance to brake contaminant	Fire Safety	Total Points	% Before Restriction	% After Restriction
3-methyl hexane	3M 08180	8%	5	0	1	4	4	0	1.1	1%	1%
methanol	3M 08880	8%	5	0	1	4	5	0	1.1	1%	1%
ethyl benzene	3M 08880	6%	5	0	1	4	5	0	0.9	1%	1%
n-heptane	CRC Brakleen Non-Chlorinated 05054	4%	5	0	2	5	3	0	0.6	0%	1%
ethanol	Trueguard	10%	5	0	0	4	4	0	1.3	1%	1%
naphtha	Trueguard	90%	5	0	0	4	4	0	11.7	9%	13%
water	CRC Smart Washer Ozzy Juice	100%	0	5	0	4	0	5	14.0	10%	16%
									totals	100%	100%
								Points Before Restriction	134.4		
								Points After Restriction	89.2		

Appendix B: Estimated Costs for Respirator PPE for 2024 TSCA Risk Management Economic Analyses

Appendix B: Estimated Costs for Respirator PPE for 2024 TSCA Risk Management Economic Analyses

November 2024

Submitted to:

Economic and Policy Analysis Branch
Existing Chemicals Risk Management Division
Office of Pollution, Prevention, and Toxics
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue
Washington, DC 20460

Submitted by:

Abt Global
6130 Executive Boulevard
Rockville, MD 20852

1. Introduction

This appendix presents estimates for the costs of personal protective equipment (PPE) for respiratory protection, for the purposes of this rulemaking.

EPA's cost estimates for implementing and maintaining a respiratory PPE program reflect the assumption that facilities will follow OSHA's Respiratory Protection Standard (OSHA 2009),[1] which identifies several types of respirators and their Assigned Protection Factors (APFs). The APF denotes the level of respiratory protection that a given respirator is expected to provide employees. An employer may select any respirator that has an APF equal to or greater than the applicable requirement.

Table B-1 reproduces Table 1 of OSHA's guidance document on Assigned Protection Factors for the Revised Respiratory Protection Standard (OSHA 2009) and presents each type of respirator with its expected APF.

Table B-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
Air-Purifying Respirator (APR)	5	10	50	-	-
Powered Air-Purifying Respirator (PAPR)	-	50	1,000	25/1,000[1]	25
Supplied-Air Respirator (SAR) or Airline Respirator					
• Demand mode	-	10	50		
• Continuous flow mode	-	50	1,000	25/1,000[1]	25
• Pressure-demand or other positive-pressure mode	-	50	1,000	-	-
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	-
[1]The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1,000 or greater to receive an APF of 1,000. It is assumed that respirators have an APF of 1,000.					

As indicated in Table B-1, above, respirators are grouped into different classes defined by the air supply system, operating mode, and the type of facepiece. The major air supply systems (as defined in OSHA (2009)) are:

- **Air Purifying Respirator (APR).** A respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

[1] The Respiratory Protection Standard (Occupational Safety and Health Administration (OSHA)), promulgated by OSHA, contains requirements for program administration, procedures for respirator selection, employee training, fit testing, medical evaluation, respirator use, APFs and Maximum Use Concentrations (MUCs), as well as other provisions.

- **Atmosphere-Supplying Respirator.** A respirator that supplies breathing air from a source independent of the ambient atmosphere. Includes SAR and SCBA units.

- **Powered Air-Purifying Respirator (PAPR).** A type of air purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering. The inlet covering is the portion of a respirator that forms the protective barrier between the user's respiratory tract and an air-purifying device or breathing air source, or both.

- **Self-Contained Breathing Apparatus (SCBA).** An atmosphere-supplying respirator, where the source of breathing air is designed to be carried by the user.

- **Supplied-Air Respirator (SAR) or Airline Respirator.** An atmosphere-supplying respirator, where the source of breathing air is not designed to be carried by the user.

The types of operating modes (based on definitions in OSHA (2009)) are:

- **Continuous Flow Mode.** Provides a continuous flow of breathable air to the respirator facepiece.

- **Demand Mode.** Admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation.

- **Positive Pressure Mode**. The pressure inside the respirator inlet covering exceeds the ambient air pressure outside the respirator.

- **Pressure Demand Mode**. Admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece by inhalation.

And the major facepiece types (as defined in OSHA's APF Guide, unless otherwise noted) are:

- **Full Facepiece.** Covers from the hairline to below the chin, and typically provides eye protection as well (NIOSH 2012).

- **Half Mask.** Covers the nose, mouth, and under the chin (NIOSH 2012).

- **Helmet/Hood.** A helmet is a rigid respiratory inlet covering that also provides head protection against impact and penetration. A hood is a respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.

- **Loose-Fitting Facepiece.** A respiratory inlet covering that is designed to form a partial seal with the face.

- **Quarter Mask.** Covers the mouth and nose, and the lower sealing surface rests between the chin and mouth (NIOSH 2012).

Not all respirators presented in Table B-1 are suitable to include in a cost analysis. Table B-2 presents the respirators that are included and excluded from the cost analysis, with an explanation for a respirator's exclusion noted as a footnote in the table.

Table B-2: Respirators Selected for Cost Analysis

Respirator[1]		APF	Included in Analysis
APR[2]	APR Quarter Mask[3]	5	✗
	APR Half Mask	10	✓
	APR Full Facepiece	50	✓[2]
PAPR[2]	PAPR Half Mask	50	✓[2]
	PAPR Full Facepiece	1,000	✓[2]
	PAPR Helmet/Hood	1,000	✓[2]
	PAPR Loose-Fitting Facepiece	25	✓
SAR	SAR Demand Mode Half Mask[4]	10	✗
	SAR Demand Mode Full Facepiece[4]	50	✗
	SAR Continuous Flow Mode Half Mask	50	✓
	SAR Continuous Flow Mode Full Facepiece	1,000	✓
	SAR Continuous Flow Mode Helmet/Hood	1,000	✓
	SAR Continuous Flow Mode Loose-Fitting Facepiece	25	✓
	SAR Pressure-Demand or other Positive-Pressure Mode Half Mask[5]	50	✗
	SAR Pressure-Demand or other Positive-Pressure Mode Full Facepiece[5]	1,000	✗
SCBA	SCBA Demand Mode Half Mask[4]	10	✗
	SCBA Demand Mode Full Facepiece[4]	50	✗
	SCBA Demand Mode Helmet/Hood[4]	50	✗
	SCBA Pressure-Demand or other Positive-Pressure Mode Full Facepiece	10,000	✓
	SCBA Pressure-Demand or other Positive-Pressure Mode Helmet/Hood	10,000	✓

[1] APR: Air-Purifying Respirator; PAPR: Powered-Air-Purifying Respirator; SAR: Supplied-Air Respirator: SCBA: Self Contained Breathing Apparatus

[2] APR and PAPR respirators are excluded for applications where filters are not effective protection and supplied air must be used.

[3] EPA was unable to locate retailers selling quarter masks online. Given this, EPA assumes it is not widely used and excludes it from the cost analysis.

[4] The respirator is typically no longer used because demand mode creates negative pressure in the mask during inhalation, so if there is leakage, contaminated air could enter the mask and be inhaled by the wearer (U.S. DOE 1999). For this reason, the respirator should be excluded from the cost analysis.

[5] SAR respirators operated in pressure-demand and other positive-pressure modes require a high pressure air supply. A high pressure air supply is provided by a compressed air cylinder or the combination of a fixed air filtration panel and an air compressor. Both of these air supply systems are expected to be more costly than the pump needed to supply a SAR respirator operated in continuous flow mode. These respirators are excluded from the cost analysis as a result.

Section 1 presents an overview of the methodology used to estimate an average incremental respiratory PPE cost per worker. Section 2 presents the wage rates used in this analysis. Section 3 presents the written respiratory plan costs. Section 4 presents the medical evaluation costs. Section 5 presents the fit testing costs. Section 6 presents the training costs. Section 7 presents the respiratory cleaning costs. Section 8 presents the estimated useful life and unit cost estimates for PPE equipment. Section 9 presents the estimated baseline use for respirators. Section 10 presents the total initial and annually recurring respiratory protection costs. Section 11 presents the incremental costs that account for baseline PPE usage.

1. Overview of Methodology to Estimate Respiratory PPE Costs

In addition to costs for compliant respirator equipment, it is assumed that facilities will incorporate the following elements from the Respiratory Protection Standard into their PPE program, even if they would not be required to do so by a potential rule:

- Develop a written respiratory protection plan with procedures for the selection, use, cleaning, storage, and maintenance of respirators;
- Medical evaluations, to determine if an employee has an existing health condition that would inhibit safe use of a respirator;
- Fit testing, to ensure that the respirator is providing a level of protection consistent with its APF; and
- Training, to ensure that an employee understands how to properly use the equipment they are assigned.
- Cleaning respirator components as needed to ensure that it is in sanitary condition

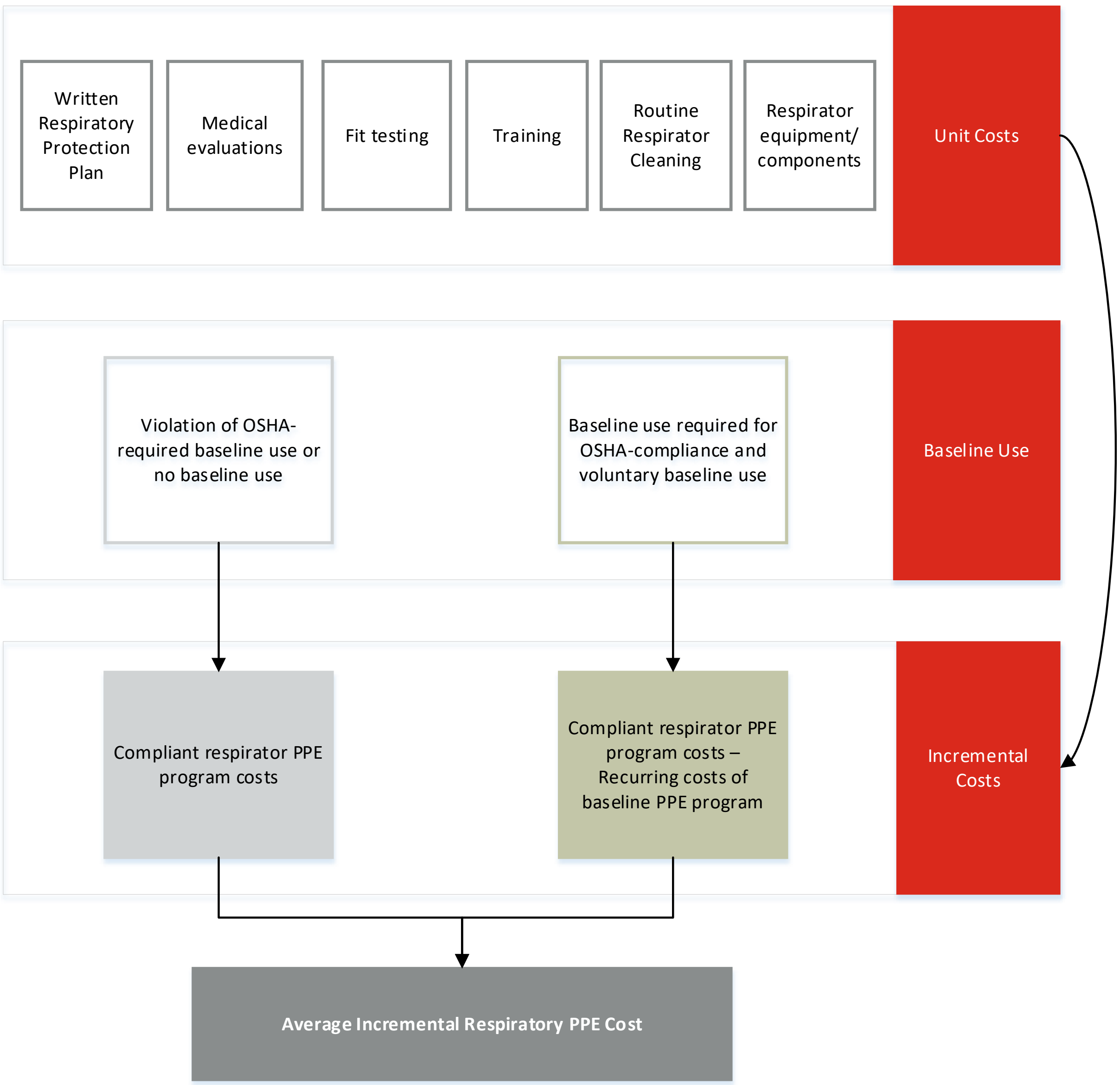
In the baseline, some establishments may already be required to provide employees with respirators under the Respiratory Protection Standard. The analysis also assumes that some establishments that are not required to provide PPE may do so anyway voluntarily ("voluntary use").

As explained further in Section 10, establishments comply with OSHA requirements by selecting an APF that provides adequate protection given the Permissible Exposure Limit (PEL) for that substance and workplace-specific exposure levels. Thus, facilities may be fully compliant with OSHA requirements in the baseline even though they provide respirators with a lower APF than what may be required under a TSCA risk management action. This analysis therefore estimates the incremental costs for facilities compliant with the OSHA-required baseline use because EPA assumes that most establishments will need to upgrade their respirator to be compliant with an EPA standard. For facilities that voluntarily provide respirators but are not required to do so by OSHA because their workplace exposure levels are below the PEL, this analysis assumes that they may need to upgrade their respirator program to comply with an EPA standard.

Thus, facilities are expected to fall into two groups, based on their baseline use of respiratory PPE: (1) no baseline use; (2) compliant with OSHA-required use or voluntary use. All costs are presented in 2022$ unless otherwise noted.

Figure B-1 presents an overview of the methodology used to estimate incremental respiratory PPE costs.

Figure B-1: Methodology to Estimate Respiratory PPE Costs



2. Industry Wage Rates

Loaded wage rates are calculated by adding fringe benefits and overhead to the wage or salary to derive a fully loaded labor cost. Loaded wage rates are calculated for several labor categories: Managerial, Professional/ Technical, Clerical, Production Workers, Industrial Hygienists, and EPA staff.

Wages and fringe benefits for each labor category (*e.g.*, managerial, professional/technical, clerical labor, and production labor were taken from the U.S. Bureau of Labor Statistics (BLS) Employer Costs for Employee Compensation (ECEC) Supplementary Tables, for December 2022 (BLS 2023d). In the BLS report, wages are represented by the "wages and salaries" cost component and fringe benefits are represented by "total benefits." Separate wage rates are estimated for different sectors, which include manufacturing, construction/mining, transportation and public utilities, wholesale trade, retail trade, and services.

The cost of fringe benefits such as paid leave and insurance, specific to each labor category, are taken from the same ECEC series. Fringe benefits as a percent of wages are calculated separately for each labor category.

An additional loading factor of 20 percent is applied to total compensation to account for overhead. This loading factor is described in *Handbook on Valuing Changes in Time Use Induced by Regulatory Requirements and Other U.S. EPA Actions* (EPA 2020a), and is reflective of multiplier values used in prior EPA RIAs and ICRs that are based on industry- and occupation-specific overhead rates affected by EPA regulations. This overhead loading factor is multiplied by the total compensation (wages plus fringe benefits). The calculated overhead costs (20% of the total compensation) are shown in Table B-3 as well as the total hourly loaded wages.

For industrial hygienists, wages were based on another BLS data series, *Occupational Employment and Wage Statistics (OEWS), May 2022 National Occupational Employment and Wage Estimates.* OEWS data were used because ECEC data were not available for very specific occupations. However, the OEWS data covers only wages, not fringe benefits. Therefore, the Industrial Hygienist fringe benefits continue to be based on ECEC data.

The wage rate for Industrial Hygienists is the average hourly mean wage for *Occupational Health and Safety Specialists,* Standard Occupational Classification (SOC) 19-5011 (BLS 2023e).

As with other labor categories, the fringe benefits factor came from U.S. Bureau of Labor Statistics (BLS) *Employer Costs for Employee Compensation* (ECEC) Supplementary Tables, for December 2022 (BLS 2023d). Benefits for "professional and related" occupations were used, and loaded wages were calculated as for other types of labor. An additional loading factor of 20 percent of total compensation was applied to account for overhead.

Table B-3: Industry Wage Rates

EPAB Labor Category	Data Sources	Wage	Fringe Benefit	Total Compensation	Overhead, % total compensation[1]	Fully Loaded Wages
		(a)	(b)	(c) = (a) + (b)	(d)	(e) = (c) x (1 + (d))
Manufacturing						
Managerial	BLS *ECEC*, Private Manufacturing Industries, "Mgt, Business, and Financial"[2]	$54.29	$24.66	$78.95	20%	$94.74
Production Worker	BLS *ECEC*, Private Manufacturing Industries, "Production occupations"[2]	$21.79	$11.63	$33.42	20%	$40.10
Construction and Mining						
Managerial	BLS *ECEC*, Private Goods Producing Industries, "Mgt, Business, and Financial"[2]	$52.17	$22.53	$74.70	20%	$89.64
Construction/Extraction Worker	BLS *ECEC*, Private Goods Producing Industries, "Construction, extraction, farming, fishing, and forestry"[2]	$28.68	$13.71	$42.39	20%	$50.87
Transportation and Public Utilities						
Managerial	BLS *ECEC*, Trade, Transportation, and Utilities **Industries**, "Mgt, Business, and Financial"[2]	$54.12	$21.82	$75.94	20%	$91.13
Maintenance and Repair Worker	BLS *ECEC*, Trade, Transportation, and Utilities **Industries**, "Installation, maintenance, and repair"[2]	$31.08	$15.29	$46.37	20%	$55.64
Wholesale Trade						
Managerial	BLS *ECEC*, Wholesale Trade Industries, "Sales and Office Occupations"[2]	$34.87	$12.93	$47.80	20%	$57.36
Production/	BLS *ECEC*, Wholesale Trade **Industries**, "Production, transportation, and material moving"[2]	$20.95	$9.42	$30.37	20%	$36.44
Retail Trade						

Table B-3: Industry Wage Rates

EPAB Labor Category	Data Sources	Wage	Fringe Benefit	Total Compensation	Overhead, % total compensation[1]	Fully Loaded Wages
		(a)	(b)	(c) = (a) + (b)	(d)	(e) = (c) x (1 + (d))
Managerial	BLS ECEC, Retail Trade Industries, “All Workers” [2]	$18.39	$5.59	$23.98	20%	$28.78
Production/	BLS ECEC, Retail Trade Industries, “Production, transportation, and material moving"[2]	$16.66	$6.15	$22.81	20%	$27.37
Services						
Managerial	BLS ECEC, Service Industries, “Mgt, Business, and Financial” [2]	$54.77	$24.99	$79.76	20%	$95.71
Maintenance and Repair Worker	BLS ECEC, Service Industries, “Installation, maintenance, and repair"[2]	$28.39	$13.15	$41.54	20%	$49.85
All Sectors						
Industrial Hygienist	Wage*: BLS OES Occupat. Employ. and Wage Stats.*, for Manufacturing (NAICS 31, 32, 33), average of wages for *Occup. Health/ Safety Specialists* (SOC 19-5011) [3,4]	$39.47	$19.96	$59.43	20%	$71.32

[1] An overhead rate of 20% is used based on assumptions in Handbook on Valuing Changes in Time Use Induced by Regulatory Requirements and Other U.S. EPA Actions (EPA 2020b).

[2]Source: Employer Costs for Employee Compensation Historical Supplementary Tables, National Compensation Survey: December 2006 – December 2022 (BLS 2023d).

[3]Source: Occupational Employment Statistics (Occupational Employment and Wages) for May 2022, (BLS 2023e).

[4] Fringe benefits are not reported in the BLS OEWS (BLS 2023e). It is therefore assumed that fringes as a percentage of wages are 50.576%, based on the percentage for Private Manufacturing Industries, “Professional and related” in the BLS ECEC (BLS 2023d).

3. Written Respiratory Protection Plan

It is estimated that the development of a written respiratory protection plan will initially require 8 hours of an industrial hygienist's time and then require 2 hours annually after the first year for the industrial hygienist to update the plan (OSHA 2016).[2] The estimated costs by industry sector are presented below in Table B-4. Note that these costs are per establishment costs, whereas all other costs presented in this respirator protection cost analysis are estimated on a per worker basis.

Table B-4: Per Establishment Costs for Written Respiratory Protection Program

<table>
<tr><th rowspan="2">Sector</th><th rowspan="2">Initial Costs for Plan Development (8 hours of Industrial Hygienist Wage Rate of $68.50)[1]</th><th rowspan="2">Annual Costs for Updating Plan (2 hours of Industrial Hygienist Wage Rate of $68.50) [1]</th><th rowspan="2">Percent of Establishments Without a Baseline Plan[2]</th><th colspan="2">Incremental Costs</th></tr>
<tr><th>Initial</th><th>Recurring</th></tr>
<tr><td>Manufacturing</td><td rowspan="7">$570.56</td><td rowspan="7">$142.64</td><td>72%</td><td>$409.24</td><td>$102.31</td></tr>
<tr><td>Construction</td><td>78%</td><td>$446.15</td><td>$111.54</td></tr>
<tr><td>Mining</td><td>66%</td><td>$375.83</td><td>$93.96</td></tr>
<tr><td>Transportation and Public Utilities</td><td>88%</td><td>$503.20</td><td>$125.80</td></tr>
<tr><td>Wholesale Trade</td><td>85%</td><td>$486.07</td><td>$121.52</td></tr>
<tr><td>Retail Trade</td><td>96%</td><td>$548.81</td><td>$137.20</td></tr>
<tr><td>Services</td><td>95%</td><td>$540.76</td><td>$135.19</td></tr>
<tr><td colspan="6">[1]See Table B-3 (BLS 2023a, BLS 2023c).
[2]See Table B-14 below (BLS 2003, U.S. Census Bureau 2001).</td></tr>
</table>

[2] OSHA (2016) assumed the plan would be developed by a human resources manager, but this analysis uses the industrial hygienist wage to estimate the cost of the labor burden.

4. Medical Evaluation Costs

All employees must receive a medical evaluation before they are required to wear a respirator. The employer identifies a physician or other licensed health care professional to perform an initial medical evaluation using a medical questionnaire or a medical examination that gathers the same information as the questionnaire. Many respirator distributors are now offering medical questionnaires online. For example, 3M offers the services for $31 per employee and estimates it will take an employee about 15 minutes to complete (3M 2019). The cost to the employer for this component of the medical evaluation includes the cost of the medical questionnaire service ($31), plus the loaded wage of an employee for 15 minutes to complete the questionnaire.

Any employee failing the initial medical evaluation must receive a follow-up examination. It is estimated that 23 percent of employees fail the initial medical evaluation (OSHA 2010). The total cost of the follow-up medical examination incorporates the cost of the employee's time (time spent traveling, waiting, and being examined) and the cost of the examination. The cost of the employee's time is estimated by multiplying their loaded wage rate by travel time, wait time, and estimated duration of the follow-up medical examination. The cost of the follow-up medical examination is equal to $201, estimated as the cost presented in OSHA (2010) and inflating the value from 1994 to 2022 dollars using the CPI for medical care services (BLS 2023b)

Table B-5 presents the estimated per-employee medical evaluation costs. The full medical evaluation costs are included as initial costs. To account for new employees and/or employees that need a new medical evaluation, annual recurring costs are estimated as one fifth of the initial costs.

Table B-5: Medical Evaluation Costs per Employee

Cost Input	Cost Per Hour	Number of Hours Per Employee		Cost Per Employee	
		Initial	Recurring	Initial	Recurring
Questionnaire and Examination					
Online Medical History Questionnaire Services	-	-	-	$32.00	$6.40
Cost of Medical Exam[1]	-	-	-	$48.30	$9.66
Employee Time for Questionnaire, by Industry					
Manufacturing	$40.10	0.25	0.05	$10.03	$2.01
Construction	$50.87	0.25	0.05	$12.72	$2.54
Mining	$50.87	0.25	0.05	$12.72	$2.54
Transportation and Public Utilities	$55.64	0.25	0.05	$13.91	$2.78
Wholesale Trade	$36.44	0.25	0.05	$9.11	$1.82
Retail Trade	$27.37	0.25	0.05	$6.84	$1.37
Services	$49.85	0.25	0.05	$12.46	$2.49
Employee Time for Exam, by Industry[2]					
Manufacturing	$40.10	0.46	0.092	$18.45	$3.69
Construction	$50.87	0.46	0.092	$23.40	$4.68
Mining	$50.87	0.46	0.092	$23.40	$4.68
Transportation and Public Utilities	$55.64	0.46	0.092	$25.59	$5.12
Wholesale Trade	$36.44	0.46	0.092	$16.76	$3.35
Retail Trade	$27.37	0.46	0.092	$12.59	$2.52
Services	$49.85	0.46	0.092	$22.93	$4.59
Total Medical Evaluation Costs Per Employee, by Industry					
Manufacturing				**$108.77**	**$21.75**
Construction				**$116.42**	**$23.28**
Mining				**$116.42**	**$23.28**
Transportation and Public Utilities				**$119.80**	**$23.96**
Wholesale Trade				**$106.17**	**$21.23**
Retail Trade				**$99.73**	**$19.95**
Services				**$115.69**	**$23.14**

[1] The cost per employee is estimated by multiplying the cost of a medical examination ($201) by the 23 percent of employees that fail the initial medical evaluation (OSHA 2010)

[2] 23 percent of employees that fail the initial medical evaluation and incur a 2 hour labor burden, 23%*2 = 0.46 hours on average per employee (OSHA 2010).

5. Fit Testing

Before an employee can wear a negative or positive pressure tight-fitting mask/facepiece respirator, they must be fit tested with the same make, model, style, and size of respirator that will be used. The employer shall ensure that employees pass an appropriate qualitative fit test or quantitative fit test.

Qualitative fit tests may only be used to fit test negative pressure APRs that must achieve a fit factor of 100 or less (29 CFR 1910.134(f)(6)).[3] They involve a chemical test kit that uses an employee's sense of smell, taste, or reaction to an irritant to detect leakage into the mask/facepiece. There are four qualitative fit test methods accepted by OSHA (OSHA 2015).

- Saccharin, which leaves a sweet taste in your mouth;
- Isoamyl acetate, which smells like bananas;
- Bitrex, which leaves a bitter taste in your mouth; and
- Irritant smoke (Stannic Chloride), which can cause coughing.

It is assumed that a manager performs the qualitative fit test and that the test takes an hour to complete (ERG 2003).

Quantitative fit testing uses a machine to measure the actual amount of leakage into the facepiece and does not rely on the employee's sense of taste, smell, or irritation to detect leakage. The respirators used during this type of fit testing have a probe attached to the facepiece that is connected to the machine by a hose (OSHA 2015). There are three quantitative fit test methods accepted by OSHA (OSHA 2015):

1. Generated aerosol;
2. Ambient aerosol; and
3. Controlled Negative Pressure.

Quantitative fit tests are more expensive than qualitative fit tests because they take longer to perform (two hours instead of one) but may produce better results. They are typically performed by an industrial hygienist.[4] It is assumed that each employee receiving a quantitative fit test will require one hour of the industrial hygienist's time and two hours of the employee's (ERG 2003).

Table B-6 presents the qualitative per-employee fit testing costs. Table B-7 presents the quantitative per-employee fit testing costs.

[3] Fit factor is a quantitative estimate of the fit of the respirator, and typically estimates the ratio of the concentration of a substance outside of the respirator to its concentration inside the respirator.

[4] Quantitative fit tests can also be performed by a certified supervisor, but this scenario is not considered.

Table B-6: Qualitative Fit Testing Costs per Employee

Sector	Cost Input	Cost Per Hour	Number of Hours Per Employee	Cost Per Employee
Manufacturing	Cost of Manager[1]	$94.74	0.25	$23.69
	Cost of Employee's Time	$40.10	1.00	$40.10
	Fit-test Materials[2]			$0.78
	Total Cost			**$64.57**
Construction	Cost of Manager[1]	$89.64	0.25	$22.41
	Cost of Employee's Time	$50.87	1.00	$50.87
	Fit-test Materials[2]			$0.78
	Total Cost			**$74.06**
Mining	Cost of Manager[1]	$89.64	0.25	$22.41
	Cost of Employee's Time	$50.87	1.00	$50.87
	Fit-test Materials[2]			$0.78
	Total Cost			**$74.06**
Transportation and Public Utilities	Cost of Manager[1]	$91.13	0.25	$22.78
	Cost of Employee's Time	$55.64	1.00	$55.64
	Fit-test Materials[2]			$0.78
	Total Cost			**$79.20**
Wholesale Trade	Cost of Manager[1]	$57.36	0.25	$14.34
	Cost of Employee's Time	$36.44	1.00	$36.44
	Fit-test Materials[2]			$0.78
	Total Cost			**$51.56**
Retail Trade	Cost of Manager[1]	$28.78	0.25	$7.20
	Cost of Employee's Time	$27.37	1.00	$27.37
	Fit-test Materials[2]			$0.78
	Total Cost			**$35.35**
Services	Cost of Manager[1]	$95.71	0.25	$23.93
	Cost of Employee's Time	$49.85	1.00	$49.85
	Fit-test Materials[2]			$0.78
	Total Cost			**$74.56**

[1] The number of hours per employee for a Manager to perform a qualitative fit test is 15 minutes rather than 1 hour because the qualitative fit test is assumed to be conducted in groups of four (ERG 2003)

[2] Cost estimate is an average of four online retailers (www.airgas.com, www.zefon.com, www.asasupplies.com, www.premiersafety.com).

[3] The number of hours per employee for an Industrial Hygienist to perform a quantitative fit test is 1 hour rather than 2 because it is assumed that an Industrial Hygienist can perform the fit test on two employees at a time (ERG 2003)

Table B-7: Quantitative Fit Testing Costs per Employee

Sector	Cost Input	Cost Per Hour	Number of Hours Per Employee	Cost Per Employee
Manufacturing	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$40.10	2.00	$80.20
	Total Cost			**$151.52**
Construction	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$50.87	2.00	$101.74
	Total Cost			**$173.06**
Mining	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$50.87	2.00	$101.74
	Total Cost			**$173.06**
Transportation and Public Utilities	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$55.64	2.00	$111.28
	Total Cost			**$182.60**
Wholesale Trade	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$36.44	2.00	$72.88
	Total Cost			**$144.20**
Retail Trade	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$27.37	2.00	$54.74
	Total Cost			**$126.06**
Services	Cost of Industrial Hygienist's Time[3]	$71.32	1.00	$71.32
	Cost of Employee's Time	$49.85	2.00	$99.70
	Total Cost			**$171.02**

[1] The number of hours per employee for a Manager to perform a qualitative fit test is 15 minutes rather than 1 hour because the qualitative fit test is assumed to be conducted in groups of four (ERG 2003)

[2] Cost estimate is an average of four online retailers.

[3] The number of hours per employee for an Industrial Hygienist to perform a quantitative fit test is 1 hour rather than 2 because it is assumed that an Industrial Hygienist can perform the fit test on two employees at a time (ERG 2003)

6. Training

After an employee is properly fitted for a respirator, they will receive training to ensure proper use of the equipment. Table B-8 presents the estimated hourly employee training costs.

Table B-8: Annual Training Costs: APR

	Employee Type	Price/Hour	Number of Hours Per Employee	Cost/Employee
Manufacturing	Worker	$40.10	2	$80.20
	Manager[1]	$94.74	0.5	$47.37
	Total Cost			**$127.57**
Construction	Worker	$50.87	2	$101.74
	Manager[1]	$89.64	0.5	$44.82
	Total Cost			**$146.56**
Mining	Worker	$50.87	2	$101.74
	Manager[1]	$89.64	0.5	$44.82
	Total Cost			**$146.56**
Transportation and Public Utilities	Worker	$55.64	2	$111.28
	Manager[1]	$91.13	0.5	$45.57
	Total Cost			**$156.85**
Wholesale Trade	Worker	$36.44	2	$72.88
	Manager[1]	$57.36	0.5	$28.68
	Total Cost			**$101.56**
Retail Trade	Worker	$27.37	2	$54.74
	Manager[1]	$28.78	0.5	$14.39
	Total Cost			**$69.13**
Services	Worker	$49.85	2	$99.70
	Manager[1]	$95.71	0.5	$47.86
	Total Cost			**$147.56**

[1] The number of hours per employee for a Manager to conduct training is ¼ of the worker's time because training is assumed to be conducted in groups of four (ERG 2003)

The duration of training varies with the complexity of the respirator. ERG (2003) estimates that APR systems require two hours of training per year, PAPR and SAR systems both require 4 hours of training per year, and SCBA systems require 8 hours of training per year. Table B-9 presents the estimated annual training costs per employee for PAPR and SAR systems. Table B-10 presents the estimated annual training costs per employee for SCBA systems.

Table B-9: Annual Training Costs: PAPR/SAR

	Employee Type	Price/Hour	Number of Hours	Cost/Employee
Manufacturing	Worker	$40.10	4	$160.40
	Manager[1]	$94.74	1	$94.74
	Total Cost			**$255.14**
Construction	Worker	$50.87	4	$203.48
	Manager[1]	$89.64	1	$89.64
	Total Cost			**$293.12**
Mining	Worker	$50.87	4	$203.48
	Manager[1]	$89.64	1	$89.64
	Total Cost			**$293.12**
Transportation and Public Utilities	Worker	$55.64	4	$222.56
	Manager[1]	$91.13	1	$91.13
	Total Cost			**$313.69**
Wholesale Trade	Worker	$36.44	4	$145.76
	Manager[1]	$57.36	1	$57.36
	Total Cost			**$203.12**
Retail Trade	Worker	$27.37	4	$109.48
	Manager[1]	$28.78	1	$28.78
	Total Cost			**$138.26**
Services	Worker	$49.85	4	$199.40
	Manager[1]	$95.71	1	$95.71
	Total Cost			**$295.11**

[1] The number of hours per employee for a Manager to conduct training is ¼ of the worker’s time because training is assumed to be conducted in groups of four (ERG 2003)

Table B-10: Annual Training Costs: SCBA

	Employee Type	Price/Hour	Number of Hours	Cost/Employee
Manufacturing	Worker	$40.10	8	$320.80
	Manager[1]	$94.74	2	$189.48
	Total Cost			**$510.28**
Construction	Worker	$50.87	8	$406.96
	Manager[1]	$89.64	2	$179.28
	Total Cost			**$586.24**
Mining	Worker	$50.87	8	$406.96
	Manager[1]	$89.64	2	$179.28
	Total Cost			**$586.24**
Transportation and Public Utilities	Worker	$55.64	8	$445.12
	Manager[1]	$91.13	2	$182.26
	Total Cost			**$627.38**
Wholesale Trade	Worker	$36.44	8	$291.52
	Manager[1]	$57.36	2	$114.72
	Total Cost			**$406.24**
Retail Trade	Worker	$27.37	8	$218.96
	Manager[1]	$28.78	2	$57.56
	Total Cost			**$276.52**
Services	Worker	$49.85	8	$398.80
	Manager[1]	$95.71	2	$191.42
	Total Cost			**$590.22**
[1] The number of hours per employee for a Manager to conduct training is ¼ of the worker's time because training is assumed to be conducted in groups of four (ERG 2003)				

7. Respirator Cleaning and Maintenance Costs

It is estimated that each worker will need clean their respirator every other shift, or 125 times per year, requiring 5 minutes of labor per cleaning (OSHA 2016). Thus, the estimated annual labor burden for cleaning is 10.42 hours per worker. The estimated costs by industry sector are presented below in Table B-11. EPA assumes that this labor burden also accounts for the time required for any regular maintenance of the respirators that is needed, such as changing filters.

Table B-11: Annual Cleaning Costs Per Worker

Sector	Worker Labor Cost Per Hour of Training	Annual Cleaning Labor Hours	Annual Cost
Manufacturing	$40.10	10.42	$417.71
Construction	$50.87	10.42	$529.90
Mining	$50.87	10.42	$529.90
Transportation and Public Utilities	$55.64	10.42	$579.58
Wholesale Trade	$36.44	10.42	$379.58
Retail Trade	$27.37	10.42	$285.10
Services	$49.85	10.42	$519.27

8. Useful Life and Unit Cost Estimates

Useful life is equal to the number of years until a respirator or respirator component needs to be replaced, as well as the number of years until a medical evaluation, fit testing, or training is required. The annual replacement rate of a respirator or respirator component, or the annual reoccurrence of other PPE program elements, is therefore equal to 1 divided by the useful life. Table B-12 presents the useful lives of respirators, respirator components, training, and fit testing. Respirator useful lives are presented as those of the individual respirator system components (*e.g.,* mask, pump, breathing tube, etc.) or as the useful life of a full respiratory system or system components kit (if the components in the kit have similar useful lives). Individual respirator components are listed if they have different useful lives. The table also includes the sources and assumptions underlying the useful life estimates.

The useful life for some components depends on a variety of factors, making it difficult to identify a representative estimate. In these cases, assumptions are made about the component's useful life using available literature. For example, the filter cartridge replacement rate varies with a multitude of factors, including humidity, temperature, and atmospheric pressure. The analysis assumes a cartridge replacement rate of 50 times per year for a PAPR and 100 times per year for an APR, consistent with the rates used in ERG (2003).[5]

Note that useful life expectancies and costs are estimates and may vary by industry, facility, and or/geographic location. Therefore, estimated costs are expected to represent a typical facility – actual costs for a specific facility may be higher or lower.

[5] EPA also reviewed the cartridge replacement frequency estimations predicted by 3M's online software application (3M 2015). The range of expected lives predicted by the 3M replacement frequency estimator software varies greatly. For example, the NIOSH-approved GVP 401 cartridges have an estimated service life of 127 minutes in an environment of >95% humidity and 86 degrees Fahrenheit. However, the useful life jumps to 197 hours when used in an environment of <65% humidity and 32 degrees Fahrenheit. The 3M software confirms that replacement rate estimates are highly dependent on factors that vary nationally, and that it is up to each facility to replace cartridges as required by their environmental parameters. The analysis also used the 3M software to confirm that the replacement rate estimates from ERG (2003) of 50 times per year for PAPR and 100 times per year for APR fall within the predicted range and are thus reasonable estimates.

Table B-12: Respirator PPE Useful Life

Respirator System	Component	Useful Life (years)	Description
APF Factor 10			
APR, Half Mask	Half Mask, APR	2	Estimate based on the equipment service life of an APR, full facepiece respirator (ERG 2003)
	Cartridge Filters, APR	0.01	Assume APR cartridges are replaced at a rate of 100 per year (ERG 2003)
	Training	1	ERG (2003)
	Qualitative Fit Testing	1	29 CFR 1910.134(f)(2)
APF Factor 25			
PAPR, Loose-Fitting Facepiece	Loose-Fitting Facepiece, PAPR	3	ERG (2003)
	Cartridge Filters, PAPR	0.02	Assume PAPR cartridges are replaced at a rate of 50 per year (ERG 2003)
	PAPR System	3	Assembly kit does not include facepiece and breathing tube. Useful life from OSHA (1996)and ERG (2003)
	Breathing Tube	3	Assume breathing tubes have the same useful life as a mask or facepiece, since facepieces are regularly sold with breathing tubes.
	Training	1	ERG (2003)
SAR, Continuous Flow Mode, Loose-Fitting Facepiece	Loose-Fitting Facepiece (PAPR)	3	ERG (2003)
	Breathing Tube	3	Assume breathing tubes have the same useful life as masks or facepieces, since facepieces are regularly sold with breathing tubes.
	Pump	7	Pumps are assumed to have a useful life of 7 years for all industries. The useful life is estimated by considering a range of daily run times for 260 days per year under the assumption that the pump has a service life of 10,000 hours (Northern Safety & Industrial 2016) and not more than 10 years.
	Pump Installation	7	Assume every time a new pump is purchased, it will need to be installed in a clean air environment. Assume $50 worth of labor and materials used for installation.
	Pump Inlet Filter	0.48	Assume pump inlet filters have a 500 hour life span (MST Inc. 2001). Employees assumed to work 260 days per year. The replacement rate is calculated with the assumption of 4 hours of use per day (1040 hours per year).
	Pump Outlet Filter	0.19	Assume pump outlet filters have a 200 hour life span (MST Inc. 2001). Employees assumed to work 260 days per year. The replacement rate is calculated with the assumption of 4 hours of use per day, and 0.19 is rounded to 0.20 for analysis
APF Factor 50			
APR, Full Facepiece	Full Facepiece, APR	2	ERG (2003)
	Cartridge Filters, APR	0.01	Assume APR cartridges are replaced at a rate of 100 per year (ERG 2003)
	Training	1	ERG (2003)
	Qualitative Fit Testing	1	29 CFR 1910.134(f)(2)
PAPR, Half Mask	Half Mask	3	ERG (2003)

Table B-12: Respirator PPE Useful Life

Respirator System	Component	Useful Life (years)	Description
	Cartridge Filters (PAPR)	0.02	Assume PAPR cartridges are replaced at a rate of 50 per year (ERG 2003)
	PAPR System Components Kit	3	OSHA (1996); ERG (2003)
	Breathing Tube	3	Assume breathing tubes have the same useful life as masks or facepieces, since facepieces are regularly sold with breathing tubes.
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
SAR, Continuous Flow Mode, Half Mask	Half Mask	3	ERG (2003)
	Breathing Tube and Airline Hose	3	Assume breathing tubes have the same useful life as a mask or facepiece, since facepieces are regularly sold with breathing tubes. Airline hose assumed to be replaced with breathing tube.
	Pump (1/4 HP)	7	Pumps are assumed to have a useful life of 7 years for all industries. The useful life is estimated by considering a range of daily run times for 260 days per year under the assumption that the pump has a service life of 10,000 hours (Northern Safety & Industrial 2016) and not more than 10 years.
	Pump Installation	7	Assume every time a new pump is purchased, it will need to be installed in a clean air environment. Assume $50 worth of labor and materials used for installation.
	Pump Inlet Filter	0.48	A replacement rate of about once every two years (MST Inc. 2001)
	Pump Outlet Filter	0.19	Assume pump outlet filters have a 200 hour life span (MST Inc. 2001). Employees assumed to work 260 days per year. The replacement rate is calculated with the assumption of 4 hours of use per day, and 0.19 is rounded to 0.20 for analysis
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
APF Factor 1,000			
PAPR, Full Facepiece	Full Facepiece	3	ERG (2003)
	PAPR System	3	Assembly kit does not include facepiece and breathing tube. Useful life from OSHA (1996) and ERG (2003)
	Breathing Tube	3	Assume breathing tubes have the same useful life as a mask or facepiece because they are regularly sold with breathing tubes.
	Cartridge Filters (PAPR)	0.02	Assume PAPR cartridges are replaced at a rate of 50 per year (ERG 2003)
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
PAPR Helmet/Hood	Hood	3	OSHA (1996); ERG (2003)
	PAPR System Components Kit	3	OSHA (1996); ERG (2003)

Table B-12: Respirator PPE Useful Life

Respirator System	Component	Useful Life (years)	Description
	Breathing Tube	3	Assume breathing tubes have the same useful life as a mask or facepiece because they are regularly sold with breathing tubes.
	Cartridge Filters (PAPR)	0.02	Assume PAPR cartridges are replaced at a rate of 50 per year (ERG 2003)
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
SAR, Continuous Flow Mode, Full Facepiece	Full Facepiece	3	ERG (2003)
	Pump (1/4 HP)	7	Pumps are assumed to have a useful life of 7 years for all industries. The useful life is estimated by considering a range of daily run times for 260 days per year under the assumption that the pump has a service life of 10,000 hours (Northern Safety & Industrial 2016) and not more than 10 years.
	Breathing Tube and Airline Hose	3	Assume breathing tubes have the same useful life as a mask or facepiece because they are regularly sold with breathing tubes. Airline hose assumed to be replaced with breathing tube.
	Pump Installation	7	Assume that every time a new pump is purchased, it will need to be installed in a clean air environment. Assume $50 worth of labor and materials used for installation.
	Pump Inlet Filter	0.48	A replacement rate of about once every two years (MST Inc. 2001)
	Pump Outlet Filter	0.19	Assume pump outlet filters have a 200 hour life span (MST Inc. 2001). Employees assumed to work 260 days per year. The replacement rate is calculated with the assumption of 4 hours of use per day, and 0.19 is rounded to 0.2
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
SAR, Continuous Flow Mode, Helmet/Hood	Hood	3	OSHA (1996); ERG (2003)
	Pump (3/4 HP)	7	Pumps are assumed to have a useful life of 7 years for all industries. The useful life is estimated by considering a range of daily run times for 260 days per year under the assumption that the pump has a service life of 10,000 hours (Northern Safety & Industrial 2016) and not more than 10 years.
	Breathing Tube and Airline Hose	3	Assume breathing tubes have the same useful life as a mask or facepiece because they are regularly sold with breathing tubes. Airline hose assumed to be replaced with breathing tube.
	Pump Installation	7	Assume that every time a new pump is purchased, it will need to be installed in a clean air environment. Assume $50 worth of labor and materials used for installation.
	Pump Inlet Filter	0.48	A replacement rate of about once every two years (MST Inc. 2001)
	Pump Outlet Filter	0.19	Assume pump outlet filters have a 200 hour life span (MST Inc. 2001). Employees assumed to work 260 days per year. The replacement rate is calculated with the assumption of 4 hours of use per day, and 0.19 is rounded to 0.2
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
APF Factor 10,000			

Table B-12: Respirator PPE Useful Life

Respirator System	Component	Useful Life (years)	Description
SCBA, Positive Pressure Mode, Full Facepiece	Positive Pressure SCBA System (includes entire system, including full facepiece)	3	ERG (2003)
	Air Compressor	16	Estimated useful life for air compressor is 20 years with preventative maintenance, 16 years without preventative maintenance. Assume preventative maintenance not done. Assume an industrial air compressor ($27,021.80) will serve about 5 employees, recharging their SCBA cylinders. ($27,021.800/5 = $5,404.36) As an alternative to filling SCBA cylinders on site with an air compressor, a cylinder recharge system may be used. Costs for this service are not currently developed (Koo 2015).
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
SCBA, Positive Pressure Mode, Helmet/Hood	Positive Pressure SCBA System (includes entire system, including hood)	3	ERG (2003)
	Air Compressor	16	Estimated useful life for air compressor is 20 years with preventative maintenance, 16 years without preventative maintenance. Assume preventative maintenance not done. Assume an industrial air compressor ($27,021.80) will serve about 5 employees, recharging their SCBA cylinders. ($27,021.800/5 = $5,404.36). As an alternative to filling SCBA cylinders on site with an air compressor, a cylinder recharge system may be used. Costs for this service are not currently developed (Koo 2015).
	Training	1	ERG (2003)
	Quantitative Fit Testing	1	29 CFR 1910.134(f)(2)
APR: Air-Purifying Respirators; PAPR: Powered Air-Purifying Respirator; SAR: Supplied-Air Respirator; SCBA: Self-Contained Breathing Apparatus			

Table B-13 presents unit costs estimates for respirators and respirator system components. Average annual recurring costs are estimated as the unit cost divided by the useful life of each component.

Respirators are organized by their corresponding APF. Unit cost estimates for individual respirator system components and kits are based on price data collected from retailer websites. Price data are averaged for component and kit unit cost estimates that incorporate the price of more than one product brand.

Table B-13: PPE Equipment Unit Costs per Worker, by Respirator System

Respirator System	Component	Unit Cost	Useful Life (Years)	Unit Costs	
				Initial	Recurring
APF Factor 10					
APR, Half Mask	Half Mask, (APR)	$22.45	2	$22	$11
	Cartridge Filters (APR)	$20.32	0.01	$2,032	$2,032
			Total	**$2,054**	**$2,043**
APF Factor 25					
PAPR, Loose-Fitting Facepiece	Loose-Fitting Facepiece (PAPR)	$59.03	3	$59	$20
	Cartridge Filters (PAPR)	$12.91	0.02	$646	$646
	PAPR System	$1,175.01	3	$1,175	$392
	Breathing Tube	$60.41	3	$60	$20
			Total	**$1,940**	**$1,077**
SAR, Continuous Flow Mode, Loose-Fitting Facepiece	Loose-Fitting Facepiece (PAPR)	$59.03	3	$59	$20
	Breathing Tube	$164.32	3	$164	$55
	Pump	$1,018.46	7	$1,018	$145
	Pump Installation	$55.74	7	$56	$8
	Pump Inlet Filter	$8.68	0.48	$18	$18
	Pump Outlet Filter	$14.67	0.19	$77	$77
			Total	**$1,393**	**$323**
APF Factor 50					
APR, Full Facepiece	Full Facepiece (APR)	$246.28	2	$246	$123
	Cartridge Filters (APR)	$20.32	0.01	$2,032	$2,032
			Total	**$2,278**	**$2,155**
PAPR, Half Mask	Half Mask	$22.45	3	$22	$7
	Cartridge Filters (PAPR)	$12.91	0.02	$646	$646
	PAPR System Components Kit	$1,175.01	3	$1,175	$392
	Breathing Tube and Airline Hose	$60.41	3	$60	$20
			Total	**$1,903**	**$1,065**

Table B-13: PPE Equipment Unit Costs per Worker, by Respirator System

Respirator System	Component	Unit Cost	Useful Life (Years)	Unit Costs	
				Initial	Recurring
SAR, Continuous Flow Mode, Half Mask	Half Mask	$22.45	3	$22	$7
	Breathing Tube	$164.32	3	$164	$55
	Pump	$1,018.46	7	$1,018	$145
	Pump Installation	$55.74	7	$56	$8
	Pump Inlet Filter	$8.68	0.48	$18	$18
	Pump Outlet Filter	$14.67	0.19	$77	$77
			Total	**$1,356**	**$311**
APF Factor 1,000					
PAPR, Full Facepiece	Full Facepiece	$202.48	3	$202	$67
	PAPR System	$1,175.01	3	$1,175	$392
	Breathing Tube	$60.41	3	$60	$20
	Cartridge Filters (PAPR)	$12.91	0.02	$646	$646
			Total	**$2,083**	**$1,125**
PAPR, Helmet/Hood	Hood	$100.14	3	$100	$33
	PAPR System Components Kit	$1,175.01	3	$1,175	$392
	Breathing Tube	$60.41	3	$60	$20
	Cartridge Filters (PAPR)	$12.91	0.02	$646	$646
			Total	**$1,981**	**$1,091**
SAR, Continuous Flow Mode, Full Facepiece	Full Facepiece	$202.48	3	$202	$67
	Pump (1/4 HP)	$1,018.46	7	$1,018	$145
	Breathing Tube and Airline Hose	$164.32	3	$164	$55
	Pump Installation	$55.74	7	$56	$8
	Pump Inlet Filter	$8.68	0.48	$18	$18
	Pump Outlet Filter	$14.67	0.19	$77	$77
			Total	**$1,536**	**$371**
SAR, Continuous Flow Mode, Helmet/Hood	Hood	$100.14	3	$100	$33
	Pump (3/4 HP)	$1,101.11	7	$1,101	$157
	Breathing Tube and Airline Hose	$164.32	3	$164	$55
	Pump Installation	$55.74	7	$56	$8
	Pump Inlet Filter	$13.07	0.48	$27	$27
	Pump Outlet Filter	$14.67	0.19	$77	$77
			Total	**$1,526**	**$358**

Table B-13: PPE Equipment Unit Costs per Worker, by Respirator System

Respirator System	Component	Unit Cost	Useful Life (Years)	Unit Costs	
				Initial	Recurring
APF Factor 10,000					
SCBA, Positive-pressure Mode, Full Facepiece	Positive-pressure SCBA System (includes full facepiece):	$2,535.81	3	$2,536	$845
	Air Compressor	$6,024.97	16	$6,025	$377
			Total	**$8,561**	**$1,222**
SCBA, Positive-pressure Mode, Helmet/Hood	Positive-pressure SCBA system (includes hood)	$2,775.05	3	$2,775	$925
	Air Compressor	$6,024.97	16	$6,025	$377
			Total	**$8,800**	**$1,302**

9. Baseline Respirator PPE Use

Incremental costs of complying with a respirator PPE requirement are estimated by incorporating the baseline respirator use among affected facilities. The Respiratory Protection Rule specifies that employees exposed to harmful substances must wear respiratory protection if workplace exposure levels are above the specified Permissible Exposure Limit (PEL) for that substance. The suitability of an APF for a workplace is determined by the Maximum Use Concentration (MUC), or the maximum concentration of a substance that an employee will be protected against while wearing a respirator of a given APF. The MUC is calculated by multiplying the APF of a respirator by the exposure limit of a substance (OSHA 2009).

For example, given a PEL of 100 ppm, a worker can be expected to be protected from concentrations of up to 1,000 ppm while wearing an APF 10 respirator. The APF required for compliance with OSHA's Respiratory Protection Rule is therefore determined by dividing the MUC of a workplace by the PEL. For example, if exposure of a regulated substance is 10,000 ppm, facilities will need to provide workers with a respirator of an APF of 100 to be compliant with the rule.

It is worth noting that a number of factors are taken into account when selecting a respirator, including cost, comfort, compatibility with the facility layout, and mobility requirements of the job. Thus, it is likely that respirator selection is not based solely on required APF or cost alone and that facilities may provide respirators with APFs above what is required.

This analysis uses the Bureau of Labor Statistic's 2001 Respirator Usage in Private Sector Firms (RUPS) survey to estimate the percentage of facilities that use each type of respirator in the baseline (BLS 2003). The RUPS was conducted jointly by the Bureau of Labor Statistics (BLS) and the National Institute forOccupational Safety and Health (NIOSH).). The survey was conducted between August 2000 and January 2001, and collected data on the number of private sector establishments that use respirators, as well as the types of respirators they use. The survey was sent to a sample of 40,002 establishments (75.5 percent response rate) that is representative of all private sector establishments.

For each industry sector, Table B-14 presents the number and percent of establishments using each type of respirator and the percent of establishments associated with each APF. Note that because the mode used by supplied air or self-contained breathing apparatus systems (continuous flow or pressure demand) is not specified in the survey, it is assumed that establishments are evenly divided between the two modes for each respirator type.

Table B-14: Baseline Respirator Use, by APF

Sector	APF	Respirator Type	Number of Establish-ments	Percent of Establishments Using Respirators	
				Type	APF
Manufacturing	10	APR, Half Mask	28,345	38.58%	38.58%
	25	PAPR, Loose-Fitting Facepiece	511	0.70%	0.70%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	15,091	20.54%	26.45%
		PAPR, Half Mask	2,372	3.23%	
		SAR, Continuous Flow Half Mask	1,971	2.68%	
	1,000	PAPR, Full Facepiece	3,398	4.62%	27.59%
		PAPR, Helmet/Hood	5,647	7.69%	
		SAR, Continuous Flow Full Facepiece	2,729	3.71%	

Table B-14: Baseline Respirator Use, by APF

Sector	APF	Respirator Type	Number of Establish-ments	Percent of Establishments Using Respirators	
				Type	APF
		SAR, Continuous Flow Helmet/Hood	8,498	11.57%	
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	2,457	3.34%	6.68%
		SCBA, Positive-pressure Mode, Helmet/Hood	2,457	3.34%	
Construction	10	APR, Half Mask	26,008	37.38%	37.38%
	25	PAPR, Loose-Fitting Facepiece	2,822	4.06%	4.06%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	12,834	18.44%	28.78%
		PAPR, Half Mask	5,012	7.20%	
		SAR, Continuous Flow Half Mask	2,184	3.14%	
	1,000	PAPR, Full Facepiece	3,148	4.52%	24.48%
		PAPR, Helmet/Hood	3,164	4.55%	
		SAR, Continuous Flow Full Facepiece	4,020	5.78%	
		SAR, Continuous Flow Helmet/Hood	6,698	9.63%	
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	1,848	2.66%	5.32%
		SCBA, Positive-pressure Mode, Helmet/Hood	1,848	2.66%	
Mining	10	APR, Half Mask	2,052	47.10%	47.10%
	25	PAPR, Loose-Fitting Facepiece	0	0.00%	0.00%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	727	16.69%	23.30%
		PAPR, Half Mask	241	5.53%	
		SAR, Continuous Flow Half Mask	47	1.08%	
	1,000	PAPR, Full Facepiece	265	6.08%	20.97%
		PAPR, Helmet/Hood	150	3.44%	
		SAR, Continuous Flow Full Facepiece	137	3.15%	
		SAR, Continuous Flow Helmet/Hood	362	8.30%	
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	188	4.32%	8.64%
		SCBA, Positive-pressure Mode, Helmet/Hood	188	4.32%	
Transportation and Public Utilities	10	APR, Half Mask	4,760	30.19%	30.19%
	25	PAPR, Loose-Fitting Facepiece	124	0.79%	0.79%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	2,556	16.21%	21.68%
		PAPR, Half Mask	341	2.16%	
		SAR, Continuous Flow Half Mask	522	3.31%	
	1,000	PAPR, Full Facepiece	810	5.14%	29.79%
		PAPR, Helmet/Hood	796	5.05%	
		SAR, Continuous Flow Full Facepiece	1,373	8.71%	
		SAR, Continuous Flow Helmet/Hood	1,716	10.89%	

Table B-14: Baseline Respirator Use, by APF

Sector	APF	Respirator Type	Number of Establish-ments	Percent of Establishments Using Respirators	
				Type	APF
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	1,384	8.78%	17.56%
		SCBA, Positive-pressure Mode, Helmet/Hood	1,384	8.78%	
Wholesale Trade	10	APR, Half Mask	15,096	38.42%	38.42%
	25	PAPR, Loose-Fitting Facepiece	1,254	3.19%	3.19%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	8,637	21.98%	25.90%
		PAPR, Half Mask	814	2.07%	
		SAR, Continuous Flow Half Mask	726	1.85%	
	1,000	PAPR, Full Facepiece	1,979	5.04%	21.40%
		PAPR, Helmet/Hood	2,371	6.03%	
		SAR, Continuous Flow Full Facepiece	1,007	2.56%	
		SAR, Continuous Flow Helmet/Hood	3,055	7.77%	
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	2,178	5.54%	11.08%
		SCBA, Positive-pressure Mode, Helmet/Hood	2,178	5.54%	
Retail Trade	10	APR, Half Mask	10,556	43.46%	43.46%
	25	PAPR, Loose-Fitting Facepiece	2,188	9.01%	9.01%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	4,289	17.66%	31.35%
		PAPR, Half Mask	2,270	9.35%	
		SAR, Continuous Flow Half Mask	1,053	4.34%	
	1,000	PAPR, Full Facepiece	800	3.29%	11.65%
		PAPR, Helmet/Hood	630	2.59%	
		SAR, Continuous Flow Full Facepiece	684	2.81%	
		SAR, Continuous Flow Helmet/Hood	720	2.96%	
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	550	2.26%	4.52%
		SCBA, Positive-pressure Mode, Helmet/Hood	550	2.26%	
Services	10	APR, Half Mask	45,508	51.85%	51.85%
	25	PAPR, Loose-Fitting Facepiece	833	0.95%	0.95%
		SAR, Continuous Flow Loose-Fitting Facepiece	-	-	
	50	APR, Full Facepiece	15,753	17.95%	24.68%
		PAPR, Half Mask	2,110	2.40%	
		SAR, Continuous Flow Half Mask	3,800	4.33%	
	1,000	PAPR, Full Facepiece	7,362	8.39%	17.46%
		PAPR, Helmet/Hood	3,157	3.60%	
		SAR, Continuous Flow Full Facepiece	2,410	2.75%	
		SAR, Continuous Flow Helmet/Hood	2,386	2.72%	
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	2,229	2.54%	5.08%

Table B-14: Baseline Respirator Use, by APF

Sector	APF	Respirator Type	Number of Establish-ments	Percent of Establishments Using Respirators	
				Type	APF
		SCBA, Positive-pressure Mode, Helmet/Hood	2,229	2.54%	
Source: BLS (2003)					

Baseline use of PPE in each industry was estimated using the 2001 RUPS survey data (BLS 2003) estimates for the number of establishments using PPE and the 2001 Census County Business Patterns data (U.S. Census Bureau 2001) to estimate the total number of establishments by industry (see Table B-15).

Table B-15: Percent of Baseline PPE Use by Industry

Industry	Percent of Establishments with Baseline PPE Use
Manufacturing	28%
Construction	22%
Mining	34%
Transportation and Public Utilities	12%
Wholesale trade	15%
Retail trade	4%
Service	5%
Sources: (BLS 2003) and (U.S. Census Bureau 2001)	

10. Total Annual Respiratory Program Costs

Table B-16 presents the total initial costs of a PPE program, by respirator system. Table B-17 presents the total annual recurring costs of a PPE program, by respirator system. Both tables cover all seven industry sectors included in the analysis.

Table B-16: Total Initial PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
Manufacturing	10	APR, Half Mask	$409	$2,054	$109	$0	$0	$0	$2,572
	25	PAPR, Loose-Fitting Facepiece	$409	$1,940	$109	$0	$0	$0	$2,458
	25	SAR, Loose-Fitting Facepiece	$409	$1,393	$109	$0	$0	$0	$1,911
	50	APR, Full Facepiece	$409	$2,278	$109	$0	$0	$0	$2,796
	50	PAPR, Half Mask	$409	$1,903	$109	$0	$0	$0	$2,421
	50	SAR, Continuous Flow Half Mask	$409	$1,356	$109	$0	$0	$0	$1,874
	1,000	PAPR, Full Facepiece	$409	$2,083	$109	$0	$0	$0	$2,601
	1,000	PAPR, Helmet/Hood	$409	$1,981	$109	$0	$0	$0	$2,499
	1,000	SAR, Continuous Flow Full Facepiece	$409	$1,536	$109	$0	$0	$0	$2,054
	1,000	SAR, Continuous Flow Helmet/Hood	$409	$1,526	$109	$0	$0	$0	$2,044
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$409	$8,561	$109	$0	$0	$0	$9,079
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$409	$8,800	$109	$0	$0	$0	$9,318
Construction	10	APR, Half Mask	$446	$2,054	$116	$0	$0	$0	$2,617
	25	PAPR, Loose-Fitting Facepiece	$446	$1,940	$116	$0	$0	$0	$2,503
	25	SAR, Loose-Fitting Facepiece	$446	$1,393	$116	$0	$0	$0	$1,955
	50	APR, Full Facepiece	$446	$2,278	$116	$0	$0	$0	$2,841
	50	PAPR, Half Mask	$446	$1,903	$116	$0	$0	$0	$2,466
	50	SAR, Continuous Flow Half Mask	$446	$1,356	$116	$0	$0	$0	$1,919
	1,000	PAPR, Full Facepiece	$446	$2,083	$116	$0	$0	$0	$2,646
	1,000	PAPR, Helmet/Hood	$446	$1,981	$116	$0	$0	$0	$2,544
	1,000	SAR, Continuous Flow Full Facepiece	$446	$1,536	$116	$0	$0	$0	$2,099

Table B-16: Total Initial PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
	1,000	SAR, Continuous Flow Helmet/Hood	$446	$1,526	$116	$0	$0	$0	$2,088
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$446	$8,561	$116	$0	$0	$0	$9,123
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$446	$8,800	$116	$0	$0	$0	$9,363
Mining	10	APR, Half Mask	$376	$2,054	$116	$0	$0	$0	$2,547
	25	PAPR, Loose-Fitting Facepiece	$376	$1,940	$116	$0	$0	$0	$2,432
	25	SAR, Loose-Fitting Facepiece	$376	$1,393	$116	$0	$0	$0	$1,885
	50	APR, Full Facepiece	$376	$2,278	$116	$0	$0	$0	$2,771
	50	PAPR, Half Mask	$376	$1,903	$116	$0	$0	$0	$2,396
	50	SAR, Continuous Flow Half Mask	$376	$1,356	$116	$0	$0	$0	$1,849
	1,000	PAPR, Full Facepiece	$376	$2,083	$116	$0	$0	$0	$2,576
	1,000	PAPR, Helmet/Hood	$376	$1,981	$116	$0	$0	$0	$2,473
	1,000	SAR, Continuous Flow Full Facepiece	$376	$1,536	$116	$0	$0	$0	$2,029
	1,000	SAR, Continuous Flow Helmet/Hood	$376	$1,526	$116	$0	$0	$0	$2,018
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$376	$8,561	$116	$0	$0	$0	$9,053
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$376	$8,800	$116	$0	$0	$0	$9,292
Transportation and Public Utilities	10	APR, Half Mask	$503	$2,054	$120	$0	$0	$0	$2,677
	25	PAPR, Loose-Fitting Facepiece	$503	$1,940	$120	$0	$0	$0	$2,563
	25	SAR, Loose-Fitting Facepiece	$503	$1,393	$120	$0	$0	$0	$2,016
	50	APR, Full Facepiece	$503	$2,278	$120	$0	$0	$0	$2,901
	50	PAPR, Half Mask	$503	$1,903	$120	$0	$0	$0	$2,526
	50	SAR, Continuous Flow Half Mask	$503	$1,356	$120	$0	$0	$0	$1,979
	1,000	PAPR, Full Facepiece	$503	$2,083	$120	$0	$0	$0	$2,706

Table B-16: Total Initial PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
	1,000	PAPR, Helmet/Hood	$503	$1,981	$120	$0	$0	$0	$2,604
	1,000	SAR, Continuous Flow Full Facepiece	$503	$1,536	$120	$0	$0	$0	$2,159
	1,000	SAR, Continuous Flow Helmet/Hood	$503	$1,526	$120	$0	$0	$0	$2,149
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$503	$8,561	$120	$0	$0	$0	$9,184
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$503	$8,800	$120	$0	$0	$0	$9,423
Wholesale Trade	10	APR, Half Mask	$486	$2,054	$106	$0	$0	$0	$2,647
Wholesale Trade	25	PAPR, Loose-Fitting Facepiece	$486	$1,940	$106	$0	$0	$0	$2,532
Wholesale Trade	25	SAR, Loose-Fitting Facepiece	$486	$1,393	$106	$0	$0	$0	$1,985
Wholesale Trade	50	APR, Full Facepiece	$486	$2,278	$106	$0	$0	$0	$2,871
Wholesale Trade	50	PAPR, Half Mask	$486	$1,903	$106	$0	$0	$0	$2,496
Wholesale Trade	50	SAR, Continuous Flow Half Mask	$486	$1,356	$106	$0	$0	$0	$1,948
Wholesale Trade	1,000	PAPR, Full Facepiece	$486	$2,083	$106	$0	$0	$0	$2,676
Wholesale Trade	1,000	PAPR, Helmet/Hood	$486	$1,981	$106	$0	$0	$0	$2,573
Wholesale Trade	1,000	SAR, Continuous Flow Full Facepiece	$486	$1,536	$106	$0	$0	$0	$2,129
Wholesale Trade	1,000	SAR, Continuous Flow Helmet/Hood	$486	$1,526	$106	$0	$0	$0	$2,118
Wholesale Trade	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$486	$8,561	$106	$0	$0	$0	$9,153
Wholesale Trade	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$486	$8,800	$106	$0	$0	$0	$9,392
Retail Trade	10	APR, Half Mask	$549	$2,054	$100	$0	$0	$0	$2,703
Retail Trade	25	PAPR, Loose-Fitting Facepiece	$549	$1,940	$100	$0	$0	$0	$2,588
Retail Trade	25	SAR, Loose-Fitting Facepiece	$549	$1,393	$100	$0	$0	$0	$2,041
Retail Trade	50	APR, Full Facepiece	$549	$2,278	$100	$0	$0	$0	$2,927
Retail Trade	50	PAPR, Half Mask	$549	$1,903	$100	$0	$0	$0	$2,552

Table B-16: Total Initial PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
	50	SAR, Continuous Flow Half Mask	$549	$1,356	$100	$0	$0	$0	$2,005
	1,000	PAPR, Full Facepiece	$549	$2,083	$100	$0	$0	$0	$2,732
	1,000	PAPR, Helmet/Hood	$549	$1,981	$100	$0	$0	$0	$2,630
	1,000	SAR, Continuous Flow Full Facepiece	$549	$1,536	$100	$0	$0	$0	$2,185
	1,000	SAR, Continuous Flow Helmet/Hood	$549	$1,526	$100	$0	$0	$0	$2,174
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$549	$8,561	$100	$0	$0	$0	$9,209
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$549	$8,800	$100	$0	$0	$0	$9,449
Services	10	APR, Half Mask	$541	$2,054	$116	$0	$0	$0	$2,711
	25	PAPR, Loose-Fitting Facepiece	$541	$1,940	$116	$0	$0	$0	$2,596
	25	SAR, Loose-Fitting Facepiece	$541	$1,393	$116	$0	$0	$0	$2,049
	50	APR, Full Facepiece	$541	$2,278	$116	$0	$0	$0	$2,935
	50	PAPR, Half Mask	$541	$1,903	$116	$0	$0	$0	$2,560
	50	SAR, Continuous Flow Half Mask	$541	$1,356	$116	$0	$0	$0	$2,013
	1,000	PAPR, Full Facepiece	$541	$2,083	$116	$0	$0	$0	$2,740
	1,000	PAPR, Helmet/Hood	$541	$1,981	$116	$0	$0	$0	$2,638
	1,000	SAR, Continuous Flow Full Facepiece	$541	$1,536	$116	$0	$0	$0	$2,193
	1,000	SAR, Continuous Flow Helmet/Hood	$541	$1,526	$116	$0	$0	$0	$2,182
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$541	$8,561	$116	$0	$0	$0	$9,217
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$541	$8,800	$116	$0	$0	$0	$9,456

Table B-17: Total Annual Recurring PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
Manufacturing	10	APR, Half Mask	$102	$2,043	$22	$65	$128	$418	$2,777
	25	PAPR, Loose-Fitting Facepiece	$102	$1,077	$22	$0	$255	$418	$1,874
	25	SAR, Loose-Fitting Facepiece	$102	$323	$22	$0	$255	$418	$1,120
	50	APR, Full Facepiece	$102	$2,155	$22	$65	$128	$418	$2,889
	50	PAPR, Half Mask	$102	$1,065	$22	$152	$255	$418	$2,013
	50	SAR, Continuous Flow Half Mask	$102	$311	$22	$152	$255	$418	$1,259
	1,000	PAPR, Full Facepiece	$102	$1,125	$22	$152	$255	$418	$2,073
	1,000	PAPR, Helmet/Hood	$102	$1,091	$22	$152	$255	$418	$2,039
	1,000	SAR, Continuous Flow Full Facepiece	$102	$371	$22	$152	$255	$418	$1,319
	1,000	SAR, Continuous Flow Helmet/Hood	$102	$358	$22	$152	$255	$418	$1,306
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$102	$1,222	$22	$152	$510	$418	$2,425
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$102	$1,302	$22	$152	$510	$418	$2,505
Construction	10	APR, Half Mask	$112	$2,043	$23	$74	$147	$530	$2,929
	25	PAPR, Loose-Fitting Facepiece	$112	$1,077	$23	$0	$293	$530	$2,035
	25	SAR, Loose-Fitting Facepiece	$112	$323	$23	$0	$293	$530	$1,281
	50	APR, Full Facepiece	$112	$2,155	$23	$74	$147	$530	$3,040
	50	PAPR, Half Mask	$112	$1,065	$23	$173	$293	$530	$2,196
	50	SAR, Continuous Flow Half Mask	$112	$311	$23	$173	$293	$530	$1,442
	1,000	PAPR, Full Facepiece	$112	$1,125	$23	$173	$293	$530	$2,256
	1,000	PAPR, Helmet/Hood	$112	$1,091	$23	$173	$293	$530	$2,222
	1,000	SAR, Continuous Flow Full Facepiece	$112	$371	$23	$173	$293	$530	$1,502
	1,000	SAR, Continuous Flow Helmet/Hood	$112	$358	$23	$173	$293	$530	$1,489

Table B-17: Total Annual Recurring PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$112	$1,222	$23	$173	$586	$530	$2,646
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$112	$1,302	$23	$173	$586	$530	$2,726
Mining	10	APR, Half Mask	$94	$2,043	$23	$74	$147	$530	$2,911
	25	PAPR, Loose-Fitting Facepiece	$94	$1,077	$23	$0	$293	$530	$2,017
	25	SAR, Loose-Fitting Facepiece	$94	$323	$23	$0	$293	$530	$1,263
	50	APR, Full Facepiece	$94	$2,155	$23	$74	$147	$530	$3,023
	50	PAPR, Half Mask	$94	$1,065	$23	$173	$293	$530	$2,178
	50	SAR, Continuous Flow Half Mask	$94	$311	$23	$173	$293	$530	$1,424
	1,000	PAPR, Full Facepiece	$94	$1,125	$23	$173	$293	$530	$2,238
	1,000	PAPR, Helmet/Hood	$94	$1,091	$23	$173	$293	$530	$2,204
	1,000	SAR, Continuous Flow Full Facepiece	$94	$371	$23	$173	$293	$530	$1,484
	1,000	SAR, Continuous Flow Helmet/Hood	$94	$358	$23	$173	$293	$530	$1,471
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$94	$1,222	$23	$173	$586	$530	$2,628
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$94	$1,302	$23	$173	$586	$530	$2,708
Transportation and Public Utilities	10	APR, Half Mask	$126	$2,043	$24	$79	$157	$580	$3,009
	25	PAPR, Loose-Fitting Facepiece	$126	$1,077	$24	$0	$314	$580	$2,120
	25	SAR, Loose-Fitting Facepiece	$126	$323	$24	$0	$314	$580	$1,366
	50	APR, Full Facepiece	$126	$2,155	$24	$79	$157	$580	$3,121
	50	PAPR, Half Mask	$126	$1,065	$24	$183	$314	$580	$2,290
	50	SAR, Continuous Flow Half Mask	$126	$311	$24	$183	$314	$580	$1,537
	1,000	PAPR, Full Facepiece	$126	$1,125	$24	$183	$314	$580	$2,350
	1,000	PAPR, Helmet/Hood	$126	$1,091	$24	$183	$314	$580	$2,316

Table B-17: Total Annual Recurring PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
	1,000	SAR, Continuous Flow Full Facepiece	$126	$371	$24	$183	$314	$580	$1,597
	1,000	SAR, Continuous Flow Helmet/Hood	$126	$358	$24	$183	$314	$580	$1,583
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$126	$1,222	$24	$183	$627	$580	$2,761
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$126	$1,302	$24	$183	$627	$580	$2,841
Wholesale Trade	10	APR, Half Mask	$122	$2,043	$21	$52	$102	$380	$2,719
	25	PAPR, Loose-Fitting Facepiece	$122	$1,077	$21	$0	$203	$380	$1,802
	25	SAR, Loose-Fitting Facepiece	$122	$323	$21	$0	$203	$380	$1,049
	50	APR, Full Facepiece	$122	$2,155	$21	$52	$102	$380	$2,831
	50	PAPR, Half Mask	$122	$1,065	$21	$144	$203	$380	$1,934
	50	SAR, Continuous Flow Half Mask	$122	$311	$21	$144	$203	$380	$1,181
	1,000	PAPR, Full Facepiece	$122	$1,125	$21	$144	$203	$380	$1,994
	1,000	PAPR, Helmet/Hood	$122	$1,091	$21	$144	$203	$380	$1,960
	1,000	SAR, Continuous Flow Full Facepiece	$122	$371	$21	$144	$203	$380	$1,241
	1,000	SAR, Continuous Flow Helmet/Hood	$122	$358	$21	$144	$203	$380	$1,228
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$122	$1,222	$21	$144	$406	$380	$2,295
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$122	$1,302	$21	$144	$406	$380	$2,374
Retail Trade	10	APR, Half Mask	$137	$2,043	$20	$35	$69	$285	$2,590
	25	PAPR, Loose-Fitting Facepiece	$137	$1,077	$20	$0	$138	$285	$1,657
	25	SAR, Loose-Fitting Facepiece	$137	$323	$20	$0	$138	$285	$904
	50	APR, Full Facepiece	$137	$2,155	$20	$35	$69	$285	$2,702
	50	PAPR, Half Mask	$137	$1,065	$20	$126	$138	$285	$1,771

Table B-17: Total Annual Recurring PPE Costs

Sector	APF	Respirator System	Respirator Program Costs	Equipment Costs	Medical Evaluation Costs	Fit Test Costs	Training Costs	Cleaning Costs	Total Costs
	50	SAR, Continuous Flow Half Mask	$137	$311	$20	$126	$138	$285	$1,018
	1,000	PAPR, Full Facepiece	$137	$1,125	$20	$126	$138	$285	$1,831
	1,000	PAPR, Helmet/Hood	$137	$1,091	$20	$126	$138	$285	$1,797
	1,000	SAR, Continuous Flow Full Facepiece	$137	$371	$20	$126	$138	$285	$1,078
	1,000	SAR, Continuous Flow Helmet/Hood	$137	$358	$20	$126	$138	$285	$1,064
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$137	$1,222	$20	$126	$277	$285	$2,067
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$137	$1,302	$20	$126	$277	$285	$2,146
Services	10	APR, Half Mask	$135	$2,043	$23	$75	$148	$519	$2,943
	25	PAPR, Loose-Fitting Facepiece	$135	$1,077	$23	$0	$295	$519	$2,050
	25	SAR, Loose-Fitting Facepiece	$135	$323	$23	$0	$295	$519	$1,296
	50	APR, Full Facepiece	$135	$2,155	$23	$75	$148	$519	$3,055
	50	PAPR, Half Mask	$135	$1,065	$23	$171	$295	$519	$2,209
	50	SAR, Continuous Flow Half Mask	$135	$311	$23	$171	$295	$519	$1,455
	1,000	PAPR, Full Facepiece	$135	$1,125	$23	$171	$295	$519	$2,269
	1,000	PAPR, Helmet/Hood	$135	$1,091	$23	$171	$295	$519	$2,234
	1,000	SAR, Continuous Flow Full Facepiece	$135	$371	$23	$171	$295	$519	$1,515
	1,000	SAR, Continuous Flow Helmet/Hood	$135	$358	$23	$171	$295	$519	$1,502
	10,000	SCBA, Positive-pressure Mode, Full Facepiece	$135	$1,222	$23	$171	$590	$519	$2,661
	10,000	SCBA, Positive-pressure Mode, Helmet/Hood	$135	$1,302	$23	$171	$590	$519	$2,740

11. Annual Incremental Respirator PPE Costs

Facilities that do not provide PPE in the baseline are assumed to incur the total costs for implementing a respirator program with the APF level required under TSCA. These costs are estimated as the weighted average of the costs presented in Table B-16 and Table B-17 for each given APF and industry sector, using the percentages presented in Table B-14 to weight the different respirator systems with the same APF.

Facilities with a baseline respirator program are assumed to incur incremental costs if they are required to switch to respirators with a higher APF or to switch from purified air respirators to supplied air respirators. Facilities that are already using respirators compliant with the TSCA requirements are not assumed to incur any costs. Estimated baseline respirator costs for facilities that must switch to compliant respirators is estimated as the weighted average of the costs of respirators that can no longer be used, using the percentages presented in Table B-14 to weight the costs of the different respirator systems. Respirators that can no longer be used include those with APFs below the requirements or respirators that use purified air when supplied air respirators are required.

Note that the costs of using higher APF respirators are sometimes lower than costs of using lower APF respirators. This is generally the case when comparing purified air respirators with supplied air respirators because the filters used in purified air respirators are relatively expensive. These purified air respirators are still often preferred, despite their higher costs, because they are more comfortable to wear (with a supplied air respirator the workers are either carrying a relatively heavy tank or are tethered to the hose that is supplying the air). However, when the estimated costs of compliant respirators are lower than the cost of the baseline respirators, the incremental costs of the compliant respirators are assumed to be zero (rather than assuming a cost savings).

Table B-18 presents the initial incremental PPE costs for purified or supplied air. Table B-19 presents the annual incremental recurring PPE costs of purified or supplied air. Table B-20 presents the initial incremental PPE costs for supplied air only. Table B-21 presents the annual incremental recurring PPE costs for supplied air only. All four tables cover the seven industry sectors included in the analysis.

Table B-18: Incremental PPE Costs, Purified or Supplied Air, Initial Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	10	72%	$2,572	$0	$1,845
	25		$2,458	$0	$1,763
	50		$2,657	$52	$1,920
	1,000		$2,265	$0	$1,625
	10,000		$9,198	$6,246	$8,364
Construction	10	78%	$2,617	$0	$2,046
	25		$2,503	$0	$1,957
	50		$2,646	$24	$2,075
	1,000		$2,278	$0	$1,782
	10,000		$9,243	$6,353	$8,613
Mining	10	66%	$2,547	$0	$1,678
	25		$2,432	$0	$1,602
	50		$2,639	$62	$1,759
	1,000		$2,256	$0	$1,486
	10,000		$9,173	$6,093	$8,122
Transportation and Public Utilities	10	88%	$2,677	$0	$2,361
	25		$2,563	$0	$2,260
	50		$2,723	$29	$2,405
	1,000		$2,325	$0	$2,051
	10,000		$9,303	$5,558	$8,861
Wholesale Trade	10	85%	$2,647	$0	$2,255
	25		$2,532	$0	$2,157
	50		$2,775	$84	$2,376
	1,000		$2,379	$0	$2,027
	10,000		$9,273	$5,920	$8,776
Retail Trade	10	96%	$2,703	$0	$2,600
	25		$2,588	$0	$2,490
	50		$2,687	$3	$2,585
	1,000		$2,436	$0	$2,343
	10,000		$9,329	$6,373	$9,216
Services	10	95%	$2,711	$0	$2,569
	25		$2,596	$0	$2,461
	50		$2,737	$19	$2,595
	1,000		$2,546	$0	$2,413
	10,000		$9,337	$6,313	$9,179

Table B-19: Incremental PPE Costs, Purified or Supplied Air, Recurring Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	10	72%	$2,777	$0	$1,992
	25		$1,874	$0	$1,344
	50		$2,617	$0	$1,877
	1,000		$1,641	$0	$1,177
	10,000		$2,465	$71	$1,788
Construction	10	78%	$2,929	$0	$2,290
	25		$2,035	$0	$1,591
	50		$2,655	$0	$2,076
	1,000		$1,770	$0	$1,384
	10,000		$2,686	$169	$2,137
Mining	10	66%	$2,911	$0	$1,917
	25		$2,017	$0	$1,329
	50		$2,748	$0	$1,810
	1,000		$1,816	$0	$1,196
	10,000		$2,668	$46	$1,773
Transportation and Public Utilities	10	88%	$3,009	$0	$2,653
	25		$2,120	$0	$1,870
	50		$2,796	$0	$2,466
	1,000		$1,844	$0	$1,626
	10,000		$2,801	$229	$2,497
Wholesale Trade	10	85%	$2,719	$0	$2,316
	25		$1,802	$0	$1,536
	50		$2,641	$0	$2,250
	1,000		$1,616	$0	$1,377
	10,000		$2,334	$0	$1,989
Retail Trade	10	96%	$2,590	$0	$2,491
	25		$1,657	$0	$1,594
	50		$2,191	$0	$2,108
	1,000		$1,447	$0	$1,392
	10,000		$2,107	$0	$2,026
Services	10	95%	$2,943	$0	$2,789
	25		$2,050	$0	$1,943
	50		$2,692	$0	$2,551
	1,000		$2,023	$0	$1,918
	10,000		$2,701	$1	$2,560

Table B-20: Incremental PPE Costs, Supplied Air Only, Initial Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	25	72%	$1,911	$0	$1,371
	50		$1,874	$0	$1,344
	1,000		$2,046	$0	$1,468
	10,000		$9,198	$6,694	$8,490
Construction	25	78%	$1,955	$0	$1,529
	50		$1,919	$0	$1,500
	1,000		$2,092	$0	$1,636
	10,000		$9,243	$6,709	$8,691
Mining	25	66%	$1,885	$0	$1,242
	50		$1,849	$0	$1,218
	1,000		$2,021	$0	$1,331
	10,000		$9,173	$6,669	$8,318
Transportation and Public Utilities	25	88%	$2,016	$0	$1,778
	50		$1,979	$0	$1,746
	1,000		$2,153	$0	$1,899
	10,000		$9,303	$6,742	$9,001
Wholesale Trade	25	85%	$1,985	$0	$1,691
	50		$1,948	$0	$1,660
	1,000		$2,121	$0	$1,807
	10,000		$9,273	$6,657	$8,885
Retail Trade	25	96%	$2,041	$0	$1,964
	50		$2,005	$0	$1,928
	1,000		$2,179	$0	$2,096
	10,000		$9,329	$6,675	$9,228
Services	25	95%	$2,049	$0	$1,942
	50		$2,013	$0	$1,908
	1,000		$2,188	$0	$2,073
	10,000		$9,337	$6,651	$9,197

Table B-21: Incremental PPE Costs, Supplied Air Only, Recurring Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	25	72%	$1,120	$0	$803
	50		$1,259	$0	$903
	1,000		$1,309	$0	$939
	10,000		$2,465	$76	$1,790
Construction	25	78%	$1,281	$0	$1,002
	50		$1,442	$0	$1,127
	1,000		$1,494	$0	$1,168
	10,000		$2,686	$178	$2,139
Mining	25	66%	$1,263	$0	$832
	50		$1,424	$0	$938
	1,000		$1,475	$0	$971
	10,000		$2,668	$50	$1,775
Transportation and Public Utilities	25	88%	$1,366	$0	$1,205
	50		$1,537	$0	$1,355
	1,000		$1,589	$0	$1,402
	10,000		$2,801	$278	$2,503
Wholesale Trade	25	85%	$1,049	$0	$893
	50		$1,181	$0	$1,006
	1,000		$1,231	$0	$1,049
	10,000		$2,334	$0	$1,989
Retail Trade	25	96%	$904	$0	$869
	50		$1,018	$0	$979
	1,000		$1,071	$0	$1,030
	10,000		$2,107	$0	$2,026
Services	25	95%	$1,296	$0	$1,228
	50		$1,455	$0	$1,379
	1,000		$1,508	$0	$1,429
	10,000		$2,701	$1	$2,560

As noted previously, when the estimated costs of compliant respirators are lower than the cost of the baseline respirators, the incremental costs of the compliant respirators are assumed to be zero (see Table B-18 to Table B-21). We present alternative incremental cost estimates in Table B-22 through Table B-25, which include all cost savings from switching to higher APF respirators in the incremental cost estimates.

Table B-22: Alternative Incremental PPE Costs (includes cost savings where more protective PPE has lower costs), Purified or Supplied Air, Initial Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	10	72%	$2,734	$0	$1,961
	25		$2,619	($112)	$1,847
	50		$2,818	$52	$2,036
	1,000		$2,427	($239)	$1,673
	10,000		$9,360	$6,246	$8,479
Construction	10	78%	$2,741	$0	$2,144
	25		$2,627	($103)	$2,032
	50		$2,771	$24	$2,172
	1,000		$2,403	($255)	$1,823
	10,000		$9,367	$6,353	$8,710
Mining	10	66%	$2,741	$0	$1,806
	25		$2,627	($115)	$1,691
	50		$2,834	$62	$1,887
	1,000		$2,451	($248)	$1,530
	10,000		$9,367	$6,093	$8,250
Transportation and Public Utilities	10	88%	$2,745	$0	$2,421
	25		$2,630	($112)	$2,307
	50		$2,791	$29	$2,464
	1,000		$2,393	($236)	$2,082
	10,000		$9,371	$5,558	$8,921
Wholesale Trade	10	85%	$2,731	$0	$2,327
	25		$2,617	($106)	$2,214
	50		$2,859	$84	$2,448
	1,000		$2,463	($237)	$2,064
	10,000		$9,357	$5,920	$8,848
Retail Trade	10	96%	$2,725	$0	$2,621
	25		$2,610	($95)	$2,507
	50		$2,709	$3	$2,606
	1,000		$2,457	($219)	$2,355
	10,000		$9,351	$6,373	$9,237
Services	10	95%	$2,741	$0	$2,598
	25		$2,626	($112)	$2,483
	50		$2,766	$19	$2,623
	1,000		$2,576	($140)	$2,434
	10,000		$9,367	$6,313	$9,207

Table B-23: Alternative Incremental PPE Costs (includes cost savings where more protective PPE has lower costs), Purified or Supplied Air, Recurring Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	10	72%	$2,817	$0	$2,021
	25		$1,914	($887)	$1,122
	50		$2,657	($86)	$1,882
	1,000		$1,681	($748)	$994
	10,000		$2,506	$71	$1,817
Construction	10	78%	$2,960	$0	$2,314
	25		$2,066	($806)	$1,440
	50		$2,686	($110)	$2,076
	1,000		$1,801	($738)	$1,247
	10,000		$2,717	$169	$2,161
Mining	10	66%	$2,960	$0	$1,950
	25		$2,066	($894)	$1,056
	50		$2,797	($109)	$1,805
	1,000		$1,864	($802)	$954
	10,000		$2,717	$46	$1,805
Transportation and Public Utilities	10	88%	$3,025	$0	$2,668
	25		$2,137	($866)	$1,782
	50		$2,813	($112)	$2,468
	1,000		$1,861	($679)	$1,561
	10,000		$2,818	$229	$2,512
Wholesale Trade	10	85%	$2,740	$0	$2,334
	25		$1,824	($846)	$1,428
	50		$2,662	($5)	$2,267
	1,000		$1,637	($782)	$1,279
	10,000		$2,356	($56)	$1,998
Retail Trade	10	96%	$2,595	$0	$2,496
	25		$1,663	($772)	$1,570
	50		$2,197	($149)	$2,107
	1,000		$1,453	($784)	$1,367
	10,000		$2,112	($119)	$2,027
Services	10	95%	$2,950	$0	$2,796
	25		$2,057	($877)	$1,904
	50		$2,699	($160)	$2,550
	1,000		$2,031	($676)	$1,889
	10,000		$2,708	$1	$2,567

Table B-24: Alternative Incremental PPE Costs (includes cost savings where more protective PPE has lower costs), Supplied Air Only, Initial Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	25	72%	$2,072	($709)	$1,286
	50		$2,036	($746)	$1,249
	1,000		$2,208	($548)	$1,428
	10,000		$9,360	$6,694	$8,606
Construction	25	78%	$2,080	($693)	$1,475
	50		$2,043	($729)	$1,439
	1,000		$2,217	($527)	$1,618
	10,000		$9,367	$6,709	$8,788
Mining	25	66%	$2,080	($697)	$1,132
	50		$2,043	($734)	$1,095
	1,000		$2,216	($552)	$1,271
	10,000		$9,367	$6,669	$8,446
Transportation and Public Utilities	25	88%	$2,083	($712)	$1,753
	50		$2,047	($748)	$1,717
	1,000		$2,221	($535)	$1,895
	10,000		$9,371	$6,742	$9,060
Wholesale Trade	25	85%	$2,070	($713)	$1,658
	50		$2,033	($750)	$1,621
	1,000		$2,205	($560)	$1,796
	10,000		$9,357	$6,657	$8,957
Retail Trade	25	96%	$2,063	($678)	$1,959
	50		$2,027	($715)	$1,922
	1,000		$2,201	($506)	$2,098
	10,000		$9,351	$6,675	$9,249
Services	25	95%	$2,079	($703)	$1,934
	50		$2,043	($740)	$1,897
	1,000		$2,217	($529)	$2,074
	10,000		$9,367	$6,651	$9,225

Table B-25: Alternative Incremental PPE Costs (includes cost savings where more protective PPE has lower costs), Supplied Air Only, Recurring Costs

Sector	APF	Baseline Percentage of No Use	Baseline No Use Cost	Baseline Use Cost	Average Incremental APF Cost
Manufacturing	25	72%	$1,160	($1,528)	$400
	50		$1,300	($1,389)	$540
	1,000		$1,350	($1,291)	$603
	10,000		$2,506	$76	$1,819
Construction	25	78%	$1,312	($1,475)	$704
	50		$1,473	($1,315)	$865
	1,000		$1,525	($1,211)	$928
	10,000		$2,717	$178	$2,163
Mining	25	66%	$1,312	($1,537)	$340
	50		$1,473	($1,376)	$501
	1,000		$1,523	($1,307)	$557
	10,000		$2,717	$50	$1,807
Transportation and Public Utilities	25	88%	$1,383	($1,519)	$1,040
	50		$1,553	($1,349)	$1,211
	1,000		$1,606	($1,225)	$1,272
	10,000		$2,818	$278	$2,518
Wholesale Trade	25	85%	$1,070	($1,536)	$684
	50		$1,202	($1,404)	$816
	1,000		$1,252	($1,321)	$871
	10,000		$2,356	($63)	$1,997
Retail Trade	25	96%	$909	($1,468)	$819
	50		$1,023	($1,354)	$932
	1,000		$1,076	($1,235)	$988
	10,000		$2,112	($125)	$2,027
Services	25	95%	$1,303	($1,544)	$1,155
	50		$1,462	($1,385)	$1,314
	1,000		$1,516	($1,264)	$1,370
	10,000		$2,708	$1	$2,567

12. Appendix C References

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