

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

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Notice

This is not an official guidance document and should not be relied upon to determine applicable regulatory requirements. 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 the regulatory determinations that an individual firm would make were it to apply the rule's requirements to its specific circumstances. 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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Acronyms and Abbreviations

1-BP 1-Bromopropane

A/C Air conditioner

ACGIH® American Conference of Governmental Industrial Hygienists

ACS American Community Survey

APF Assigned Protection Factor

BLS U.S. Bureau of Labor Statistics

BMD Benchmark dose

BMDL Benchmark dose lower bound

BMR Benchmark response level

CAA Clean Air Act

CARB California Air Resources Board

CASRN Chemical Abstracts Service Registry Number

CDC Centers for Disease Control and Prevention

CDR Chemical Data Reporting

CEPA Canadian Environmental Protection Act

CERCLA Comprehensive Environmental Response, Compensation and Liability Act

CFC Chlorofluorocarbon

CFR *Code of Federal Regulations*

CIH Certified Industrial Hygienist

CMR Code of Massachusetts Regulations

COU Condition of use

CPID Consumer Product Information Database

CPSC Consumer Product Safety Commission

CVD Conveyorized Vapor Degreasing

DCE Dichloroethylene

DCM Methylene chloride

DDCC Direct dermal contact controls

DLI Dry Cleaning and Laundry Institute

DMCF Dose metric conversion factor

DOD Department of Defense

DOE Department of Energy

DOT Department of Transportation

ECEC Employer Costs for Employee Compensation

ECEL Existing chemical exposure limit

ECHO Enforcement and Compliance History Online

EJ Environmental justice

EPA U.S. Environmental Protection Agency

EPCRA Emergency Planning and Community Right-To-Know Act

EU European Union

EVD Enclosed Vapor Degreasing

FBR Freeboard refrigeration device

FDA Food and Drug Administration

FFDCA Federal Food, Drug, and Cosmetic Act

FIFRA Federal Insecticide, Fungicide, and Rodenticide Act

FR *Federal Register*

FHSA Federal Hazardous Substances Act

GDP Gross Domestic Product

HAP Hazardous air pollutant

HCFC Hydrochlorofluorocarbon

HFC Hydrofluorocarbon

HFE Hydrofluoroether

HOC Monitoring and Hierarchy of Controls

HSP Hansen Solubility Parameters

IAC Indiana Administrative Code

ICR Information collection requests

IECR Inhalation excess cancer risk

IRIS Integrated Risk Information System

IRTA Institute for Research and Technical Assistance

IUR Inhalation unit risk

LADC Lifetime Average Daily Concentration

lb Pound

LLC Limited liability company

MCL Maximum contaminant level

MCLG Maximum contaminant level goal

MMT Media Migration Technology

NAICS North American Industry Classification System

NATA National Air Toxics Assessment

NCA National Cleaners Association

NEI National Emissions Inventory

NESHAP National emission standards for hazardous air pollutants

NFSA National Film and Sound Archive of Australia

N.J.R. New Jersey Register

NMP N-Methylpyrrolidone

NPDWR National Primary Drinking Water Regulations

OEHHA Office of Environmental Health Hazard Assessment (California)

OES Occupational exposure scenario

OEWS Occupational Employment and Wage Statistics

OLS Ordinary least squares

ONU Occupational non-users

OSH Occupational Safety and Health

OSHA Occupational Safety and Health Administration

OTC Ozone Transport Commission

OTVD Open Top Vapor Degreasing

PC Prescriptive controls

PCBTF Parachlorobenzotrifluoride

PCE Perchloroethylene

PDV Present Discounted Value

PEL Permissible exposure limit

PPE Personal protective equipment

ppm Parts per million

PPRC Pollution Prevention Resource Center

PUMA Public Use Microdata Area

PVA Polyvinyl alcohol

PVC Polyvinyl chloride

RCRA Resource Conservation and Recovery Act

R.C.S.A. Regulations of Connecticut State Agencies

RFA Regulatory Flexibility Act

RI Rhode Island

RTR Risk and technology review

SBA U.S. Small Business Administration

SBREFA Small Business Regulatory Enforcement Fairness Act

SCAQMD South Coast Air Quality Management District

SDWA Safe Drinking Water Act

SDS Safety Data Sheet

SMILES Simplified molecular-input line-entry system

SNAP Significant New Alternatives Policy

STEL Short Term Exposure Limit

SUSB Statistics of U.S. Businesses

TCE Trichloroethylene

TLV® Threshold limit value

TRI Toxics Release Inventory

TSCA Toxic Substances Control Act

TTO Total toxic organics

TURI Toxics Use Reduction Institute

TWA Time-weighted average

UCB University of California Berkeley

VOC Volatile organic compound

VSL Value for a statistical life

WCPP Workplace chemical protection program

WVD Web Vapor Degreasing

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Executive Summary

Introduction

The U.S. Environmental Protection Agency (EPA) is undertaking rulemaking under section 6(a) of the Toxic Substances Control Act (TSCA) for perchloroethylene (PCE) after completing a risk evaluation and determining that the chemical substance presents unreasonable risk under the conditions of use (COUs). 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; disposal; and industrial, commercial, and consumer use of PCE. EPA is establishing the regulation under the authority granted by section 6 of TSCA. The final rule, “Regulation of Perchloroethylene Under TSCA Section 6(a),” addresses the unreasonable risk of injury to health from PCE, under the COUs. These COUs are presented in Table ES-1. Table ES-1 also lists use categories considered for purposes of the economic analysis and defines how the economic analysis use categories map to the COUs. The use categories are the categories of PCE use that are considered in the economic analysis.

| Table ES-1: Use Categories Considered in the Economic Analysis Mapped to the Conditions of Use Defined in the Risk Evaluation | |
| --- | --- |
| Use Category | Condition of Use |
| Manufacturing | Manufacturing (domestic manufacturing) |
| Import/Repackage | Manufacturing (import) |
| Repackaging |
| Reactant/Intermediate | Processing as a reactant/intermediate |
| Processing Aid in Petrochemical Manufacturing | Industrial and commercial use as a processing aid in catalyst regeneration in petrochemical manufacturing |
| Production of Maskant for Chemical Milling | Processing into formulation, mixture, or reaction product in paint and coating products1 |
| Use as Maskant for Chemical Milling | Industrial and commercial use in paints and coatings in maskant for chemical milling |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Industrial and commercial use as solvent for batch open-top vapor degreaser |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Industrial and commercial use as solvent for closed-loop batch vapor degreaser3 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Industrial and commercial use as solvent for in-line conveyorized vapor degreaser |
| Vapor Degreasing: Web Vapor Degreasing (WVD) | Industrial and commercial use as solvent for in-line web cleaner vapor degreaser |
| Incorporation into adhesive and sealant products | Processing into formulation, mixture, or reaction product in adhesive and sealant products |
| Incorporation into other formulation, mixture, and reaction products3 | Processing into formulation, mixture, or reaction product in other chemical products and preparations |
| Processing into formulation, mixture, or reaction product in cleaning and degreasing products |
| Processing into formulation, mixture, or reaction product in paint and coating products1 |
| Processing Aid, Except Petrochemical | Industrial and commercial use as a processing aid in sectors other than petrochemical manufacturing |
| Department of Defense (DOD) Uses | Industrial and commercial use in specialty DOD uses (oil analysis and water pipe repair) |
| Adhesives and Sealants | Industrial and commercial use in solvent-based adhesives and sealants |
| Consumer use in adhesives for arts and crafts (including industrial adhesive, arts and crafts adhesive, gun ammunition sealant) |
| Consumer use in adhesives for arts and crafts (livestock grooming adhesive) |
| Consumer use in adhesives for arts and crafts (column adhesive, caulk, and sealant) |
| Paint and Coatings | Industrial and commercial use in solvent-based paints and coatings |
| Consumer use in solvent-based paints and coatings (outdoor water shield (liquid)) |
| Consumer use in solvent-based paints and coatings (coatings and primers (aerosol)) |
| Consumer use in solvent-based paints and coatings (rust primer and sealant (liquid)) |
| Consumer use in solvent-based paints and coatings (metallic overglaze) |
| Aerosol Spray Cleaning/Degreasing | Industrial and commercial use as solvent for aerosol spray degreaser/cleaner - General |
| Industrial and commercial use as solvent for aerosol spray degreaser/cleaner - Energized Electrical Cleaning |
| Consumer use in cleaners and degreasers (other) |
| Consumer use in automotive care products (brake cleaner) |
| Consumer use in automotive care products (parts cleaner) |
| Consumer use in aerosol cleaner (vandalism mark and stain remover) |
| Liquid and Spray Batch Cold Cleaning | Industrial and commercial use as solvent for cold cleaning |
| Photographic Film Use | Commercial use for photographic film |
| Lubricants and Greases | Industrial and commercial use as a solvent for aerosol lubricants |
| Industrial and commercial use as a solvent for penetrating lubricants and cutting tool coolants |
| Consumer use in lubricants and greases (cutting fluid) |
| Consumer use in lubricants and greases (lubricants and penetrating oils) |
| Wipe and Liquid Cleaning and Polishing | Industrial and commercial use in wipe cleaning |
| Industrial and commercial use in non-aerosol cleaner |
| Industrial and commercial use in automotive care products (e.g., engine degreaser and brake cleaner) |
| Industrial and commercial use in metal (e.g., stainless steel) and stone polishes |
| Consumer use in non-aerosol cleaner (e.g., marble and stone polish) |
| Consumer use in metal (e.g., stainless steel) and stone polishes |
| Spot Removers | Industrial and commercial use in other spot cleaning and spot removers, including carpet cleaning |
| Inks and Ink Removal | Commercial use in inks and ink removal products (based on printing) |
| Commercial use in inks and ink removal products (based on photocopying) |
| Consumer use in inks and ink removal products |
| Anti-Spatter Welding Aerosol | Industrial and commercial use in welding |
| Consumer use in welding |
| Mold Cleaning, Release, and Protectants | Industrial and commercial use (in cleaning and furniture care products) for mold release |
| Commercial use in mold cleaning, release, and protectant products |
| Consumer use in mold cleaning, release, and protectant products |
| Dry Cleaning Machines | Industrial and commercial use in dry cleaning and spot cleaning post-2006 dry cleaning |
| Industrial and commercial use in dry cleaning and spot cleaning, 4th and 5th generation-only dry cleaning |
| Consumer use in dry cleaning solvent4 |
| Laboratory Chemicals | Industrial and commercial use in laboratory chemicals |
| Recycling and Disposal | Recycling |
| Disposal |
| Overlapping COUs | Industrial and commercial use in foundry applications |
| Industrial and commercial use in wood furniture manufacturing |
| Industrial and commercial use in other textile processing |
| 1This COU is mapped into two use categories to distinguish between paint and coatings products for chemical milling and other paint and coatings products.  2Closed-loop vapor degreasing includes batch closed-loop or airless vapor degreaser systems.  3Costs and benefits for processors that formulate products containing PCE are generally accounted for under the end use category for the product(s) they would need to reformulate under the options.  4This COU represents emissions from clothing or other textiles brought home by consumers after they were dry cleaned. | |

Background

This final rule applies to PCE (CASRN 127-18-4). PCE is a colorless, volatile liquid with a mildly sweet odor that is produced in and imported into the United States. PCE is manufactured, processed, distributed, used, and disposed of as part of many industrial, commercial, and consumer COUs. PCE is used for the production of fluorinated compounds, as a solvent for dry cleaning and vapor degreasing, in catalyst regeneration in petrochemical manufacturing, and in a variety of commercial and consumer applications. These applications include adhesives, paints and coatings, aerosol degreasers, brake cleaners, aerosol lubricants, sealants, stone polish, stainless steel polish, and wipe cleaners. According to the 2016 reporting year for Chemical Data Reporting, the total aggregate production volume of PCE in the United States decreased from 388 million pounds to around 324 million pounds between 2012 and 2015 ([EPA 2012-2015](#_ENREF_71)). The total aggregate production volume ranged from 250 to 500 million pounds between 2016 and 2019 according to Chemical Data Reporting ([EPA 2016-2019](#_ENREF_76)).

EPA determined that PCE presents an unreasonable risk of injury to health, without consideration of costs or other non-risk factors, including an unreasonable risk to potentially exposed or susceptible subpopulations identified as relevant to the risk evaluation by EPA, under the COUs. Accordingly, to address the identified unreasonable risk, EPA is finalizing, under TSCA section 6(a), to: (i) Prohibit most industrial and commercial uses and the manufacture (including import), processing, and distribution in commerce, of PCE for those uses.; (ii) Prohibit the manufacture (including import), processing, and distribution in commerce of PCE for all consumer use; (iii) Prohibit the manufacture (including import), processing, distribution in commerce, and commercial use of PCE in dry cleaning and spot cleaning through a 10-year phaseout; (iv) Require a PCE Workplace Chemical Protection Program (WCPP), including an inhalation exposure concentration limit, direct dermal contact controls, and related workplace exposure controls for many occupational conditions of use of PCE not prohibited; (v) Require prescriptive workplace controls for laboratory use and energized electrical cleaner; (vi) Establish recordkeeping and downstream notification requirements; and (vii) Provide a 10-year time limited exemption under TSCA section 6(g) for certain emergency uses of PCE in furtherance of National Aeronautics and Space Administration’s (NASA) mission, for specific conditions of use which are critical or essential and for which no technically and economically feasible safer alternative is available; and (viii) Identify a regulatory threshold for products containing PCE for the prohibitions and restrictions on PCE.

Options Analyzed

EPA is finalizing under TSCA section 6(a) to: (i) Prohibit most industrial and commercial uses and the manufacture (including import), processing, and distribution in commerce, of PCE for those uses; (ii) Prohibit the manufacture (including import), processing, and distribution in commerce of PCE for all consumer use; (iii) Prohibit the manufacture (including import), processing, distribution in commerce, and commercial use of PCE in dry cleaning and spot cleaning through a 10-year phaseout; (iv) Require a PCE Workplace Chemical Protection Program (WCPP), including an inhalation exposure concentration limit, direct dermal contact controls, and related workplace exposure controls for many occupational conditions of use of PCE not prohibited; (v) Require prescriptive workplace controls for laboratory use and energized electrical cleaner; (vi) Establish recordkeeping and downstream notification requirements; and (vii) Provide a 10-year time limited exemption under TSCA section 6(g) for certain emergency uses of PCE in furtherance of (NASA’s mission, for specific conditions of use which are critical or essential and for which no technically and economically feasible safer alternative is available; and (viii) Identify a regulatory threshold for products containing PCE for the prohibitions and restrictions on PCE. See unit IV of the Final Rule for detailed descriptions of the provisions.

The primary alternative regulatory action (Option 2) considered by EPA combines prohibitions and requirements for a WCPP to address the unreasonable risk from PCE driven by the various COUs. While in some ways it is similar to Option 1, Option 2 differs from the final regulatory action mostly by prohibiting several more conditions of use, in some cases with 10-year section 6(g) exemptions for aerospace uses. Option 2 has a WCPP for laboratory uses instead of prescriptive controls. The alternative regulatory action additionally includes longer compliance timeframes for prohibitions and a WCPP.

All options prohibit the use of PCE unless it is expressly authorized by that particular option.

Table ES-2 summarizes the options by use category.

|  |  |  |  |
| --- | --- | --- | --- |
| Table ES-2: Summary of Options by Use Category | | | |
| Use Category | | | Option 1  (Final Rule) | Option 2  (Primary Alternative) |
| Manufacturing | | | **WCPP** | **WCPP** |
| Import/Repackage | | |
| Reactant/Intermediate | | |
| Processing Aid in Petrochemical Manufacturing | | |
| Production of Maskant for Chemical Milling | | | **Prohibit**, with section 6(g) exemption for chemical milling of aircraft skins and prohibition in 10 years |
| Use as Maskant for Chemical Milling | | |
| Vapor Degreasing | | Open Top Vapor Degreasing (OTVD) | **Prohibit**, with section 6(g) exemption for aerospace uses and prohibition in 10 years |
| Enclosed Vapor Degreasing (EVD) |
| Conveyorized Vapor Degreasing (CVD) | **Prohibit** | **Prohibit** |
| Web Vapor Degreasing (WVD) |
| Recycling and Disposal | | | **WCPP** | **WCPP** |
| Incorporation into adhesive and sealant products | | | **WCPP** | **Prohibit** |
| Incorporation into Other Formulation, Mixture, and Reaction Products1 | | | **WCPP** | **Prohibit** (with section 6(g) exemption for cleaning and degreasing products for aerospace use and prohibition in 10 years) |
| Laboratory Chemicals | | | **PC** | **WCPP** |
| Processing Aid, Except Petrochemical | | | **WCPP** | **Prohibit** |
| Adhesives and Sealants | | | **WCPP** (for uses not prohibited) |
| Paint and Coatings | | | **Prohibit** |
| Aerosol Spray Cleaning/Degreasing | | | **PC** (for uses not prohibited) |
| Liquid and Spray Batch Cold Cleaning | | | **Prohibit** |
| Photographic Film Use | | |
| Lubricants and Greases | | |
| Wipe and Liquid Cleaning and Polishing | | |
| Spot Removers2 | | |
| Inks and Ink Removal | | |
| Anti-Spatter Welding Aerosol | | |
| Mold Cleaning, Release and Protectants | | |
| Dry Cleaning Machines | | | 10-Year Phaseout | 15-Year Phaseout |
| Specialty DOD Uses (oil analysis and water pipe repair) | | | **Prohibit** | **Prohibit** |
| Possibly Inactive COUs/Overlapping Tasks3 | | |
| 1Costs and benefits for processors that formulate products containing PCE are generally accounted for under the end use category for the product(s) they would need to reformulate under the options.  2Options 1 and 2 have 10- and 15-year phaseouts for dry cleaning machines and spot removers by establishments with PCE dry cleaning machines, respectively.  3Includes textile processing, wood furniture manufacturing, foundry applications, welding.  Note: Use of PCE by Federal agencies and contractors acting for or on behalf of Federal agencies are subject to a different compliance timeframe not captured in our analyses.  Table abbreviations: Workplace Chemical Protection Program (WCPP); direct dermal contact controls (DDCC); Prescriptive controls with Monitoring, and Respiratory and Dermal PPE requirements (prescriptive controls, or PC). | | | | |

Estimated Number of Affected Entities and Individuals

Table ES-3 presents a summary of baseline of the number of firms using PCE and the number of occupational and consumer users exposed to PCE for each use category. Occupational users include workers working directly with PCE and occupational non-users (ONUs).

|  |  |  |  |
| --- | --- | --- | --- |
| Table ES-3: Summary of Estimated Number of Facilities and Individuals with Occupational Exposure, by Use Category | | | |
| Use Category | Number of Facilities | Number of Workers | Number of ONUs |
| Manufacturing | 13 | 1,720 | 815 |
| Import/Repackage | 16 | 59 | 21 |
| Reactant/Intermediate | 8 | 330 | 150 |
| Processing Aid in Petrochemical Manufacturing | 64 | 806 | 346 |
| Production of Maskant for Chemical Milling | 1 | 14 | 61 |
| Use as Maskant for Chemical Milling | 71 | 497 | 2,130 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | 85 | 595 | 170 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | 14 | 98 | 28 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | 2 | 14 | 4 |
| Recycling and Disposal | 94 | 1,598 | 658 |
| Incorporation into Adhesive and Sealant Products | 12 | 252 | 96 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Aerosol) | 18 | 378 | 144 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Other) | 13 | 273 | 104 |
| Laboratory Chemicals | 26 | 26 | 236 |
| Processing Aid, Except Petrochemical | 2 | 25 | 11 |
| Adhesives and Sealants | 853 | 25,596 | 9,385 |
| Paint and Coatings | 30 | 1,230 | 720 |
| Aerosol Spray Cleaning/Degreasing | 148,296 | 201,370 | 10,615 |
| Liquid and Spray Batch Cold Cleaning | 13 | 546 | 325 |
| Photographic Film Use | 60 | 32 | 70 |
| Lubricants and Greases | 1,018 | 3,054 | 407 |
| Wipe and Liquid Cleaning and Polishing | 823 | 2,470 | 329 |
| Inks and Ink Removal | 28 | 26 | 44 |
| Anti-Spatter Welding Aerosol | 100 | 300 | 40 |
| Mold Cleaning, Release and Protectants | 100 | 300 | 40 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | 6,000 | 18,000 | 4,500 |
| **Total** | **157,760** | **259,609** | **31,449** |
| Notes: See sections 6.2.1 through 6.2.24 for a description of assumptions and sources used to develop the estimates. | | | |

Estimated Incremental Costs

Table ES-4 through Table ES-6 present the total annualized costs for 2, 3 and 7 percent discount rates. Note that EPA was unable to estimate costs of prohibition for three COUs that have either a WCPP requirement or are prohibited across the two options: production and use of chemical maskant and use as a processing aid outside the petrochemical sector. Under Option 2 where these uses are prohibited, WCPP costs are used as a proxy under the options where these uses are prohibited. Since switching to alternatives is an available compliance strategy under the uses with a WCPP requirement option, it is reasonable to assume that affected entities would simply switch to alternatives if it were less costly to switch compared to the costs of compliance with a WCPP. Thus, it is possible that the WCPP compliance costs are overstated if there are instances where switching to alternatives is less costly. It follows that compliance costs under a prohibition would exceed the costs of compliance with a WCPP.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Table ES-4: Total Annualized Costs by Use Category by Option (2% Discount Rate) | | | | | |
| Use Category | Option 1  (Final Rule) | Option 2  (Alternative Option) | Notes | | |
| Option 1  (Final Rule) | Option 2  (Alternative Option | |
| Manufacturing | $1,995,617 | $1,995,617 | WCPP | WCPP | |
| Import/Repackage | $204,284 | $204,284 | WCPP | WCPP | |
| Reactant/Intermediate | $385,999 | $385,999 | WCPP | WCPP | |
| Processing Aid in Petrochemical Manufacturing | $1,042,387 | $1,042,387 | WCPP | WCPP | |
| Production of Maskant for chemical milling | $43,722 | $43,722 | WCPP | Prohibition1 | |
| Use as Maskant for Chemical Milling | $1,428,373 | $1,428,373 | WCPP | Prohibition1 | |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $11,092,618 | $25,553,406 | WCPP | Prohibition2 | |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100,105 | $4,208,796 | WCPP | Prohibition | |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $634,637 | $634,637 | Prohibition | Prohibition | |
| Recycling and Disposal | $769,425 | $769,425 | WCPP | WCPP | |
| Incorporation into Adhesive and Sealant Products | accounted for under end-use categories | | | | |
| Incorporation into other formulation, mixture, or reaction products (aerosol) |
| Incorporation into other formulation, mixture, or reaction products (other) |
| Laboratory Chemicals | $321 | $113,191 | Prescriptive Controls | WCPP | |
| Processing Aid, except petrochemical | $32,341 | $32,341 | WCPP | Prohibition | |
| Adhesives and Sealants | $165,655 | $165,655 | Prohibition3 | Prohibition | |
| Paint and Coatings | $3,908 | $3,908 | Prohibition | Prohibition | |
| Aerosol Spray Cleaning/Degreasing | $892,955 | $892,955 | Prohibition | Prohibition | |
| Aerosol Spray Cleaning/Degreasing -EEC | $20,239,509 | $20,239,509 | Prescriptive Controls | Prohibition1 | |
| Liquid and Spray Batch Cold Cleaning | $4,125,144 | $4,125,144 | Prohibition | Prohibition | |
| Photographic Film Use | $331 | $331 | Prohibition | Prohibition | |
| Lubricants and Greases | $102,906 | $102,906 | Prohibition | Prohibition | |
| Wipe and Liquid Cleaning and Polishing | $30,749 | $30,749 | Prohibition | Prohibition | |
| Inks and Ink Removal | $3,897 | $3,897 | Prohibition | Prohibition | |
| Anti-Spatter Welding Aerosol | $8,034 | $8,034 | Prohibit | Prohibition | |
| Mold Cleaning, Release and Protectants | $23,011 | $23,011 | Prohibit | Prohibition | |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $106,446 | $45,303 | 10-Year Phase Out | 15-Year Phase Out | |
| **Total** | **$43,432,371** | **$62,053,579** |  |  | |
| 1Since the costs of prohibition are unknown, the WCPP costs are used as a proxy estimate for the prohibition costs. Note that WCPP costs should be lower than the cost of prohibition (because switching to an alternative is a viable compliance strategy under a WCPP requirement, so if it is the more cost-effective compliance strategy then firms are likely to switch to alternatives instead of following the WCPP requirements.  2Vapor degreasing costs are lower under Option 2 compared to Option 1 because 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  3While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | |
| Table ES-5: Total 20-Year Annualized Costs by Use Category by Option (3% Discount Rate) | | | | | |
| Use Category | Option 1  (Final Rule) | Option 2  (Alternative Option) | Notes | | |
| Option 1  (Final Rule) | Option 2  (Alternative Option | |
| Manufacturing | $1,991,790 | $1,991,790 | WCPP | WCPP | |
| Import/Repackage | $204,090 | $204,090 | WCPP | WCPP | |
| Reactant/Intermediate | $385,361 | $385,361 | WCPP | WCPP | |
| Processing Aid in Petrochemical Manufacturing | $1,041,331 | $1,041,331 | WCPP | WCPP | |
| Production of Maskant for chemical milling | $43,638 | $43,638 | WCPP | Prohibition1 | |
| Use as Maskant for Chemical Milling | $1,427,061 | $1,427,061 | WCPP | Prohibition1 | |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $11,584,564 | $27,206,430 | WCPP | Prohibition2 | |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100,137 | $4,481,059 | WCPP | Prohibition | |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $688,354 | $688,354 | Prohibition | Prohibition | |
| Recycling and Disposal | $770,090 | $770,090 | WCPP | WCPP | |
| Incorporation into Adhesive and Sealant Products | accounted for under end-use categories | | | | |
| Incorporation into other formulation, mixture, or reaction products (aerosol) |
| Incorporation into other formulation, mixture, or reaction products (other) |
| Laboratory Chemicals | $350 | $113,342 | Prescriptive Controls | WCPP | |
| Processing Aid, except petrochemical | $32,309 | $32,309 | WCPP | Prohibition | |
| Adhesives and Sealants | $181,033 | $181,033 | Prohibition3 | Prohibition | |
| Paint and Coatings | $4,271 | $4,271 | Prohibition | Prohibition | |
| Aerosol Spray Cleaning/Degreasing | $975,851 | $975,851 | Prohibition | Prohibition | |
| Aerosol Spray Cleaning/Degreasing -EEC | $20,465,820 | $20,465,820 | Prescriptive Controls | Prohibition | |
| Liquid and Spray Batch Cold Cleaning | $4,474,303 | $4,474,303 | Prohibition | Prohibit | |
| Photographic Film Use | $362 | $362 | Prohibition | Prohibit | |
| Lubricants and Greases | $112,459 | $112,459 | Prohibition | Prohibit | |
| Wipe and Liquid Cleaning and Polishing | $33,603 | $33,603 | Prohibit | Prohibit | |
| Inks and Ink Removal | $4,259 | $4,259 | Prohibit | Prohibit | |
| Anti-Spatter Welding Aerosol | $8,780 | $8,780 | Prohibit | Prohibit | |
| Mold Cleaning, Release and Protectants | $25,147 | $25,147 | Prohibit | Prohibit | |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $109,327 | $43,571 | 10-Year Phase Out | 15-Year Phase Out | |
| **Total** | **$44,664,289** | **$64,714,312** |  |  | |
| 1Since the costs of prohibition are unknown, the WCPP costs are used as a proxy estimate for the prohibition costs. Note that WCPP costs should be lower than the cost of prohibition (because switching to an alternative is a viable compliance strategy under a WCPP requirement, so if it is the more cost-effective compliance strategy then firms are likely to switch to alternatives instead of following the WCPP requirements.  2 Vapor degreasing costs are lower under Option 2 compared to Option 1 because 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  3While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | |
| Table ES-6: Total 20-Year Annualized Costs by Use Category by Option (7% Discount Rate) | | | | | |
| Use Category | Option 1  (Final Rule) | Option 2  (Alternative Option) | Notes | | |
| Option 1  (Final Rule) | | Option 2  (Alternative Option |
| Manufacturing | $1,975,145 | $1,975,145 | WCPP | | WCPP |
| Import/Repackage | $203,245 | $203,245 | WCPP | | WCPP |
| Reactant/Intermediate | $382,587 | $382,587 | WCPP | | WCPP |
| Processing Aid in Petrochemical Manufacturing | $1,036,737 | $1,036,737 | WCPP | | WCPP |
| Production of Maskant for Chemical Milling | $43,275 | $43,275 | WCPP | | Prohibition1 |
| Use as Maskant for Chemical Milling | $1,421,354 | $1,421,354 | WCPP | | Prohibition1 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $13,724,146 | $34,274,791 | WCPP | | Prohibition2 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100,278 | $5,645,260 | WCPP | | Prohibition |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $921,980 | $921,980 | Prohibition | | Prohibition |
| Recycling and Disposal | $772,985 | $772,985 | WCPP | | WCPP |
| Incorporation into Adhesive and Sealant Products | accounted for under end-use categories | | | | |
| Incorporation into other formulation, mixture, or reaction products (aerosol) |
| Incorporation into other formulation, mixture, or reaction products (other) |
| Laboratory Chemicals | $480 | $114,001 | Prescriptive Controls | | WCPP |
| Processing Aid, except petrochemical | $32,167 | $32,167 | WCPP | | Prohibition |
| Adhesives and Sealants | $247,917 | $247,917 | Prohibition3 | | Prohibition |
| Paint and Coatings | $5,849 | $5,849 | Prohibition | | Prohibition |
| Aerosol Spray Cleaning/Degreasing | $1,336,383 | $1,336,383 | Prohibition | | Prohibition |
| Aerosol Spray Cleaning/Degreasing - EEC | $21,450,092 | $21,450,092 | Prescriptive Controls | | Prohibition |
| Liquid and Spray Batch Cold Cleaning | $5,992,873 | $5,992,873 | Prohibition | | Prohibition |
| Photographic Film Use | $495 | $495 | Prohibition | | Prohibition |
| Lubricants and Greases | $154,007 | $154,007 | Prohibition | | Prohibition |
| Wipe and Liquid Cleaning and Polishing | $46,018 | $46,018 | Prohibition | | Prohibition |
| Inks and Ink Removal | $5,832 | $5,832 | Prohibition | | Prohibition |
| Anti-Spatter Welding Aerosol | $12,024 | $12,024 | Prohibition | | Prohibition |
| Mold Cleaning, Release and Protectants | $34,438 | $34,438 | Prohibition | | Prohibition |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $127,794 | $37,934 | 10-Year Phase Out | | 15-Year Phase Out |
| **Total** | **$50,028,099** | **$76,147,387** |  | |  |
| 1Since the costs of prohibition are unknown, the WCPP costs are used as a proxy estimate for the prohibition costs. Note that WCPP costs should be lower than the cost of prohibition (because switching to an alternative is a viable compliance strategy under a WCPP requirement, so if it is the more cost-effective compliance strategy then firms are likely to switch to alternatives instead of following the WCPP requirements.  2Vapor degreasing costs are lower under Option 2 compared to Option 1 because 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  3While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | |

**Unquantified Costs**

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. Additional unquantified costs are discussed in more detail in section 7.14, but the most notable unquantified cost includes applications where PCE is more effective, reducing labor time and wait time, and this analysis was unable to quantify these costs. There may be some safety-critical applications, such as adhesives used in aviation, where alternatives would need to undergo extensive safety reviews and testing before they could replace the PCE adhesives. The impact of a prohibition of PCE for *these uses* could therefore lead to significant unquantified costs.

Estimated Incremental Benefits

The health benefits monetized in this analysis include the cancer endpoints considered in EPA’s ([2020h](#_ENREF_91)) risk evaluation: (1) liver cancer, (2) kidney cancer, (3) brain gliomas, and (3) testicular cancer. The benefits for reducing other health risks associated with PCE exposure were not estimated. The risk evaluation identified other potential health effects of PCE exposure, including neurotoxicity and central nervous system effects from acute exposures, and neurotoxicity effects, kidney and liver effects, immune system toxicity, reproductive toxicity, and developmental toxicity from chronic exposures. The most notable of these unmonetized effects was neurotoxicity, which included both subclinical effects (color confusion, decrements in visual reproduction, pattern memory, and pattern recognition) and clinical effects (higher rates of drug and alcohol use for those exposed to PCE in drinking water in utero or in early childhood). Reductions in PCE exposure therefore may be associated with important, but currently unmonetized, benefits.

Table ES-7 through Table ES-9 present the low and high estimates for the total monetized cancer benefits by option and use category, using 2, 3 and 7 percent discount rates. Low and high estimates were calculated using low and high willingness-to-pay estimates in the literature for non-fatal cancer cases. Benefits are presented in 2022 dollars.

| Table ES-7: Total 20-Year Annualized Benefits by Use Category and Option (2% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Low Estimate | | High Estimate | | Notes | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $89,704 | $89,704 | $232,529 | $232,529 | WCPP | WCPP |
| Import/Repackage | $1,307 | $1,307 | $3,387 | $3,387 | WCPP | WCPP |
| Reactant/Intermediate | $17,211 | $17,211 | $44,613 | $44,613 | WCPP | WCPP |
| Processing Aid in Petrochemical Manufacturing | $9,766 | $9,766 | $25,315 | $25,315 | WCPP | WCPP |
| Production of Maskant for Chemical Milling | $262 | $262 | $678 | $678 | WCPP | WCPP |
| Use as Maskant for Chemical Milling | $453,281 | $453,281 | $1,174,983 | $1,174,983 | WCPP | WCPP |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD)1 | $234,735 | $139,663 | $608,475 | $362,032 | WCPP | Prohibition |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD)1 | $177 | $306 | $459 | $793 | WCPP | Prohibition |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD)1 | $60,535 | $60,535 | $156,918 | $156,918 | Prohibition | Prohibition |
| Recycling and Disposal | $1,239 | $1,239 | $3,213 | $3,213 | WCPP | WCPP |
| Incorporation into Adhesive and Sealant Products2 | $5,376 | $5,376 | $13,934 | $13,934 | Prohibition2 | Prohibition |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | $186,838 | $187,078 | $484,316 | $484,938 | Prohibition except WCPP for EEC | Prohibition |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | $5,824 | $5,824 | $15,096 | $15,096 | Prohibition | Prohibition |
| Laboratory Chemicals | $0 | $1,253 | $0 | $3,249 | Prescriptive Controls | WCPP |
| Processing Aid, Except Petrochemical | $303 | $355 | $785 | $919 | WCPP | Prohibition |
| Adhesives and Sealants2 | $257,400 | $257,400 | $667,225 | $667,225 | Prohibition | Prohibition |
| Paint and Coatings | $67,395 | $67,395 | $174,700 | $174,700 | Prohibition | Prohibition |
| Aerosol Spray Cleaning/Degreasing except EEC | $11,290,762 | $11,290,762 | $29,312,620 | $29,312,620 | Prohibition | Prohibition |
| Aerosol Spray Cleaning/Degreasing - EEC | $10,735 | $10,954 | $27,869 | $28,438 | Prescriptive Controls | Prohibition |
| Liquid and Spray Batch Cold Cleaning | $89,431 | $89,431 | $231,821 | $231,821 | Prohibition | Prohibition |
| Photographic Film Use | $29,257 | $29,257 | $75,838 | $75,838 | Prohibition | Prohibition |
| Lubricants and Greases | $334,250 | $334,250 | $866,434 | $866,434 | Prohibition | Prohibition |
| Wipe and Liquid Cleaning and Polishing | $19,414,230 | $19,414,230 | $50,402,439 | $50,402,439 | Prohibition | Prohibition |
| Inks and Ink Removal | $4,437 | $4,437 | $11,501 | $11,501 | Prohibition | Prohibition |
| Anti-Spatter Welding Aerosol | $32,834 | $32,834 | $85,112 | $85,112 | Prohibition | Prohibition |
| Mold Cleaning, Release and Protectants | $853 | $853 | $2,210 | $2,210 | Prohibition | Prohibition |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $988 | $319 | $2,565 | $827 | 10-Year Phase Out | 15-Year Phase Out |
| **Total** | **$32,599,129** | **$32,505,280** | **$84,625,036** | **$84,381,764** |  |  |
| 1Vapor degreasing benefits are lower under Option 2 compared to Option 1 because 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  2While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Table ES-8: Total 20-Year Annualized Benefits by Use Category and Option (3% Discount Rate, 2022$) | | | | | | |
| Use Category | Low Estimate | | High Estimate | | Notes | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $73,522 | $73,522 | $202,735 | $202,735 | WCPP | WCPP |
| Import/Repackage | $1,071 | $1,071 | $2,953 | $2,953 | WCPP | WCPP |
| Reactant/Intermediate | $14,106 | $14,106 | $38,897 | $38,897 | WCPP | WCPP |
| Processing Aid in Petrochemical Manufacturing | $8,004 | $8,004 | $22,071 | $22,071 | WCPP | WCPP |
| Production of Maskant for Chemical Milling | $214 | $214 | $591 | $591 | WCPP | WCPP |
| Use as Maskant for Chemical Milling | $371,514 | $371,514 | $1,024,432 | $1,024,432 | WCPP | WCPP |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD)1 | $192,391 | $110,963 | $530,511 | $305,974 | WCPP | Prohibition |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD)1 | $145 | $243 | $401 | $670 | WCPP | Prohibition |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD)1 | $49,615 | $49,615 | $136,812 | $136,812 | Prohibition | Prohibition |
| Recycling and Disposal | $1,016 | $1,016 | $2,800 | $2,800 | WCPP | WCPP |
| Incorporation into Adhesive and Sealant Products2 | $4,406 | $4,406 | $12,149 | $12,149 | Prohibition2 | Prohibition |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | $153,134 | $153,331 | $422,260 | $422,803 | Prohibition except WCPP for EEC | Prohibition |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | $4,773 | $4,773 | $13,161 | $13,161 | Prohibition | Prohibition |
| Laboratory Chemicals | $0 | $1,027 | $0 | $2,833 | Prescriptive Controls | WCPP |
| Processing Aid, Except Petrochemical | $248 | $291 | $685 | $802 | WCPP | Prohibition |
| Adhesives and Sealants3 | $210,967 | $210,967 | $581,733 | $581,733 | Prohibition | Prohibition |
| Paint and Coatings | $55,238 | $55,238 | $152,316 | $152,316 | Prohibition | Prohibition |
| Aerosol Spray Cleaning/Degreasing except EEC | $9,250,784 | $9,250,784 | $25,549,178 | $25,549,178 | Prohibition | Prohibition |
| Aerosol Spray Cleaning/Degreasing - EEC | $8,795 | $8,975 | $24,291 | $24,787 | Prescriptive Controls | Prohibition |
| Liquid and Spray Batch Cold Cleaning | $73,299 | $73,299 | $202,118 | $202,118 | Prohibition | Prohibition |
| Photographic Film Use | $23,979 | $23,979 | $66,121 | $66,121 | Prohibition | Prohibition |
| Lubricants and Greases | $273,955 | $273,955 | $755,418 | $755,418 | Prohibition | Prohibition |
| Wipe and Liquid Cleaning and Polishing | $15,906,531 | $15,906,531 | $43,931,278 | $43,931,278 | Prohibition | Prohibition |
| Inks and Ink Removal | $3,637 | $3,637 | $10,028 | $10,028 | Prohibition | Prohibition |
| Anti-Spatter Welding Aerosol | $26,911 | $26,911 | $74,206 | $74,206 | Prohibition | Prohibition |
| Mold Cleaning, Release and Protectants | $699 | $699 | $1,927 | $1,927 | Prohibition | Prohibition |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $775 | $242 | $2,139 | $669 | 10-Year Phase Out | 15-Year Phase Out |
| **Total** | **$26,709,730** | **$26,629,312** | **$73,761,211** | **$73,539,462** |  |  |
| 1Vapor degreasing benefits are lower under Option 2 compared to Option 1 because 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  2While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | | |

| Table ES-9: Total 20-Year Annualized Benefits by Use Category and Option (7% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Low Estimate | | High Estimate | | Notes | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $38,259 | $38,259 | $129,911 | $129,911 | WCPP | WCPP |
| Import/Repackage | $557 | $557 | $1,892 | $1,892 | WCPP | WCPP |
| Reactant/Intermediate | $7,340 | $7,340 | $24,925 | $24,925 | WCPP | WCPP |
| Processing Aid in Petrochemical Manufacturing | $4,165 | $4,165 | $14,143 | $14,143 | WCPP | WCPP |
| Production of Maskant for Chemical Milling | $112 | $112 | $379 | $379 | WCPP | WCPP |
| Use as Maskant for Chemical Milling | $193,324 | $193,324 | $656,450 | $656,450 | WCPP | WCPP |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD)1 | $100,114 | $50,933 | $339,948 | $172,947 | WCPP | Prohibition |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD)1 | $76 | $112 | $257 | $379 | WCPP | Prohibition |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD)1 | $25,818 | $25,818 | $87,669 | $87,669 | Prohibition | Prohibition |
| Recycling and Disposal | $530 | $530 | $1,795 | $1,795 | WCPP | WCPP |
| Incorporation into Adhesive and Sealant Products2 | $2,293 | $2,293 | $7,785 | $7,785 | Prohibition2 | Prohibition |
| Incorp. into Formulation, Mixture, and Reaction Products (Aerosol) | $79,686 | $79,788 | $270,582 | $270,930 | Prohibition except WCPP for EEC | Prohibition |
| Incorp. into Formulation, Mixture, and Reaction Products (Other) | $2,484 | $2,484 | $8,434 | $8,434 | Prohibition | Prohibition |
| Laboratory Chemicals | $0 | $535 | $0 | $1,815 | Prescriptive Controls | WCPP |
| Processing Aid, Except Petrochemical | $129 | $151 | $439 | $514 | WCPP | Prohibition |
| Adhesives and Sealants3 | $109,781 | $109,781 | $372,771 | $372,771 | Prohibition | Prohibition |
| Paint and Coatings | $28,744 | $28,744 | $97,603 | $97,603 | Prohibition | Prohibition |
| Aerosol Spray Cleaning/Degreasing except EEC | $4,866,615 | $4,866,615 | $16,420,554 | $16,420,554 | Prohibition | Prohibition |
| Aerosol Spray Cleaning/Degreasing - EEC | $4,627 | $4,721 | $15,612 | $15,931 | Prescriptive Controls | Prohibition |
| Liquid and Spray Batch Cold Cleaning | $38,142 | $38,142 | $129,516 | $129,516 | Prohibition | Prohibition |
| Photographic Film Use | $12,478 | $12,478 | $42,370 | $42,370 | Prohibition | Prohibition |
| Lubricants and Greases | $142,557 | $142,557 | $484,067 | $484,067 | Prohibition | Prohibition |
| Wipe and Liquid Cleaning and Polishing | $8,368,043 | $8,368,043 | $28,234,800 | $28,234,800 | Prohibition | Prohibition |
| Inks and Ink Removal | $1,892 | $1,892 | $6,426 | $6,426 | Prohibition | Prohibition |
| Anti-Spatter Welding Aerosol | $14,004 | $14,004 | $47,551 | $47,551 | Prohibition | Prohibition |
| Mold Cleaning, Release and Protectants | $364 | $364 | $1,235 | $1,235 | Prohibition | Prohibition |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $335 | $92 | $1,130 | $312 | 10-Year Phase Out | 15-Year Phase Out |
| **Total** | **$14,042,468** | **$13,993,833** | **$47,398,242** | **$47,233,101** |  |  |
| 1Vapor degreasing benefits are lower under Option 2 compared to Option 1 because 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  2While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | | |

Estimated Incremental Net Benefits

Quantified net benefits are estimated by subtracting the total annualized quantified cost of the options (see Chapter 7) from the total annualized quantified benefits (see Chapter 8). Total quantified costs reflect costs of compliance with the options, including requirements for prohibition, dermal protection, and WCPP/ECEL, for those uses where costs could be estimated.

Note that the costs of prohibition are not fully quantified for some uses, so they are estimated using the costs under a WCPP as a proxy for the prohibition costs. Since switching to alternatives is an available compliance strategy under the uses with a WCPP requirement option, it is reasonable to assume that affected entities would simply switch to alternatives if it were less costly to switch compared to the costs of compliance with a WCPP. Thus, it is possible that the WCPP compliance costs are overstated if there are instances where switching to alternatives is less costly. It follows that compliance costs under a prohibition would exceed the costs of compliance with a WCPP.

Total quantified benefits reflect the benefits of reduced risk for kidney, liver, brain gliomas, and testicular cancer.

Table ES-10 through Table ES-15 present the net benefits by use category estimated using 2, 3, and 7 percent discount rate and using the low and high benefits estimates. Table ES-16 summarizes the six net benefits estimates.[[1]](#footnote-3)

Note that as discussed in Chapter 7, section 7.14, there are additional unquantified costs that affect all options. Similarly, Chapter 8 notes that there are also unquantified benefits. Unquantified benefits are mostly subclinical but may be associated with important neurotoxic endpoints like reduction in impaired cognition and in drug and alcohol abuse for those exposed in utero or in early childhood. 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 options.

| s | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $1,996 | $1,996 | $90 | $90 | ($1,906) | ($1,906) |
| Import/Repackage | $204 | $204 | $1 | $1 | ($203) | ($203) |
| Reactant/Intermediate | $386 | $386 | $17 | $17 | ($369) | ($369) |
| Processing Aid in Petrochemical Manufacturing | $1,042 | $1,042 | $10 | $10 | ($1,033) | ($1,033) |
| Production of Maskant for chemical milling | $44 | $44 | $0 | $0 | ($43) | ($43) |
| Use as Maskant for Chemical Milling | $1,428 | $1,428 | $453 | $453 | ($975) | ($975) |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $11,093 | $25,553 | $235 | $140 | ($10,858) | ($25,414) |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100 | $4,209 | $0 | $0 | ($100) | ($4,208) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $635 | $635 | $61 | $61 | ($574) | ($574) |
| Recycling and Disposal | $769 | $769 | $1 | $1 | ($768) | ($768) |
| Laboratory Chemicals | $0 | $113 | $0 | $1 | ($0) | ($112) |
| Processing Aid, except petrochemical | $32 | $32 | $0 | $0 | ($32) | ($32) |
| Adhesives and Sealants | $166 | $166 | $263 | $263 | $97 | $97 |
| Paint and Coatings | $4 | $4 | $68 | $68 | $64 | $64 |
| Aerosol Spray Cleaning/Degreasing except EEC | $893 | $893 | $11,435 | $11,435 | $10,542 | $10,542 |
| Aerosol Spray Cleaning/Degreasing - EEC | $20,240 | $20,240 | $54 | $54 | ($20,186) | ($20,186) |
| Liquid and Spray Batch Cold Cleaning | $4,125 | $4,125 | $89 | $89 | ($4,036) | ($4,036) |
| Photographic Film Use | $0 | $0 | $29 | $29 | $29 | $29 |
| Lubricants and Greases | $103 | $103 | $338 | $338 | $235 | $235 |
| Wipe and Liquid Cleaning and Polishing | $31 | $31 | $19,415 | $19,415 | $19,384 | $19,384 |
| Inks and Ink Removal | $4 | $4 | $5 | $5 | $1 | $1 |
| Anti-Spatter Welding Aerosol | $8 | $8 | $33 | $33 | $25 | $25 |
| Mold Cleaning, Release and Protectants | $23 | $23 | $2 | $2 | ($21) | ($21) |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $106 | $45 | $1 | $1 | ($105) | ($45) |
| **Total** | **$43,432** | **$62,054** | **$32,599** | **$32,505** | **($10,833)** | **($29,548)** |

| Table ES-11: Total 20-Year Annualized Net Benefits by Use Category and Option (High Benefits Estimate, 2 Percent Discount Rate, 2022$, $1,000s) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $1,996 | $1,996 | $233 | $233 | ($1,763) | ($1,763) |
| Import/Repackage | $204 | $204 | $3 | $3 | ($201) | ($201) |
| Reactant/Intermediate | $386 | $386 | $45 | $45 | ($341) | ($341) |
| Processing Aid in Petrochemical Manufacturing | $1,042 | $1,042 | $25 | $25 | ($1,017) | ($1,017) |
| Production of Maskant for chemical milling | $44 | $44 | $1 | $1 | ($43) | ($43) |
| Use as Maskant for Chemical Milling | $1,428 | $1,428 | $1,175 | $1,175 | ($253) | ($253) |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $11,093 | $25,553 | $608 | $362 | ($10,484) | ($25,191) |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100 | $4,209 | $0 | $1 | ($100) | ($4,208) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $635 | $635 | $157 | $157 | ($478) | ($478) |
| Recycling and Disposal | $769 | $769 | $3 | $3 | ($766) | ($766) |
| Laboratory Chemicals | $0 | $113 | $0 | $3 | ($0) | ($110) |
| Processing Aid, except petrochemical | $32 | $32 | $1 | $1 | ($32) | ($31) |
| Adhesives and Sealants | $166 | $166 | $681 | $681 | $516 | $516 |
| Paint and Coatings | $4 | $4 | $175 | $175 | $171 | $171 |
| Aerosol Spray Cleaning/Degreasing except EEC | $893 | $893 | $29,686 | $29,686 | $28,793 | $28,793 |
| Aerosol Spray Cleaning/Degreasing - EEC | $20,240 | $20,240 | $139 | $140 | ($20,100) | ($20,100) |
| Liquid and Spray Batch Cold Cleaning | $4,125 | $4,125 | $232 | $232 | ($3,893) | ($3,893) |
| Photographic Film Use | $0 | $0 | $76 | $76 | $76 | $76 |
| Lubricants and Greases | $103 | $103 | $875 | $875 | $772 | $772 |
| Wipe and Liquid Cleaning and Polishing | $31 | $31 | $50,405 | $50,405 | $50,374 | $50,374 |
| Inks and Ink Removal | $4 | $4 | $12 | $12 | $8 | $8 |
| Anti-Spatter Welding Aerosol | $8 | $8 | $86 | $86 | $78 | $78 |
| Mold Cleaning, Release and Protectants | $23 | $23 | $4 | $4 | ($19) | ($19) |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $106 | $45 | $4 | $2 | ($103) | ($43) |
| **Total** | **$43,432** | **$62,054** | **$84,625** | **$84,382** | **$41,193** | **$22,328** |

| Table ES-12: Total 20-Year Annualized Net Benefits by Use Category and Option (Low Benefits Estimate, 3 Percent Discount Rate, 2022$, $1,000s) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $1,992 | $1,992 | $74 | $74 | ($1,918) | ($1,918) |
| Import/Repackage | $204 | $204 | $1 | $1 | ($203) | ($203) |
| Reactant/Intermediate | $385 | $385 | $14 | $14 | ($371) | ($371) |
| Processing Aid in Petrochemical Manufacturing | $1,041 | $1,041 | $8 | $8 | ($1,033) | ($1,033) |
| Production of Maskant for chemical milling | $44 | $44 | $0 | $0 | ($43) | ($43) |
| Use as Maskant for Chemical Milling | $1,427 | $1,427 | $372 | $372 | ($1,056) | ($1,056) |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $11,585 | $27,206 | $192 | $111 | ($11,392) | ($27,095) |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100 | $4,481 | $0 | $0 | ($100) | ($4,481) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $688 | $688 | $50 | $50 | ($639) | ($639) |
| Recycling and Disposal | $770 | $770 | $1 | $1 | ($769) | ($769) |
| Laboratory Chemicals | $0 | $113 | $0 | $1 | ($0) | ($112) |
| Processing Aid, except petrochemical | $32 | $32 | $0 | $0 | ($32) | ($32) |
| Adhesives and Sealants | $181 | $181 | $215 | $215 | $34 | $34 |
| Paint and Coatings | $4 | $4 | $55 | $55 | $51 | $51 |
| Aerosol Spray Cleaning/Degreasing except EEC | $976 | $976 | $9,369 | $9,369 | $8,393 | $8,393 |
| Aerosol Spray Cleaning/Degreasing - EEC | $20,466 | $20,466 | $44 | $44 | ($20,422) | ($20,422) |
| Liquid and Spray Batch Cold Cleaning | $4,474 | $4,474 | $73 | $73 | ($4,401) | ($4,401) |
| Photographic Film Use | $0 | $0 | $24 | $24 | $24 | $24 |
| Lubricants and Greases | $112 | $112 | $277 | $277 | $164 | $164 |
| Wipe and Liquid Cleaning and Polishing | $34 | $34 | $15,907 | $15,907 | $15,874 | $15,874 |
| Inks and Ink Removal | $4 | $4 | $4 | $4 | ($1) | ($1) |
| Anti-Spatter Welding Aerosol | $9 | $9 | $27 | $27 | $18 | $18 |
| Mold Cleaning, Release and Protectants | $25 | $25 | $1 | $1 | ($24) | ($24) |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $109 | $44 | $1 | $1 | ($108) | ($43) |
| **Total** | **$44,664** | **$64,714** | **$26,710** | **$26,629** | **($17,955)** | **($38,085)** |

| Table ES-13: Total 20-Year Annualized Net Benefits by Use Category and Option (High Benefits Estimate, 3 Percent Discount Rate, 2022$, $1,000s) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $1,992 | $1,992 | $203 | $203 | ($1,789) | ($1,789) |
| Import/Repackage | $204 | $204 | $3 | $3 | ($201) | ($201) |
| Reactant/Intermediate | $385 | $385 | $39 | $39 | ($346) | ($346) |
| Processing Aid in Petrochemical Manufacturing | $1,041 | $1,041 | $22 | $22 | ($1,019) | ($1,019) |
| Production of Maskant for chemical milling | $44 | $44 | $1 | $1 | ($43) | ($43) |
| Use as Maskant for Chemical Milling | $1,427 | $1,427 | $1,024 | $1,024 | ($403) | ($403) |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $11,585 | $27,206 | $531 | $306 | ($11,054) | ($26,900) |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100 | $4,481 | $0 | $1 | ($100) | ($4,480) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $688 | $688 | $137 | $137 | ($552) | ($552) |
| Recycling and Disposal | $770 | $770 | $3 | $3 | ($767) | ($767) |
| Laboratory Chemicals | $0 | $113 | $0 | $3 | ($0) | ($111) |
| Processing Aid, except petrochemical | $32 | $32 | $1 | $1 | ($32) | ($32) |
| Adhesives and Sealants | $181 | $181 | $594 | $594 | $413 | $413 |
| Paint and Coatings | $4 | $4 | $153 | $153 | $148 | $148 |
| Aerosol Spray Cleaning/Degreasing except EEC | $976 | $976 | $25,874 | $25,875 | $24,899 | $24,899 |
| Aerosol Spray Cleaning/Degreasing - EEC | $20,466 | $20,466 | $121 | $122 | ($20,345) | ($20,344) |
| Liquid and Spray Batch Cold Cleaning | $4,474 | $4,474 | $202 | $202 | ($4,272) | ($4,272) |
| Photographic Film Use | $0 | $0 | $66 | $66 | $66 | $66 |
| Lubricants and Greases | $112 | $112 | $763 | $763 | $650 | $650 |
| Wipe and Liquid Cleaning and Polishing | $34 | $34 | $43,933 | $43,933 | $43,900 | $43,900 |
| Inks and Ink Removal | $4 | $4 | $10 | $10 | $6 | $6 |
| Anti-Spatter Welding Aerosol | $9 | $9 | $75 | $75 | $66 | $66 |
| Mold Cleaning, Release and Protectants | $25 | $25 | $4 | $4 | ($22) | ($22) |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $109 | $44 | $3 | $2 | ($106) | ($42) |
| **Total** | **$44,664** | **$64,714** | **$73,761** | **$73,539** | **$29,097** | **$8,825** |

| Table ES-14: Total 20-Year Annualized Net Benefits by Use Category and Option (Low Benefits Estimate, 7 Percent Discount Rate, 2022$, $1,000s) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $1,975 | $1,975 | $38 | $38 | ($1,937) | ($1,937) |
| Import/Repackage | $203 | $203 | $1 | $1 | ($203) | ($203) |
| Reactant/Intermediate | $383 | $383 | $7 | $7 | ($375) | ($375) |
| Processing Aid in Petrochemical Manufacturing | $1,037 | $1,037 | $4 | $4 | ($1,033) | ($1,033) |
| Production of Maskant for chemical milling | $43 | $43 | $0 | $0 | ($43) | ($43) |
| Use as Maskant for Chemical Milling | $1,421 | $1,421 | $193 | $193 | ($1,228) | ($1,228) |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $13,724 | $34,275 | $100 | $51 | ($13,624) | ($34,224) |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100 | $5,645 | $0 | $0 | ($100) | ($5,645) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $922 | $922 | $26 | $26 | ($896) | ($896) |
| Recycling and Disposal | $773 | $773 | $1 | $1 | ($772) | ($772) |
| Laboratory Chemicals | $0 | $114 | $0 | $1 | ($0) | ($113) |
| Processing Aid, except petrochemical | $32 | $32 | $0 | $0 | ($32) | ($32) |
| Adhesives and Sealants | $248 | $248 | $112 | $112 | ($136) | ($136) |
| Paint and Coatings | $6 | $6 | $29 | $29 | $23 | $23 |
| Aerosol Spray Cleaning/Degreasing except EEC | $1,336 | $1,336 | $4,928 | $4,928 | $3,592 | $3,592 |
| Aerosol Spray Cleaning/Degreasing - EEC | $21,450 | $21,450 | $23 | $23 | ($21,427) | ($21,427) |
| Liquid and Spray Batch Cold Cleaning | $5,993 | $5,993 | $38 | $38 | ($5,955) | ($5,955) |
| Photographic Film Use | $0 | $0 | $12 | $12 | $12 | $12 |
| Lubricants and Greases | $154 | $154 | $144 | $144 | ($10) | ($10) |
| Wipe and Liquid Cleaning and Polishing | $46 | $46 | $8,368 | $8,368 | $8,322 | $8,322 |
| Inks and Ink Removal | $6 | $6 | $2 | $2 | ($4) | ($4) |
| Anti-Spatter Welding Aerosol | $12 | $12 | $14 | $14 | $2 | $2 |
| Mold Cleaning, Release and Protectants | $34 | $34 | $1 | $1 | ($34) | ($34) |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $128 | $38 | $0 | $0 | ($127) | ($38) |
| **Total** | **$50,028** | **$76,147** | **$14,042** | **$13,994** | **($35,986)** | **($62,154)** |

| Table ES-15: Total 20-Year Annualized Net Benefits by Use Category and Option (High Benefits Estimate, 7 Percent Discount Rate, 2022$, $1,000s) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $1,975 | $1,975 | $130 | $130 | ($1,845) | ($1,845) |
| Import/Repackage | $203 | $203 | $2 | $2 | ($201) | ($201) |
| Reactant/Intermediate | $383 | $383 | $25 | $25 | ($358) | ($358) |
| Processing Aid in Petrochemical Manufacturing | $1,037 | $1,037 | $14 | $14 | ($1,023) | ($1,023) |
| Production of Maskant for chemical milling | $43 | $43 | $0 | $0 | ($43) | ($43) |
| Use as Maskant for Chemical Milling | $1,421 | $1,421 | $656 | $656 | ($765) | ($765) |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $13,724 | $34,275 | $340 | $173 | ($13,384) | ($34,102) |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100 | $5,645 | $0 | $0 | ($100) | ($5,645) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $922 | $922 | $88 | $88 | ($834) | ($834) |
| Recycling and Disposal | $773 | $773 | $2 | $2 | ($771) | ($771) |
| Laboratory Chemicals | $0 | $114 | $0 | $2 | ($0) | ($112) |
| Processing Aid, except petrochemical | $32 | $32 | $0 | $1 | ($32) | ($32) |
| Adhesives and Sealants | $248 | $248 | $381 | $381 | $133 | $133 |
| Paint and Coatings | $6 | $6 | $98 | $98 | $92 | $92 |
| Aerosol Spray Cleaning/Degreasing except EEC | $1,336 | $1,336 | $16,629 | $16,629 | $15,293 | $15,293 |
| Aerosol Spray Cleaning/Degreasing - EEC | $21,450 | $21,450 | $78 | $78 | ($21,372) | ($21,372) |
| Liquid and Spray Batch Cold Cleaning | $5,993 | $5,993 | $130 | $130 | ($5,863) | ($5,863) |
| Photographic Film Use | $0 | $0 | $42 | $42 | $42 | $42 |
| Lubricants and Greases | $154 | $154 | $489 | $489 | $335 | $335 |
| Wipe and Liquid Cleaning and Polishing | $46 | $46 | $28,236 | $28,236 | $28,190 | $28,190 |
| Inks and Ink Removal | $6 | $6 | $7 | $7 | $1 | $1 |
| Anti-Spatter Welding Aerosol | $12 | $12 | $48 | $48 | $36 | $36 |
| Mold Cleaning, Release and Protectants | $34 | $34 | $2 | $2 | ($32) | ($32) |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $128 | $38 | $2 | $1 | ($126) | ($37) |
| **Total** | **$50,028** | **$76,147** | **$47,398** | **$47,233** | **($2,630)** | **($28,914)** |

| Table ES-16: Total 20-Year Annualized Net Benefits by Option, (Millions, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Estimate | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Low Benefits, 2 Percent Discount Rate | $43 | $62 | $33 | $33 | ($11) | ($30) |
| High Benefits, 2 Percent Discount Rate | $43 | $62 | $85 | $84 | $41 | $22 |
| Low Benefits, 3 Percent Discount Rate | $45 | $65 | $27 | $27 | ($18) | ($38) |
| High Benefits, 3 Percent Discount Rate | $45 | $65 | $74 | $74 | $29 | $9 |
| Low Benefits, 7 Percent Discount Rate | $50 | $76 | $14 | $14 | ($36) | ($62) |
| High Benefits, 7 Percent Discount Rate | $50 | $76 | $47 | $47 | ($3) | ($29) |

Environmental Justice Impacts

EPA’s *Technical Guidance for Assessing Environmental Justice in Regulatory Analysis*[[2]](#footnote-4) 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](#_ENREF_75)). This analysis presents information about the facilities, workforce, and communities potentially affected by the regulatory options under current conditions before the final rule goes into effect. It draws on publicly available data provided by EPA, the U.S. Census, and the Centers for Disease Control and Prevention (CDC), including the Toxics Release Inventory (TRI), National Air Toxics Assessment (NATA), and the American Community Survey (ACS).

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 environmental justice (EJ) analysis first characterizes the average demographic characteristics of communities near all PCE 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.

In choosing COUs, EPA used TRI to highlight categories of point sources that might have significant fenceline exposure from air emissions. No point sources were found to have significant fenceline exposure from water emissions. Eight occupational exposure scenarios (OESs) had fenceline exposure from air emissions:

* Maskant for chemical milling
* Incorporation into formulation, mixture, or reaction product
* Industrial processing aid (mostly catalyst regeneration for petrochemical manufacturing)
* Metalworking fluids
* Other industrial uses – textile processing
* Degreasing (batch open-top degreasing, batch closed-loop degreasing, web vapor degreasing, and cold cleaning)
* Manufacturing (PCE)
* Processing as a reactant (mostly refrigerant manufacture)

EPA excluded metalworking fluids and other industrial uses – textile processing from this EJ analysis. Use of PCE in metalworking fluids only presented unreasonable risk for dermal exposure in the risk evaluation, so it was not included in the EJ analysis. Other industrial uses – textile manufacturing only had one site presenting unreasonable risk (Phifer Inc. Tuscaloosa, AL), and that site’s use may be atypical for their North American Industry Classification System (NAICS) code, so it was not included in the EJ analysis.[[3]](#footnote-5)

For all six of these OESs, EPA is presenting a more granular assessment of facilities and communities with possible fenceline exposure. This analysis also presents an assessment of worker demographics for five of these OESs (all but degreasing). The analysis excludes degreasing because degreasing could take place in a very wide variety of NAICS.

EPA also assessed worker demographics for dry cleaning. A large number of dry cleaning workers would be affected by this regulation, and the effects of this regulation on such workers would depend on the phaseout period of the final regulation (the final and alternate option include 10-year and 15-year, phaseouts respectively). Most dry cleaning workers are Black, Hispanic, or Asian, with higher percentages of workers relative to the U.S. population (see section 10.6.8).

PCE regulation will affect many other workers, but this assessment is limited to the workers noted above because most other uses will be prohibited under all options.

The benefits chapter 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 non-workers.

This analysis characterizes baseline conditions, so it does not provide information about the relative merits of the alternative regulatory options. The PCE Risk Evaluation found unreasonable risk for all conditions of use except for distribution in commerce. The regulatory options prohibit most uses of PCE. Several options would be controlled either in primary or alternative options with a WCPP. The uses assessed here would all be controlled by a WCPP, except dry cleaning, which is to be regulated via a phaseout of 10 or 15 years under the regulatory option.

The risk evaluation did not evaluate potential unreasonable risk beyond the fenceline for PCE. 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 more likely to be people of color than the general population in affected states, although this varied by use assessed.

Table ES-17 presents average information on communities surrounding all existing facilities – as identified in EPA’s 2019 TRI – 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 5-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 1, 3, and 5 miles of each facility. The table presents rural in addition to overall national statistics for comparison because 53 of the 210 facilities are located in 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 ES-17: Demographics of Communities within 1-, 3-, and 5-Mile Radii of PCE Facilities across All Conditions of Use, Population Weighted Averages | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $62,193 | $67,540 | $70,802 |
| **White** | 70.4% | 87.6% | 62.2% | 59.4% | 59.1% |
| **Black** | 12.6% | 5.8% | 15.9% | 17.1% | 17.1% |
| **American Indian** | 0.8% | 1.7% | 0.7% | 0.7% | 0.6% |
| **Asian** | 5.6% | 1.2% | 6.8% | 8.0% | 8.1% |
| **Pacific Islander** | 0.2% | 0.1% | 0.1% | 0.2% | 0.2% |
| **Other** | 10.3% | 3.6% | 14.2% | 14.6% | 14.9% |
| **Hispanic** | 18.2% | 2.4% | 25.0% | 28.6% | 28.3% |
| **2x Poverty Line** | 29.8% | 26.0% | 36.7% | 35.6% | 34.0% |
| **Below Poverty Line** | 12.8% | 9.6% | 16.3% | 16.1% | 15.5% |
| **Total Population** |  |  | 742,767 | 9,153,103 | 24,741,152 |
| **NATA Cancer Risk1** | 30 |  | 37 | 35 | 34 |
| **NATA Respiratory**  **Hazard Score2** | 0.44 |  | 0.41 | 0.42 | 0.43 |
| 1 NATA cancer risk is the probability of contracting cancer over the course of a lifetime (70 years) estimated from EPA’s National Air Toxics Assessment to general population from toxic air pollutants, expresses as risk per lifetime per million people.  2 NATA respiratory hazard score index is the sum of hazard indices for those air toxics with reference concentrations based on respiratory endpoints, where each hazard index is the ratio of exposure concentration in the air to the health-based reference concentration set by EPA. | | | | | |

Table ES-17 indicates that in general, communities within 1, 3 and 5 miles of PCE facilities have a higher proportion than national or rural averages of Black or African Americans, Hispanic Americans, Asian Americans, and Americans identifying as a race other than those listed in the table. Median incomes in such communities are not significantly different from national averages, but poverty rates tend to be higher. NATA cancer and respiratory hazard scores are similar to national averages.

The full analysis presented in section 10.6 also presents sociodemographic characteristics for 14 communities near individual facilities. These facilities were chosen for industries with a few facilities or for facilities that had a large number of nearby facilities reporting to TRI. This analysis chose facilities with fenceline risk, which was defined as inhalation risk above at least one benchmark at a distance of five meters or more from the site. In general, the results from individual facilities showed little fenceline risk. However, four facilities had possible fenceline risk over a kilometer away from the facility. Many more had possible fenceline risk at 100 meters from the facility.

|  |  |  |  |
| --- | --- | --- | --- |
| Table ES-18: Demographics of the Dry Cleaning Worker Population | | | |
| Demographic | National  Population | Employed Population | Dry Cleaning |
| **White** | 60% | 62% | 31% |
| **Black** | 13% | 12% | 24% |
| **Asian** | 7% | 7% | 9% |
| **Hispanic** | 19% | 18% | 35% |
| **Other** | 1% | 1% | 1% |
| **1.5x Poverty Line** | 81% | 90% | 73% |
| **1.25-1.5x Poverty Line** | 4% | 3% | 8% |
| **1-1.25x Poverty Line** | 4% | 2% | 6% |
| **Below Poverty Line** | 11% | 5% | 12% |
| Source: [U.S. Census Bureau 2010-2022](#_ENREF_62) | | | |

Table ES-18 shows demographics of the dry cleaning worker population, which is disproportionately Black and Hispanic. We do not have demographics of the overall employee population occupationally exposed to PCE.

Estimated Small Business Impacts

Table ES-19 presents a summary of the small business impacts overall and for each of the use categories where small business impacts were estimated. Affected vapor degreasing firms have the highest costs and therefore the largest proportion of small firms with impacts above 1 and 3 percent of revenues. Costs for reformulating products are large enough to exceed 1 and 3 percent of revenues for three and one firm, respectively. WCPP costs for Import/Repackage firms exceed 1 percent of revenues for 2 small firms.

| Table ES-19: Summary of Small Business Impacts | | | | | |
| --- | --- | --- | --- | --- | --- |
| Use Category | Number of Small Firms | Average Cost (2022$, Annualized, 7% Discount Rate) | Number and Percent of Firms by Cost-Revenue Impact Threshold | | |
| <1% | 1–3% | >3% |
| Manufacturing | 1 | $58,986 | 1 (100%) | - | - |
| Import/Repackage | 8 | $12,703 | 6 (75%) | 2 (25%) | - |
| Processing Aid in Petrochemical Manufacturing | 6 | $13,698 | 6 (100%) | - | - |
| Use as maskant for chemical milling | 69 | $20,019 | 69 (100%) | - | - |
| Vapor Degreasing | 10 | $139,641 | 4 (40%) | 3 (30%) | 3 (30%) |
| Recycling and Disposal | 87 | $8,223 | 87 (100%) | - | - |
| Incorporation into other formulation, mixture, and reaction products | 25 | $37,676 | 20 (80%) | 3 (12%) | 2 (8%) |
| Laboratory Chemicals | 24 | $18 | 24 (100%) | - | - |
| Adhesives and Sealants | 800 | $291 | 800 (100%) | - | - |
| Paint and Coatings | 28 | $8 | 28 (100%) | - | - |
| Aerosol Spray Cleaning/Degreasing | 26,050 | $50 | 26,050 (100%) | - | - |
| Aerosol Spray Cleaning/Degreasing - EEC | 119,523 | $176 | 119,523 (100%) | - | - |
| Liquid and Spray Batch Cold Cleaning | 13 | $8 | 13 (100%) | - | - |
| Photographic Film Use | 60 | $8 | 60 (100%) | - | - |
| Lubricants and Greases | 1,000 | $8 | 1,000 (100%) | - | - |
| Wipe and Liquid Cleaning and Polishing | 808 | $8 | 808 (100%) | - | - |
| Inks and Ink Removal | 28 | $8 | 28 (100%) | - | - |
| Anti-Spatter Welding Aerosol | 98 | $8 | 98 (100%) | - | - |
| Mold Cleaning, Release and Protectants | 96 | $8 | 96 (100%) | - | - |
| Dry Cleaning | 5,949 | $8 | 5,949 (100%) | - | - |
| **All Use Categories** | **154,683** | **$177** | **154,670 (99.99%)** | **8 (0.01%)** | **5 (0.003%)** |

Except for liquid and batch spray cold cleaning and dry cleaning machines, no cost impacts are estimated for users of products that contain PCE who will need to switch to alternative products that do not contain PCE (e.g., PCE aerosol spray cleaners and degreasers). As noted in Chapter 5, alternative products with similar costs and efficacy are generally available. However, in some cases some effort might be required by firms using PCE 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 in the Economic Analysis.

# Introduction

The U.S. Environmental Protection Agency (EPA) is undertaking rulemaking under section 6(a) of the Toxic Substances Control Act (TSCA) for perchloroethylene (PCE) after completing a risk evaluation and determining that the chemical substance presents unreasonable risk under the conditions of use (COUs). 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 PCE. EPA is finalizing the regulation under the authority granted by section 6 of TSCA. The final rule, “Regulation of Perchloroethylene Under TSCA Section 6(a),” addresses the unreasonable risk of injury to health from PCE under the conditions of use. These COUs are presented in Table 1‑1. Table 1‑1 also lists the use categories and defines how the economic analysis use categories map to the COUs. The use categories are the categories of PCE use that are considered in the economic analysis.

| Table 1‑1: Use Categories Considered in the Economic Analysis Mapped to the Conditions of Use (COUs) in the Risk Evaluation | |
| --- | --- |
| Use Category | Condition of Use (COU) |
| Manufacturing | Manufacturing (domestic manufacturing) |
| Import/Repackage | Manufacturing (import) |
| Repackaging |
| Reactant/Intermediate | Processing as a reactant/intermediate |
| Processing Aid in Petrochemical Manufacturing | Industrial and commercial use as a processing aid in catalyst regeneration in petrochemical manufacturing |
| Production of Maskant for Chemical Milling | Processing into formulation, mixture or reaction product in paint and coating products1 |
| Use as Maskant for Chemical Milling | Industrial and commercial use in paints and coatings in maskant for chemical milling |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Industrial and commercial use as solvent for open-top batch vapor degreaser |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) 2 | Industrial and commercial use as solvent for closed-loop batch vapor degreaser |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Industrial and commercial use as solvent for in-line conveyorized vapor degreaser |
| Vapor Degreasing: Web Vapor Degreasing (WVD) | Industrial and commercial use as solvent for in-line web cleaner vapor degreaser |
| Incorporation into adhesive and sealant products | Processing into formulation, mixture, or reaction product in adhesive and sealant products |
| Incorporation into other formulation, mixture, and reaction products3 | Processing into formulation, mixture or reaction product in other chemical products and preparations |
| Processing into formulation, mixture, or reaction product in cleaning and degreasing products |
| Processing into formulation, mixture, or reaction product in paint and coating products1 |
| Processing Aid, Except Petrochemical | Industrial and commercial use as a processing aid in sectors other than petrochemical manufacturing |
| Department of Defense (DOD) Uses | Industrial and commercial use in specialty DOD uses (oil analysis and water pipe repair) |
| Adhesives and Sealants | Industrial and commercial use in solvent-based adhesives and sealants |
| Consumer use in adhesives for arts and crafts (including industrial adhesive, arts and crafts adhesive, gun ammunition sealant) |
| Consumer use in adhesives for arts and crafts (livestock grooming adhesive) |
| Consumer use in adhesives for arts and crafts (column adhesive, caulk and sealant) |
| Paint and Coatings | Industrial and commercial use in solvent-based paints and coatings |
| Consumer use in solvent-based paints and coatings (outdoor water shield (liquid)) |
| Consumer use in solvent-based paints and coatings (coatings and primers (aerosol)) |
| Consumer use in solvent-based paints and coatings (rust primer and sealant (liquid)) |
| Consumer use in solvent-based paints and coatings (metallic overglaze) |
| Aerosol Spray Cleaning/Degreasing | Industrial and commercial use as solvent for aerosol spray degreaser/cleaner - General |
| Industrial and commercial use as solvent for aerosol spray degreaser/cleaner – Energized Electrical Cleaning |
| Consumer use in cleaners and degreasers (other) |
| Consumer use in automotive care products (brake cleaner) |
| Consumer use in automotive care products (parts cleaner) |
| Consumer use in aerosol cleaner (vandalism mark and stain remover) |
| Liquid and Spray Batch Cold Cleaning | Industrial and commercial use as solvent for cold cleaning |
| Photographic Film Use | Commercial use for photographic film |
| Lubricants and Greases | Industrial and commercial use as a solvent for aerosol lubricants |
| Industrial and commercial use as a solvent for penetrating lubricants and cutting tool coolants |
| Consumer use in lubricants and greases (cutting fluid) |
| Consumer use in lubricants and greases (lubricants and penetrating oils) |
| Wipe and Liquid Cleaning and Polishing | Industrial and commercial use in wipe cleaning |
| Industrial and commercial use in non-aerosol cleaner |
| Industrial and commercial use in automotive care products (e.g., engine degreaser and brake cleaner) |
| Industrial and commercial use in metal (e.g., stainless steel) and stone polishes |
| Consumer use in non-aerosol cleaner (e.g., marble and stone polish) |
| Consumer use in metal (e.g., stainless steel) and stone polishes |
| Spot Removers | Industrial and commercial use in other spot cleaning and spot removers, including carpet cleaning |
| Inks and Ink Removal | Commercial use in inks and ink removal products (based on printing) |
| Commercial use in inks and ink removal products (based on photocopying) |
| Consumer use in inks and ink removal products |
| Anti-Spatter Welding Aerosol | Industrial and commercial use in welding |
| Consumer use in welding |
| Mold Cleaning, Release and Protectants | Industrial and commercial use (in cleaning and furniture care products) for mold release |
| Commercial use in mold cleaning, release and protectant products |
| Consumer use in mold cleaning, release and protectant products |
| Dry Cleaning Machines | Industrial and commercial use in dry cleaning and spot cleaning post-2006 dry cleaning |
| Industrial and commercial use in dry cleaning and spot cleaning, 4th and 5th generation-only dry cleaning |
| Consumer use in dry cleaning solvent4 |
| Laboratory Chemicals | Industrial and commercial use in Laboratory Chemicals |
| Recycling and Disposal | Recycling |
| Disposal |
| Overlapping COUs | Industrial and commercial use in foundry applications |
| Industrial and commercial use in wood furniture manufacturing |
| Industrial and commercial use in other textile processing |
| 1This COU is mapped into two use categories to distinguish between paint and coatings products for chemical milling and other paint and coatings products.  2Closed-loop vapor degreasing includes batch closed-loop or airless vapor degreaser systems.  3Costs and benefits for processors that formulate products containing PCE are generally accounted for under the end use category for the product(s) they would need to reformulate under the options.  4This COU represents emissions from clothing or other textiles brought home by consumers after they were dry cleaned. | |

## Background

This final rule applies to PCE (CASRN 127-18-4). PCE is a colorless, volatile liquid with a mildly sweet odor that is produced in and imported into the United States. PCE is manufactured, processed, distributed, used, and disposed of as part of many industrial, commercial, and consumer COUs. PCE is used for the production of fluorinated compounds, as a solvent for dry cleaning and vapor degreasing, in catalyst regeneration in petrochemical manufacturing, and in a variety of commercial and consumer applications such as adhesives, paints and coatings, aerosol degreasers, brake cleaners, aerosol lubricants, sealants, stone polish, stainless steel polish, and wipe cleaners. According to the 2016 reporting year for Chemical Data Reporting, the total aggregate production volume of PCE in the United States decreased from 388 million pounds to around 324 million pounds between 2012 and 2015 ([EPA 2012-2015](#_ENREF_71)). The total aggregate production volume ranged from 250 to 500 million pounds between 2016 and 2019 according to Chemical Data Reporting ([EPA 2016-2019](#_ENREF_76)).

EPA determined that PCE presents an unreasonable risk of injury to health, without consideration of costs or other non-risk factors, including an unreasonable risk to potentially exposed or susceptible subpopulations identified as relevant to the risk evaluation by EPA, under the COUs. Accordingly, to address the identified unreasonable risk, EPA is finalizing, under TSCA section 6(a), to: (i) Prohibit most industrial and commercial uses and the manufacture (including import), processing, and distribution in commerce, of PCE for those uses; (ii) Prohibit the manufacture (including import), processing, and distribution in commerce of PCE for all consumer use; (iii) Prohibit the manufacture (including import), processing, distribution in commerce, and commercial use of PCE in dry cleaning and spot cleaning through a 10-year phaseout; (iv) Require a PCE Workplace Chemical Protection Program (WCPP), including an inhalation exposure concentration limit, direct dermal contact controls, and related workplace exposure controls for many occupational conditions of use of PCE not prohibited; (v) Require prescriptive workplace controls for laboratory use and energized electrical cleaner; (vi) Establish recordkeeping and downstream notification requirements; and (vii) Provide a 10-year time limited exemption under TSCA section 6(g) for certain emergency uses of PCE in furtherance of National Aeronautics and Space Administration’s (NASA) mission, for specific conditions of use which are critical or essential and for which no technically and economically feasible safer alternative is available; and (viii) Identify a regulatory threshold for products containing PCE for the prohibitions and restrictions on PCE.

## Options Analyzed

Under Option 1, EPA is finalizing under TSCA section 6(a) to: (i) Prohibit most industrial and commercial uses and the manufacture (including import), processing, and distribution in commerce, of PCE for those uses; (ii) Prohibit the manufacture (including import), processing, and distribution in commerce of PCE for all consumer use; (iii) Prohibit the manufacture (including import), processing, distribution in commerce, and commercial use of PCE in dry cleaning and spot cleaning through a 10-year phaseout; (iv) Require a PCE WCPP, including an inhalation exposure concentration limit, direct dermal contact controls, and related workplace exposure controls for many occupational conditions of use of PCE not prohibited; (v) Require prescriptive workplace controls for laboratory use and energized electrical cleaner; (vi) Establish recordkeeping and downstream notification requirements; and (vii) Provide a 10-year time limited exemption under TSCA section 6(g) for certain emergency uses of PCE in furtherance of National Aeronautics and Space Administration’s (NASA) mission, for specific conditions of use which are critical or essential and for which no technically and economically feasible safer alternative is available; and (viii) Identify a regulatory threshold for products containing PCE for the prohibitions and restrictions on PCE. See Unit IV. of the Final Rule for detailed descriptions of the provisions.

The primary alternative regulatory action (Option 2) considered by EPA combines prohibitions and requirements for a WCPP to address the unreasonable risk from PCE driven by the various COUs. While in some ways it is similar to Option 1, Option 2 differs from the final regulatory action mostly by prohibiting several more conditions of use, in some cases with 10-year section 6(g) exemptions for aerospace uses. Option 2 has a WCPP for laboratory uses instead of prescriptive controls. The alternative regulatory action additionally includes longer compliance timeframes for prohibitions and a WCPP.

All options prohibit the use of PCE unless it is expressly authorized by that particular option.

Table 1‑2 summarizes the options by use category.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 1‑2: Summary of Options by Use Category | | | |
| Use Category | | Option 1  (Final Rule) | Option 2  (Primary Alternative) |
| Manufacturing | | **WCPP** | **WCPP** |
| Import/Repackage | |
| Reactant/Intermediate | |
| Processing Aid in Petrochemical Manufacturing | |
| Production of Maskant for Chemical Milling | | **Prohibit**, with section 6(g) exemption for chemical milling of aircraft skins and prohibition in 10 years |
| Use as Maskant for Chemical Milling | |
| Vapor Degreasing | Open Top Vapor Degreasing (OTVD) | **Prohibit**, with section 6(g) exemption for aerospace uses and prohibition in 10 years |
| Enclosed Vapor Degreasing (EVD) |
| Conveyorized Vapor Degreasing (CVD) | **Prohibit** | **Prohibit** |
| Web Vapor Degreasing (WVD) |
| Recycling and Disposal | | **WCPP** | **WCPP** |
| Incorporation into adhesive and sealant products | | **WCPP** | **Prohibit** |
| Incorporation into Other Formulation, Mixture, and Reaction Products1 | | **WCPP** | **Prohibit** (with section 6(g) exemption for cleaning and degreasing products for aerospace use and prohibition in 10 years) |
| Laboratory Chemicals | | **PC** | **WCPP** |
| Processing Aid, Except Petrochemical | | **WCPP** | **Prohibit** |
| Adhesives and Sealants | | **WCPP** (for uses not prohibited) |
| Paint and Coatings | | **Prohibit** |
| Aerosol Spray Cleaning/Degreasing | | **PC** (for uses not prohibited) |
| Liquid and Spray Batch Cold Cleaning | | **Prohibit** |
| Photographic Film Use | |
| Lubricants and Greases | |
| Wipe and Liquid Cleaning and Polishing | |
| Spot Removers2 | |
| Inks and Ink Removal | |
| Anti-Spatter Welding Aerosol | |
| Mold Cleaning, Release and Protectants | |
| Dry Cleaning Machines | | 10-Year Phaseout | 15-Year Phaseout |
| Specialty DOD Uses (oil analysis and water pipe repair) | | **Prohibit** | **Prohibit** |
| Possibly Inactive COUs/Overlapping Tasks3 | |
| 1Costs and benefits for processors that formulate products containing PCE are generally accounted for under the end use category for the product(s) they would need to reformulate under the options.  2Options 1 and 2 have 10- and 15-year phaseouts for dry cleaning machines and spot removers by establishments with PCE dry cleaning machines, respectively.  3Includes textile processing, wood furniture manufacturing, foundry applications, welding.  Note: Use of PCE by Federal agencies and contractors acting for or on behalf of Federal agencies are subject to a different compliance timeframe not captured in our analyses.  Table abbreviations: Workplace Chemical Protection Program (WCPP); direct dermal contact controls (DDCC); Prescriptive controls with Monitoring, and Respiratory and Dermal PPE requirements (Prescriptive Controls, or PC). | | | |

## Organization of this Document

Chapter 2 presents a discussion of the problems with PCE 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 PCE identified by EPA and the producers of those products. Chapter 5 discusses the availability of alternatives for the different categories of PCE usage and considers the costs and efficacy of the available alternatives. Chapter 6 presents a baseline analysis of the volume of PCE consumption and the numbers of firms, employees, and consumers using PCE. The estimated costs, benefits, and net benefits of the options are presented in Chapter 7, 8, and 9, respectively. Chapter 10 presents various impact analyses, while Chapter 11 presents various sensitivity analyses. Finally, the references are listed in Chapter 12.

# Problem Definition/Market Failure

This report estimates and evaluates the costs and benefits expected to result from the rule limiting the use of PCE finalized 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, “Regulation of Perchloroethylene Under TSCA Section 6(a)” addresses the conditions of use presented above in Table 1‑1.

## Perchloroethylene Problem

### Sources of Exposure

Exposure to PCE occurs through the chemical’s conditions of use (COUs). TSCA Section 3 defines a chemical’s COUs as “the circumstances, as determined by the Administrator, under which a chemical substance is intended, known, or reasonably foreseen to be manufactured, processed, distributed in commerce, used, or disposed of.” EPA’s *Risk Evaluation for Perchloroethylene* evaluated whether exposure resulting from each of PCE’s COUs drives unreasonable risk to human and/or environmental health ([EPA 2020h](#_ENREF_91)).

### Health Effects of PCE Exposure

EPA’s analysis of the health effects of PCE and the magnitude of human exposure to PCE are in the 2020 risk evaluation for PCE ([EPA 2020h](#_ENREF_91)). A summary is presented here.

The 2020 risk evaluation for PCE identified potential health effects of PCE including non-cancer adverse health effects such as neurotoxicity and central nervous system effects, kidney and liver effects, immune system toxicity, reproductive toxicity, and developmental toxicity and cancer hazards from carcinogenicity as well as genotoxicity.

Among the non-cancer adverse health effects, EPA identified visual deficits indicative of neurotoxicity as a primary effect of PCE in humans following acute and chronic inhalation and dermal exposures. Identified symptoms of neurotoxicity include color confusion, changes in visual contrast detection, and alteration of visual-spatial function. Impaired visual function and diminished color discrimination are the most sensitive adverse effects of PCE exposure, making them one of the earliest signs of injury or other significant adverse effects. Additionally, the 2020 risk evaluation for PCE identified that PCE exposure is associated with several types of cancer, including liver tumors, brain gliomas, kidney cancer, and testicular cancer. By the criteria presented in EPA’s *Guidelines for Carcinogen Risk Assessment* ([EPA 2005](#_ENREF_69)), PCE is characterized as “likely to be carcinogenic to humans by all routes of exposure” based on conclusive evidence in mice and rats and suggestive evidence in humans.

Other adverse health effects identified in the 2020 risk evaluation for PCE include central nervous system depression, kidney nephrotoxicity and proximal tubule nuclear enlargement, liver necrosis and extreme dilation of blood or lymph vessels, reduced sperm quality, reduced red blood cells and hemoglobin, increased immune cells, decreased fetal/placental weight, developmental neurotoxicity, and skeletal effects from chronic exposures ([EPA 2020h](#_ENREF_91)).

### Regulatory Approaches for Primary and Alternative Options

Under TSCA section 6(a), if EPA 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 only a few were determined effective in addressing the identified unreasonable risk. The regulatory mechanisms that are being utilized as part of this rulemaking include the following:

1. **Prohibitions:** The rule includes specific prohibitions on PCE for the use categories indicated in as well a general prohibition on any use not specifically permitted under the rule.
2. **Workplace Chemical Protection Program (WCPP):** The rule includes a workplace chemical protection program that includes setting an exposure limit of 0.14 ppm (8-hr time-weighted average (TWA)) for the use categories indicated in Table 2‑1 ([EPA 2021](#_ENREF_94)). Firms would be required to monitor potentially exposed persons 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 PPE or other engineering controls.
3. **Prescriptive Controls:** With respect to dermal protection, this approach differs from a WCPP because it does not require the use of elimination, substitution, engineering controls and administrative controls or work practices, in accordance with the hierarchy of controls, to the extent feasible as a means of controlling dermal exposures to comply with the direct dermal contact controls (DDCC). With respect to inhalation exposure, this approach differs from the WCPP requirements in that it would require respirators where inhalation exposures exceed the ECEL based on exposure monitoring*.* The use of elimination, substitution, engineering controls and administrative controls or work practices, in accordance with the hierarchy of controls, to the extent feasible as a means of controlling inhalation exposures would not be required.

The regulatory actions that EPA chose for PCE under this rulemaking, as well as the primary alternative option and a second 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 the alternative options were considered in this Economic Analysis.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 2‑1: Summary of Options by Use Category | | | | |
| Use Category | | Option 1  (Final Rule) | Option 2  (Primary Alternative) |
| Manufacturing | | **WCPP** | **WCPP** |
| Import/Repackage | |
| Reactant/Intermediate | |
| Processing Aid in Petrochemical Manufacturing | |
| Production of Maskant for Chemical Milling | | **Prohibit**, with section 6(g) exemption for chemical milling of aircraft skins and prohibition in 10 years |
| Use as Maskant for Chemical Milling | |
| Vapor Degreasing | Open Top Vapor Degreasing (OTVD) | **Prohibit**, with section 6(g) exemption for aerospace uses and prohibition in 10 years |
| Enclosed Vapor Degreasing (EVD) |
| Conveyorized Vapor Degreasing (CVD) | **Prohibit** | **Prohibit** |
| Web Vapor Degreasing (WVD) |
| Recycling and Disposal | | **WCPP** | **WCPP** |
| Incorporation into adhesive and sealant products | | **WCPP** | **Prohibit** |
| Incorporation into Other Formulation, Mixture, and Reaction Products1 | | **WCPP** | **Prohibit** (with section 6(g) exemption for cleaning and degreasing products for aerospace use and prohibition in 10 years) |
| Laboratory Chemicals | | **PC** | **WCPP** |
| Processing Aid, Except Petrochemical | | **WCPP** | **Prohibit** |
| Adhesives and Sealants | | **WCPP** (for uses not prohibited) |
| Paint and Coatings | | **Prohibit** |
| Aerosol Spray Cleaning/Degreasing | | **PC** (for uses not prohibited) |
| Liquid and Spray Batch Cold Cleaning | | **Prohibit** |
| Photographic Film Use | |
| Lubricants and Greases | |
| Wipe and Liquid Cleaning and Polishing | |
| Spot Removers2 | |
| Inks and Ink Removal | |
| Anti-Spatter Welding Aerosol | |
| Mold Cleaning, Release and Protectants | |
| Dry Cleaning Machines | | 10-Year Phaseout | 15-Year Phaseout |
| Specialty DOD Uses (oil analysis and water pipe repair) | | **Prohibit** | **Prohibit** |
| Possibly Inactive COUs/Overlapping Tasks3 | |
| 1Costs and benefits for processors that formulate products containing PCE are generally accounted for under the end use category for the product(s) they would need to reformulate under the options.  2Options 1 and 2 have 10- and 15-year phaseouts for dry cleaning machines and spot remover use by establishments with PCE dry cleaning machines, respectively.  3Includes textile processing, wood furniture manufacturing, foundry applications, welding.  Table abbreviations: Workplace Chemical Protection Program (WCPP); direct dermal contact controls (DDCC); Prescriptive controls with Monitoring, and Respiratory and Dermal PPE requirements (Prescriptive Controls, or PC); personal protective equipment (PPE). | | | |

## Regulatory Background

PCE is subject to numerous federal laws and regulations in the United States and is also subject to regulatory actions by states and other countries. The following is a summary of the regulatory actions pertaining to PCE implemented by EPA, other federal agencies, states, and other countries or via international treaties and agreements. None of these actions addresses the unreasonable risk under TSCA that this rule would address. For a full description see Appendix A of the Risk Evaluation ([EPA 2020h](#_ENREF_91)).

### EPA Actions Pertaining to PCE

EPA has issued numerous rules and notices pertaining to PCE under its various authorities. PCE manufacturing (including importing), processing, and use information is reported under the Chemical Data Reporting (CDR) rule (85 FR 20122, April 9, 2020). PCE is also a listed substance subject to Toxics Release Inventory (TRI) reporting requirements pursuant to section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA), effective as of January 1, 1987 (40 CFR 372.65).

Related to pesticides, PCE was first registered as a conventional chemical in 1984 pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). EPA removed PCE from its list of inert ingredients used in pesticide products in 1998 (63 FR 34384, June 24, 1998).

Relative to releases to air, PCE is designated as a hazardous air pollutant (HAP) under the Clean Air Act (CAA) section 112(b)(1) (42 U.S. Code § 7412(b)(1)) and is considered an “urban air toxic” (CAA section 112(k)). Under section 112(d), EPA has established national emission standards for hazardous air pollutants (NESHAP) for a number of specific source categories that emit PCE, including dry cleaners (40 CFR part 63, subpart M; 73 FR 39871, July 11, 2008), synthetic organic chemical manufacturing (40 CFR part 63, subparts F, G, H and I; 59 FR 19402, April 22, 1994), miscellaneous organic chemical manufacturing (40 CFR part 63, subpart FFFF; 85 FR 49084, August 12, 2020), and aerospace manufacturing and rework facilities (40 CFR part 63, subpart GG; 80 FR 76151). Under Section 112(d) and 112(f), EPA has promulgated a number of risk and technology review (RTR) NESHAP, including the RTR NESHAP for PCE Dry Cleaning (40 CFR part 63, subpart M; 71 FR 42724, July 27, 2006) and the RTR NESHAP for Halogenated Solvent Cleaning (40 CFR part 63, subpart T; 72 FR 25138, May 3, 2007). Under CAA section 612, EPA’s Significant New Alternatives Policy (SNAP) program listed PCE as an acceptable substitute for methyl chloroform and CFC-113 in metals cleaning, electronics cleaning, and precision cleaning end-uses; as an acceptable substitute for CFC-11, CFC-113, methyl chloroform, and HCFC-141b as solvents in the aerosols sector; and as an acceptable substitute for methyl chloroform for use as a carrier solvent in adhesives, coatings, and inks (59 FR 13044, March 18, 1994). PCE is excluded from the definition of volatile organic compounds (VOC) under Clean Air Act regulations (see 40 CFR 51.100(s)) addressing the development of state implementation plans (SIPs) to attain and maintain the National Ambient Air Quality Standards (NAAQS).

PCE is also listed under the National Volatile Organic Compound Emission Standards for Aerosol Coatings (40 CFR part 59, subpart E). PCE is identified as a feedstock chemical for HFC production, including for HFC-125 and HFC-134a. These chemicals are listed as regulated substances under the American Innovation and Manufacturing Act of 2020 (AIM Act), which authorizes EPA to address HFCs in three main ways: phasing down production and consumption of regulated substances through an allowance allocation program; facilitating sector-based transitions to next-generation technologies; promulgating certain regulations for purposes of maximizing reclamation and minimizing releases of regulated substances and their substitutes from equipment and ensuring the safety of technicians and consumers. *See* 42 U.S.C. 7675. Subsection (e) of the AIM Act mandates a phasedown in the production and consumption of regulated substances by 85% over a period ending in 2036 and establishes a schedule for this phasedown. EPA has established regulations to begin implementing certain provisions of the AIM Act, including the production and consumption phasedown. (40 CFR part 84, subpart A; 86 FR 55116, October 5, 2021). Use of PCE as a feedstock for HFC production is expected to decline (absent a TSCA prohibition) over time as users move to more climate-friendly alternatives, but HFC-134a and HFC-125 may persist for certain uses.

Relative to releases to water, PCE is designated as a toxic pollutant under section 307(a)(1) of the Clean Water Act and as such is subject to effluent limitations. Also under section 304, PCE is included in the list of total toxic organics (TTO) (40 CFR 413.02(i)). In 2015, EPA published updated ambient water quality criteria for PCE, including recommendations for “water + organism” and “organism only” human health criteria for states and authorized tribes to consider when adopting criteria in their water quality standards (80 FR 36986, June 29, 2015). PCE is also subject to National Primary Drinking Water Regulations (NPDWR) under the Safe Drinking Water Act (SDWA) with a maximum contaminant level goal (MCLG) of zero and an enforceable maximum contaminant level (MCL) of 0.005 mg/L (40 CFR 141.50; 40 CFR 141.61).

In terms of environmental release reporting, PCE is listed as a hazardous substance under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), so that releases of PCE in excess of 100 pounds must be reported (40 CFR 302.4). Pursuant to the Resource Conservation and Recovery Act (RCRA) section 3001, PCE is identified as a characteristic and listed hazardous waste under the following RCRA Hazardous Waste Codes: D039 (Toxicity); F001, F002; and U210 (40 CFR 261.24(b), 261.31(a), 261.33(f)).

### Other Federal Regulations

In addition to EPA actions, PCE is also subject to other federal regulations. Under the Federal Hazardous Substances Act (FHSA), visual novelty devices containing PCE are regulated by the Consumer Product Safety Commission (CPSC) (16 CFR 1500.83(a)(31)). Under the Federal Food, Drug, and Cosmetic Act (FFDCA), the Food and Drug Administration (FDA) regulates PCE in bottled water and set the maximum permissible level of PCE in bottled water to 0.005 mg/L (21 CFR 165.110). Under the Occupational Safety and Health Act (OSH Act), the Occupational Safety and Health Administration (OSHA) established the permissible exposure limit (PEL) for PCE at 100 ppm as an 8-hour time-weighted average (TWA) with an acceptable ceiling concentration of 200 ppm and an acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift of 300 ppm, for a maximum duration of 5 minutes in any 3 hours. Under the Atomic Energy Act, the Department of Energy (DOE) Worker Safety and Health Program requires its contractor employees to use the 2005 American Conference of Governmental Industrial Hygienists (ACGIH®) threshold limit value (TLV®) for PCE, which is 25 ppm (8-hour TWA) and Short Term Exposure Limit (STEL) of 100 ppm. Under the Federal Hazardous Material Transportation Act, the Department of Transportation (DOT) has designated PCE as a hazardous material, and there are special requirements for marking, labeling, and transporting it (49 CFR Part 171, 49 CFR 172, and 49 CFR 173).

### State Regulations

Many states have also taken actions to reduce risks from PCE use. Numerous states list PCE as a chemical substance of high concern to children (e.g., Oregon, Vermont, Washington). Also, under the California Proposition 65 list (California Office of Environmental Health Hazard Assessment (OEHHA)), PCE is known to the state of California to cause cancer. Additionally, California has set a state workplace PEL of 25 ppm and a STEL of 100 ppm (California, OEHHA, 1988). Several states have also established State Right-to-Know Acts, including Massachusetts (454 CMR 21.00), New Jersey (42 N.J.R. 1709(a)), Pennsylvania (Chapter 323, Hazardous Substance List), Rhode Island (RI Gen. Laws Sec. 28-21- 1et seq).

Some states regulate PCE as a VOC, and these regulations may set VOC limits for consumer products and/or ban the sale of certain consumer products as an ingredient and/or impurity. Regulated products vary from state to state, and could include contact and aerosol adhesives, aerosols, electronic cleaners, footwear or leather care products, and general degreasers, among other products. Examples of states that have VOC regulations or limits for consumer products include Connecticut (R.C.S.A. Sections 22a-174-40, 22a-174-41, and 22a-174-44), Delaware (Adm. Code Title 7, 1141), District of Columbia (Rules 20-720, 20-721, 20-735, 20-736, 20737), Illinois (35 Adm Code 223), Indiana (326 IAC 8-15), and several more. The California Air Resources Board prohibits the manufacture and the distribution in commerce of most consumer products that contain PCE under the General Consumer Products Regulation; the use of PCE in penetrant products for energized electrical cleaning when electrical current exists, residual electrical potential of a component exists, or an open flame exists is not prohibited but is subject to labelling requirements (Title 17, California Code of Regulations, Division 3, Chapter 1, Subchapter 8.5, Articles 1, 2, 3 and 4). Some of these states also require emissions reporting.

Several states have also set restrictions or phaseouts on the use of PCE in dry cleaning. The California Air Resources Board adopted the Airborne Toxic Control Measure for Emission of PCE from Dry Cleaning Operations that is phasing out the use of PCE dry cleaning machines and related equipment by January 1, 2023 (Title 17, California Code of Regulations 39109 and 93110). The Minnesota Legislature passed a ban on the use of PCE as a dry cleaning solvent under state statute starting in 2026 (Minnesota HF 91). Some states also set forth requirements for equipment, operations, maintenance, recordkeeping, and reporting for PCE dry cleaning operations (e.g., California, Maine, Massachusetts, New York).

### International Regulations

Countries other than the United States also regulate PCE (Ref. Risk Evaluation). In the European Union (EU), PCE was evaluated through the Community Rolling Action Plan in 2013. Under the “Substance Evaluation Report for PCE,” the European Chemicals Agency concluded that no further regulatory action was required for PCE at the EU level.

In Canada, PCE is on the List of Toxic Substances of the Canadian Environmental Protection Act (CEPA) 1999 Schedule 1. CEPA regulates the use and sale of PCE for solvent degreasing under Solvent Degreasing Regulations to reduce releases of PCE into the environment from solvent degreasing facilities using more than 1,000 kgs of PCE per year (SOR/2003-283) (Canada Gazette, Part II on August 13, 2003). The regulation includes a market intervention by establishing tradable allowances for the use of PCE in solvent degreasing operations that exceed the 1,000 kgs threshold per year. CEPA also regulates the use and sale of PCE in the dry cleaning industry under the Use in Dry Cleaning and Reporting Requirements Regulations (Canada Gazette, Part II on March 12, 2003).

Several countries, including Australia, Belgium, Canada, Japan, and the European Union have occupational exposure limits for PCE (GESTIS database of international occupational exposure limit values for chemical agents, accessed April 18, 2017).

## Justification for Risk Management Action for PCE

This section provides legal and economic justification of the rule to regulate PCE 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 PCE 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.

### 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. 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, under the conditions of use, without consideration of costs or other non-risk factors, including an unreasonable risk to potentially exposed or susceptible subpopulations identified as relevant to the Risk Evaluation. If unreasonable risk is found, EPA is required to perform Risk Management.

### 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.[[4]](#footnote-6) 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); and
* Inadequate or asymmetric information.

This section discusses how negative externalities are present in the market for the chemical regulated under this rule.[[5]](#footnote-7) By understanding how the market is affected by this market failure, more effective regulations can be designed.

#### Externalities

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 user, they are not considered in the production (or processing or use) and pricing decisions. As a result, the societal cost of these goods is under-valued and the level of output produced (or processed or 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 PCE subject to this rule stems from negative externalities. 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 PCE are well established ([EPA 2020d](#_ENREF_87)), some effects are difficult to quantify in humans and to predict at the individual level. (EPA 2011). 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 PCE 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 external costs 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 for manufactures, processers, distributers, and users to internalize the external costs of PCE (for example, through 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 of varied conditions of use. Instead, EPA’s approach is to decrease the volume of PCE 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 and use of PCE. 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 and users of PCE 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 PCE 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 potentially Pareto optimal (that is, it would not meet the criteria for Kaldor-Hicks efficiency). Conversely, if post-rule, the cost to society from release and exposure to PCE remains greater than costs to regulated firms, the rule would also not produce a potentially Pareto optimal outcome.

### Regulatory Remedies to Reduce Negative Externalities

As discussed in Section 2.1.3, the final and alternative options detail various requirements that will reduce the negative human health costs associated with the negative externality. Prohibition of the chemical, direct dermal contact control (DDCC), Existing Chemical Exposure Limit (ECEL), and Monitoring and Hierarchy of Controls (HOC) requirements all reduce exposure of third parties to PCE. EPA contends that these measures are sufficient to reduce negative externalities associated with PCE.

### 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, and distributing these products to comply with a single federal standard rather than a patchwork of different state regulations.

# Profile of Affected Industries

Table 3‑1 shows the industry statistics for each NAICS code ([U.S. Census Bureau 2021](#_ENREF_65); [U.S. Bureau of Economic Analysis 2023b](#_ENREF_56); [U.S. Census Bureau 2022](#_ENREF_66)), indicates which use categories are applicable for each NAICS code, and presents the estimated numbers of firms and employment for firms defined as small businesses according to the U.S. Small Business Administration (SBA) definitions ([SBA 2023](#_ENREF_100)).

NAICS codes were identified for the use categories as follows:

* Manufacturing, reactant/intermediate, and processing aid NAICS codes were identified using 2020 CDR data ([EPA 2020h](#_ENREF_91)), 2020 TRI data ([EPA 2022b](#_ENREF_96)) and [Experian (2023)](#_ENREF_19) database.
* Adhesives and sealants, batch, liquid, and spray cold cleaning, lubricants and greases, mold release and protectants, paint and coatings, and recycling and disposal NAICS codes were identified using 2017 data from the National Emissions Inventory (NEI) ([EPA 2020a](#_ENREF_84)).
* Aerosol spray cleaning/degreasing, dry cleaning, and laboratory chemicals NAICS codes were identified in EPA’s risk evaluation ([EPA 2020h](#_ENREF_91)). Wipe and liquid cleaning and polishing NAICS codes were assumed to be the same as those for aerosol degreasing. Spot remover NAICS codes were assumed to be the same as those for dry cleaning.
* Incorporation into formulation; mixture or reaction product NAICS codes were identified through product searches (see Chapter 4).
* Anti-spatter welding aerosol NAICS codes were assumed to be the same as those identified in EPA’s Economic Analysis of the Proposed Regulation of Methylene Chloride Under TSCA Section 6(a) ([EPA 2023b](#_ENREF_98) ).
* NAICS codes for remaining use categories were selected based on EPA’s best judgement.

| Table 3‑1: Industry Statistics | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Use Categories | NAICS Codes | Small Business Definition | Number of Firms | | Number of Establish-ments | Employment | | Annual Payroll (thousands, 2022$) | Preliminary Receipts (thousands, 2022$) |
| All | SBA-Defined Small | All | SBA-Defined Small |
| Manufacturing; Import/Repackage; Processing as a Reactant; Processing Aid in Petrochemical Manufacturing | 211120: Crude Petroleum Extraction | 1,250 employees | 4,570 | 4,524 | 5,333 | 85,169 | 53,015 | $11,545,414 | $190,245,951 |
| Processing Aid in Petrochemical Manufacturing | 213112: Support Activities for Oil and Gas Operations | $47m revenue | 8,487 | 8,204 | 10,289 | 216,801 | 86,552 | $18,275,332 | $79,524,777 |
| Processing Aid in Petrochemical Manufacturing | 238220: Plumbing, Heating, and Air-Conditioning Contractors | $19m revenue | 100,692 | 98,716 | 102,455 | 1,015,585 | 659,110 | $77,944,175 | $243,433,130 |
| Mold Release and Protectants | 321911: Wood Window and Door Manufacturing | 1,000 employees | 961 | 932 | 1,110 | 54,943 | 20,728 | $2,898,130 | $14,511,558 |
| Paint and Coatings | 322220: Paper Bag and Coated and Treated Paper Manufacturing | 750 employees | 575 | 509 | 740 | 48,193 | 20,732 | $3,664,983 | $24,378,377 |
| Inks and Ink Removal | 323113: Commercial Screen Printing | 500 employees | 5,156 | 5,128 | 5,187 | 64,671 | 53,488 | $2,309,292 | $9,928,024 |
| Processing Aid in Petrochemical Manufacturing; Use as maskant for chemical milling | 324110: Petroleum Refineries | 1,500 employees | 70 | 44 | 155 | 63,594 | 5,381 | $9,271,375 | $564,621,024 |
| Mold Release and Protectants | 325110: Petrochemical Manufacturing | 1,300 employees | 28 | 17 | 44 | 9,369 | 1,691 | $1,451,530 | $62,487,259 |
| Use as maskant for chemical milling | 325120: Industrial Gas Manufacturing | 1,200 employees | 63 | 0 | 502 | 13,202 | 0 | $1,127,345 | $12,527,768 |
| Inks and Ink Removal; Incorporation into other formulation, mixture, and reaction products | 325130: Synthetic Dye and Pigment Manufacturing | 1,050 employees | 112 | 97 | 146 | 8,963 | 4,201 | $874,695 | $8,470,573 |
| Incorporation into other formulation, mixture, and reaction products; Import/Repackage; Use as maskant for chemical milling | 325180: Other Basic Inorganic Chemical Manufacturing | 1,000 employees | 363 | 302 | 626 | 39,878 | 16,307 | $4,302,104 | $37,713,525 |
| Mold Release and Protectants | 325199: All Other Basic Organic Chemical Manufacturing | 1,250 employees | 591 | 511 | 814 | 67,603 | 24,105 | $7,792,086 | $90,462,304 |
| Manufacturing; Import/Repackage | 325211: Plastics Material and Resin Manufacturing | 1,250 employees | 852 | 768 | 1,125 | 75,998 | 34,018 | $8,182,313 | $105,610,189 |
| Mold Release and Protectants | 325212: Synthetic Rubber Manufacturing | 1,000 employees | 140 | 114 | 154 | 9,661 | 5,065 | $1,058,325 | $9,903,243 |
| Batch, Liquid, and Spray Cold Cleaning | 325412: Pharmaceutical Preparation Manufacturing | 1,300 employees | 1,007 | 942 | 1,280 | 147,442 | 52,343 | $18,599,623 | $182,378,238 |
| Incorporation into other formulation, mixture, and reaction products | 325510: Paint and Coating Manufacturing | 1,000 employees | 998 | 964 | 1,197 | 39,139 | 22,907 | $2,959,292 | $32,379,306 |
| Incorporation into other formulation, mixture, and reaction products; Use as maskant for chemical milling | 325520: Adhesive Manufacturing | 550 employees | 403 | 346 | 559 | 24,231 | 9,109 | $1,946,620 | $17,451,529 |
| Incorporation into other formulation, mixture, and reaction products; Use as maskant for chemical milling | 325611: Soap and Other Detergent Manufacturing | 1,100 employees | 618 | 594 | 675 | 25,387 | 11,428 | $2,070,801 | $28,786,289 |
| Incorporation into other formulation, mixture, and reaction products; Use as maskant for chemical milling | 325612: Polish and Other Sanitation Good Manufacturing | 900 employees | 419 | 396 | 458 | 15,779 | 10,287 | $1,352,389 | $7,353,459 |
| Import/Repackage; Incorporation into other formulation, mixture, and reaction products; Production of Maskant for Chemical Milling; Use as maskant for chemical milling | 325998: All Other Miscellaneous Chemical Product and Preparation Manufacturing | 650 employees | 1,064 | 982 | 1,230 | 36,900 | 17,820 | $3,329,996 | $25,778,668 |
| Manufacturing; Mold Release and Protectants; Processing as a Reactant | 326113: Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing | 750 employees | 429 | 380 | 529 | 35,951 | 15,267 | $2,512,931 | $18,990,345 |
| Use as maskant for chemical milling; Mold Release and Protectants | 326199: All Other Plastics Product Manufacturing | 750 employees | 5,187 | 4,888 | 6,156 | 374,862 | 190,204 | $20,760,557 | $112,073,941 |
| Mold Release and Protectants | 326220: Rubber and Plastics Hoses and Belting Manufacturing | 800 employees | 196 | 177 | 273 | 19,713 | 8,697 | $1,174,449 | $6,255,440 |
| Adhesives and Sealants; Paints and Coatings | 326291: Rubber Product Manufacturing for Mechanical Use | 750 employees | 346 | 315 | 411 | 30,895 | 14,720 | $1,716,444 | $8,978,491 |
| Adhesives and Sealants; Mold Release and Protectants; Paint and Coatings | 326299: All Other Rubber Product Manufacturing | 650 employees | 565 | 508 | 666 | 29,771 | 15,816 | $1,893,153 | $11,945,271 |
| Paint and Coatings | 327110: Pottery, Ceramics, and Plumbing Fixture Manufacturing | 1,000 employees | 566 | 556 | 585 | 12,508 | 8,262 | $617,721 | $2,630,357 |
| Vapor Degreasing | 327213: Glass Container Manufacturing | 1,250 employees | 29 | 22 | 69 | 14,426 | 1,704 | $1,000,619 | $5,958,023 |
| Import/Repackage | 327310: Cement Manufacturing | 1,000 employees | 101 | 84 | 215 | 14,121 | 2,460 | $1,153,452 | $10,329,231 |
| Vapor Degreasing | 331110: Iron and Steel Mills and Ferroalloy Manufacturing | 1,500 employees | 369 | 325 | 522 | 93,552 | 17,946 | $8,212,055 | $108,313,128 |
| Incorporation into other formulation, mixture, and reaction products | 331318: Other Aluminum Rolling, Drawing, and Extruding | 750 employees | 212 | 181 | 275 | 29,441 | 11,347 | $1,697,331 | $13,449,960 |
| Paint and Coatings; Processing Aid in Petrochemical Manufacturing | 331492: Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum) | 850 employees | 183 | 166 | 220 | 9,305 | 6,199 | $697,497 | $8,557,924 |
| Use as maskant for chemical milling | 332216: Saw Blade and Handtool Manufacturing | 750 employees | 864 | 845 | 930 | 26,889 | 18,722 | $1,606,514 | $7,452,662 |
| Adhesives and Sealants; Batch, Liquid, and Spray Cold Cleaning; Use as Maskant for Chemical Milling | 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 | $3,066,382 | $15,890,488 |
| Batch, Liquid, and Spray Cold Cleaning; Use as Maskant for Chemical Milling | 332813: Electroplating, Plating, Polishing, Anodizing, and Coloring | 500 employees | 2,068 | 2,032 | 2,169 | 51,056 | 42,608 | $2,558,183 | $8,462,352 |
| Batch, Liquid, and Spray Cold Cleaning | 332912: Fluid Power Valve and Hose Fitting Manufacturing | 1,000 employees | 294 | 261 | 363 | 36,324 | 12,240 | $2,767,958 | $12,747,762 |
| Vapor Degreasing | 332913: Plumbing Fixture Fitting and Trim Manufacturing | 1,000 employees | 94 | 87 | 106 | 8,536 | 3,854 | $586,353 | $5,699,023 |
| Adhesives and Sealants; Paints and Coatings | 332993: Ammunition (except Small Arms) Manufacturing | 1,500 employees | 43 | 35 | 53 | 11,441 | 625 | $1,319,727 | $3,169,269 |
| Lubricants and Greases; Vapor Degreasing; | 332999: All Other Miscellaneous Fabricated Metal Product Manufacturing | 750 employees | 3,514 | 3,458 | 3,593 | 66,842 | 56,916 | $3,884,661 | $16,471,054 |
| Use as maskant for chemical milling | 333249: Other Industrial Machinery Manufacturing | 750 employees | 1,811 | 1,742 | 1,866 | 53,766 | 42,042 | $3,916,382 | $17,135,217 |
| Incorporation into other formulation, mixture, and reaction products | 333310: Commercial and Service Industry Machinery Manufacturing | 750 employees | 457 | 410 | 576 | 37,181 | 11,735 | $3,024,619 | $19,464,280 |
| 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 | $5,614,091 | $38,044,556 |
| Vapor Degreasing; Incorporation into other formulation, mixture, and reaction products; Use as maskant for chemical milling | 333517: Machine Tool Manufacturing | 500 employees | 787 | 761 | 818 | 27,289 | 18,430 | $2,039,345 | $9,007,250 |
| Incorporation into other formulation, mixture, and reaction products | 333912: Air and Gas Compressor Manufacturing | 1,000 employees | 261 | 238 | 297 | 18,362 | 8,437 | $1,638,777 | $10,868,329 |
| Use as maskant for chemical milling | 333914: Measuring, Dispensing, and Other Pumping Equipment Manufacturing | 750 employees | 457 | 410 | 576 | 37,181 | 11,735 | $3,024,619 | $19,464,280 |
| Paint and Coatings | 333996: Fluid Power Pump and Motor Manufacturing | 1,250 employees | 132 | 116 | 157 | 10,484 | 4,092 | $884,074 | $5,113,732 |
| Manufacturing, Paints and Coatings | 333998: All Other Miscellaneous General Purpose Machinery Manufacturing | 700 employees | 1,558 | 1,467 | 1,645 | 55,552 | 29,610 | $4,477,410 | $19,323,506 |
| Incorporation into other formulation, mixture, and reaction products | 334220: Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing | 1,250 employees | 658 | 619 | 725 | 63,557 | 19,253 | $6,583,790 | $29,831,974 |
| Processing as a reactant; Vapor Degreasing | 334511: Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing | 1,350 employees | 421 | 379 | 549 | 126,636 | 10,417 | $14,190,289 | $60,055,167 |
| Import/Repackage | 334516: Analytical Laboratory Instrument Manufacturing | 1,000 employees | 608 | 558 | 689 | 48,780 | 16,728 | $5,108,454 | $19,953,163 |
| Adhesices and Sealants; Paints and Coatings | 336211: Motor Vehicle Body Manufacturing | 1,000 employees | 632 | 590 | 733 | 47,964 | 20,101 | $2,871,410 | $17,041,214 |
| Paints and Coatings | 336214: Travel Trailer and Camper Manufacturing | 1,000 employees | 601 | 585 | 729 | 54,221 | 17,342 | $3,262,538 | $20,910,405 |
| Adhesives and Sealants, Incorporation into other formulation, mixture, and reaction products | 336390: Other Motor Vehicle Parts Manufacturing | 1,000 employees | 1,268 | 1,145 | 1,483 | 148,076 | 56,090 | $8,403,915 | $74,769,964 |
| Use as Maskant for Chemical Milling; Paints and Coatings; Vapor Degreasing | 336411: Aircraft Manufacturing | 1,500 employees | 262 | 236 | 317 | 166,716 | 10,736 | $19,760,602 | $172,232,158 |
| Vapor Degreasing, Paint and Coatings | 336413: Other Aircraft Parts and Auxiliary Equipment Manufacturing | 1,250 employees | 750 | 692 | 921 | 103,133 | 26,327 | $8,524,571 | $40,923,535 |
| Batch, Liquid, and Spray Cold Cleaning | 336414: Guided Missile and Space Vehicle Manufacturing | 1,300 employees | 22 | 12 | 42 | 35,386 | 679 | $6,188,325 | $19,109,277 |
| Paints and Coatings | 336415: Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing | 1,250 employees | 16 | 7 | 33 | 16,635 | 219 | $2,393,381 | $9,683,318 |
| Adhesives and Sealants; Paints and Coatings | 336611: Ship Building and Repairing | 1,300 employees | 503 | 478 | 588 | 99,963 | 22,304 | $7,852,150 | $29,475,302 |
| Manufacturing; Incorporation into other formulation, mixture, and reaction products | 339112: Surgical and Medical Instrument Manufacturing | 1,000 employees | 1,063 | 995 | 1,234 | 109,121 | 36,227 | $10,605,096 | $46,666,286 |
| Batch, Liquid, and Spray Cold Cleaning | 339910: Jewelry and Silverware Manufacturing | 700 employees | 1,967 | 1,954 | 1,986 | 23,813 | 16,523 | $1,050,748 | $8,505,748 |
| Batch, Liquid, and Spray Cold Cleaning | 339920: Sporting and Athletic Goods Manufacturing | 750 employees | 1,586 | 1,567 | 1,649 | 39,326 | 27,983 | $2,193,584 | $12,151,989 |
| Paints and Coatings | 339950: Sign Manufacturing | 500 employees | 5,602 | 5,572 | 5,727 | 76,353 | 64,832 | $3,978,969 | $14,994,590 |
| Vapor Degreasing | 339992: Musical Instrument Manufacturing | 1,000 employees | 585 | 582 | 606 | 11,412 | 9,214 | $604,488 | $2,328,277 |
| Import/Repackage, Vapor Degreasing, Incorporation into other formulation, mixture, and reaction products | 339999: All Other Miscellaneous Manufacturing | 550 employees | 5,738 | 5,681 | 5,755 | 52,935 | 41,053 | $2,353,807 | $14,267,922 |
| Use as maskant for chemical milling | 423120: Motor Vehicle Supplies and New Parts Merchant Wholesalers | 200 employees | 8,342 | 7,904 | 13,079 | 212,705 | 78,107 | $13,566,952 | $225,887,919 |
| Use as maskant for chemical milling | 423220: Home Furnishing Merchant Wholesalers | 100 employees | 6,021 | 5,744 | 7,328 | 99,252 | 51,836 | $6,594,520 | $75,968,585 |
| Incorporation into other formulation, mixture, and reaction products | 423330: Roofing, Siding, and Insulation Material Merchant Wholesalers | 225 employees | 851 | 787 | 3,384 | 43,489 | 8,514 | $4,371,942 | $54,247,993 |
| Incorporation into other formulation, mixture, and reaction products | 423710: Hardware Merchant Wholesalers | 150 employees | 4,919 | 4,739 | 6,222 | 88,697 | 42,639 | $6,555,206 | $77,054,185 |
| Incorporation into other formulation, mixture, and reaction products | 423830: Industrial Machinery and Equipment Merchant Wholesalers | 100 employees | 22,424 | 21,246 | 29,485 | 370,240 | 172,848 | $31,817,042 | $284,063,642 |
| Use as maskant for chemical milling | 423840: Industrial Supplies Merchant Wholesalers | 125 employees | 5,811 | 5,495 | 9,463 | 105,490 | 52,940 | $8,516,036 | $90,373,582 |
| Use as maskant for chemical milling | 423850: Service Establishment Equipment and Supplies Merchant Wholesalers | 125 employees | 3,195 | 3,079 | 4,763 | 52,245 | 27,519 | $3,246,293 | $25,810,535 |
| Import/Repackage; Vapor Degreasing; Incorporation into other formulation, mixture, and reaction products; Use as maskant for chemical milling | 423990: Other Miscellaneous Durable Goods Merchant Wholesalers | 100 employees | 8,605 | 8,376 | 9,310 | 82,782 | 45,288 | $5,890,784 | $52,100,906 |
| Incorporation into other formulation, mixture, and reaction products; Processing Aid in Petrochemical Manufacturing | 424510: Grain and Field Bean Merchant Wholesalers | 200 employees | 2,185 | 2,058 | 4,841 | 53,281 | 28,816 | $3,475,494 | $222,594,502 |
| Manufacturing; Import/Repackage; Incorporation into other formulation, mixture, and reaction products; Use as maskant for chemical milling | 424690: Other Chemical and Allied Products Merchant Wholesalers | 175 employees | 6,069 | 5,767 | 9,418 | 126,009 | 50,790 | $12,047,193 | $232,201,840 |
| Processing Aid in Petrochemical Manufacturing | 424720: Petroleum and Petroleum Products Merchant Wholesalers (except Bulk Stations and Terminals) | 200 employees | 1,857 | 1,688 | 2,463 | 33,558 | 16,027 | $3,631,734 | $645,138,066 |
| Incorporation into other formulation, mixture, and reaction products | 424910: Farm Supplies Merchant Wholesalers | 200 employees | 4,965 | 4,771 | 9,216 | 107,655 | 43,048 | $9,124,323 | $168,449,948 |
| Incorporation into other formulation, mixture, and reaction products | 425120: Wholesale Trade Agents and Brokers | 125 employees | 37,217 | 36,945 | 39,527 | 289,070 | 143,891 | $16,506,326 | $817,731,540 |
| Aerosol Spray Cleaning/Degreasing; Wipe and Liquid Cleaning and Polishing | 441110: New Car Dealers | 200 employees | 17,423 | 16,559 | 21,636 | 1,177,984 | 750,891 | $75,437,196 | $1,069,684,904 |
| Aerosol Spray Cleaning/Degreasing; Wipe and Liquid Cleaning and Polishing | 441120: Used Car Dealers | $30.5m revenue | 23,627 | 22,991 | 25,512 | 154,136 | 94,791 | $8,305,089 | $119,821,256 |
| Incorporation into other formulation, mixture, and reaction products | 444120: Paint and Wallpaper Stores | $34m revenue | 1,623 | 1,593 | 7,037 | 35,427 | 9,387 | $2,714,916 | $13,389,094 |
| Import/Repackage | 455219: All Other General Merchandise Stores | $40m revenue | 7,892 | 7,811 | 41,190 | 433,086 | 39,972 | $9,495,709 | $85,894,598 |
| Aerosol Spray Cleaning/Degreasing; Wipe and Liquid Cleaning and Polishing | 459110: Sporting Goods Stores | $26.5m revenue | 16,233 | 16,102 | 21,422 | 240,816 | 96,677 | $6,351,920 | $53,013,646 |
| Photographic Film Use | 512191: Teleproduction and Other Postproduction Services | $39m revenue | 2,507 | 2,480 | 2,608 | 28,649 | 12,883 | $2,637,171 | $5,923,006 |
| Photographic Film Use | 512199: Other Motion Picture and Video Industries | $28.5m revenue | 182 | 182 | 183 | 1,218 | 1,218 | $89,724 | $283,280 |
| Manufacturing; Processing Aid in Petrochemical; Incorporation into other formulation, mixture, and reaction products | 523910: Miscellaneous Intermediation | $47m revenue | 8,378 | 8,107 | 8,611 | 47,197 | 32,619 | $11,918,288 | $33,144,906 |
| Incorporation into other formulation, mixture, and reaction products | 523940: Portfolio Management | $47m revenue | 24,430 | 23,624 | 42,791 | 342,020 | 107,016 | $106,378,230 | $281,781,826 |
| Laboratory Chemicals | 541380: Testing Laboratories | $19m revenue | 5,283 | 4,963 | 7,075 | 134,605 | 52,681 | $11,012,265 | $24,473,514 |
| Import/Repackage; Processing Aid in Petrochemical Manufacturing | 541613: Marketing Consulting Services | $19m revenue | 36,605 | 36,084 | 37,454 | 221,857 | 126,391 | $20,146,666 | $48,674,538 |
| Import/Repackage | 541714: Research and Development in Biotechnology (except Nanobiotechnology) | 1,000 employees | 3,109 | 3,056 | 3,415 | 88,706 | 58,308 | $26,233,347 | $28,961,397 |
| Mold Release and Protectants; Paints and Coatings | 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 | $77,718,729 | $114,272,382 |
| Use as maskant for chemical milling | 541990: All Other Professional, Scientific, and Technical Services | $19.5m revenue | 16,830 | 16,583 | 17,972 | 92,384 | 56,159 | $9,431,973 | $21,654,731 |
| Processing Aid in Petrochemical Manufacturing | 561110: Office Administrative Services | $12.5m revenue | 31,132 | 28,494 | 33,966 | 488,042 | 229,472 | $42,257,787 | $71,855,625 |
| Recycling and Disposal | 562211: Hazardous Waste Treatment and Disposal | $47m revenue | 414 | 359 | 873 | 34,341 | 3,475 | $2,863,143 | $10,513,720 |
| Recycling and Disposal | 562212: Solid Waste Landfill | $47m revenue | 668 | 631 | 1,439 | 18,711 | 6,044 | $1,439,583 | $9,009,427 |
| Recycling and Disposal | 562213: Solid Waste Combustors and Incinerators | $47m revenue | 37 | 26 | 61 | 2,095 | 88 | $214,161 | $1,542,145 |
| Recycling and Disposal | 562219: Other Nonhazardous Waste Treatment and Disposal | $47m revenue | 227 | 212 | 287 | 2,720 | 1,817 | $271,466 | $967,800 |
| Recycling and Disposal | 562910: Remediation Services | $25m revenue | 3,903 | 3,702 | 4,836 | 77,591 | 42,858 | $6,373,872 | $19,021,557 |
| Recycling and Disposal | 562920: Materials Recovery Facilities | $25m revenue | 1,004 | 900 | 1,389 | 20,279 | 11,156 | $1,170,223 | $7,493,067 |
| Recycling and Disposal | 562998: All Other Miscellaneous Waste Management Services | $16.5m revenue | 1,090 | 1,057 | 1,162 | 12,619 | 8,597 | $1,046,714 | $2,397,966 |
| Aerosol Spray Cleaning/Degreasing; Wipe and Liquid Cleaning and Polishing | 811111: General Automotive Repair | $9m revenue | 79,072 | 78,287 | 83,216 | 358,905 | 307,596 | $17,024,953 | $60,256,639 |
| Anti-Spatter Welding Aerosol; Wipe and Liquid Cleaning and Polishing | 811114: Other Automotive Mechanical and Electrical Repair and Maintenance | $9m revenue | 3,027 | 3,000 | 3,384 | 14,620 | 12,218 | $619,946 | $2,390,078 |
| Aerosol Spray Cleaning/Degreasing; Anti-Spatter Welding Aerosol; Wipe and Liquid Cleaning and Polishing | 811121: Automotive Body, Paint, and Interior Repair and Maintenance | $9m revenue | 32,696 | 32,098 | 35,387 | 243,020 | 180,877 | $13,415,111 | $45,179,492 |
| Aerosol Spray Cleaning/Degreasing; Wipe and Liquid Cleaning and Polishing | 811122: Automotive Glass Replacement Shops | $17.5m revenue | 4,764 | 4,744 | 6,051 | 29,811 | 28,419 | $1,438,627 | $5,053,835 |
| Aerosol Spray Cleaning/Degreasing; Wipe and Liquid Cleaning and Polishing | 811191: Automotive Oil Change and Lubrication Shops | $11m revenue | 4,467 | 4,368 | 8,236 | 61,501 | 32,632 | $2,040,064 | $6,852,899 |
| Aerosol Spray Cleaning/Degreasing; Wipe and Liquid Cleaning and Polishing | 811198: All Other Automotive Repair and Maintenance | $10m revenue | 3,637 | 3,596 | 4,007 | 17,686 | 10,639 | $869,088 | $2,820,947 |
| Aerosol Spray Cleaning/Degreasing | 811210: Computer and Office Machine Repair and Maintenance | $34m revenue | 5,068 | 5,014 | 5,454 | 33,730 | 22,877 | $1,696,768 | $5,319,656 |
| Wipe and Liquid Cleaning and Polishing | 811211: Consumer Electronics Repair and Maintenance | $34m revenue | 1,746 | 1,728 | 1,845 | 12,636 | 7,510 | $565,786 | $1,731,891 |
| Wipe and Liquid Cleaning and Polishing | 811219: Other Electronic and Precision Equipment Repair and Maintenance | $34m revenue | 2,787 | 2,702 | 3,421 | 35,369 | 15,943 | $3,189,357 | $9,847,277 |
| Aerosol Spray Cleaning/Degreasing; Anti-Spatter Welding Aerosol; Wipe Cleaning and Polishing | 811310: Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance | $12.5m revenue | 19,986 | 19,238 | 21,814 | 200,268 | 101,827 | $13,621,320 | $46,618,986 |
| Aerosol Spray Cleaning/Degreasing; Wipe Cleaning and Polishing | 811411: Home and Garden Equipment Repair and Maintenance | $9m revenue | 1,704 | 1,698 | 1,722 | 4,559 | 4,317 | $141,948 | $724,784 |
| Aerosol Spray Cleaning/Degreasing; Wipe Cleaning and Polishing | 811490: Other Personal and Household Goods Repair and Maintenance | $9m revenue | 9,938 | 9,864 | 10,643 | 36,437 | 29,621 | $1,387,414 | $4,980,158 |
| Dry Cleaning Machines | 812320: Drycleaning and Laundry Services (except Coin-Operated) | $8m revenue | 18,087 | 17,953 | 20,643 | 131,543 | 113,492 | $2,258,311 | $9,397,332 |
| Dry Cleaning Machines | 812332: Industrial Launderers | $47m revenue | 380 | 356 | 1,544 | 63,811 | 12,149 | $3,193,513 | $10,200,763 |
| Sources: [U.S. Census Bureau 2021](#_ENREF_65); [U.S. Bureau of Economic Analysis 2023b](#_ENREF_56); [U.S. Census Bureau 2022](#_ENREF_66); [SBA 2023](#_ENREF_100). | | | | | | | | | |

# Products Formulated with PCE

This chapter presents the results from EPA’s search to identify products that might contain PCE and discusses some of the implications of the prohibition of PCE use in these products. The search was conducted using the Consumer Product Information Database (CPID), at [www.whatsinproducts.com](http://www.whatsinproducts.com); retail websites that sell related products (e.g., [www.grainger.com](http://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 2017b](#_ENREF_78), [EPA 2017c](#_ENREF_79), [EPA 2017d](#_ENREF_80), [EPA 2017e](#_ENREF_81), [EPA 2017f](#_ENREF_82)).

EPA expects that manufacturers that already have alternative products would respond to an option that prohibits or restricts PCE use by discontinuing the PCE product without replacing it with a new product line. Thus, 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 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 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 an option prohibiting PCE, 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 PCE by product type. Table 4‑2 presents the parent company names, NAICS codes, annual revenue, number of employees, small business threshold, small business status, and the number of products formulated with PCE for each product formulator.

| Table 4‑1: Companies and Types of Products Containing PCE by Product Type | | | | |
| --- | --- | --- | --- | --- |
| Use Category  (Product Type) | Parent Company Name | Product Name | % PCE | Has Existing PCE-Free Alternative |
| Adhesive and Sealants: Adhesives | Eclectic Products, Inc. (The Willamette Valley Company LLC) | E-6000 CLEAR | ≥50 -≤75 | No |
| E-6000 MV BLACK (NON-FLAM) | ≥60 -≤72 | No |
| E-6000 LV WHITE (NON-FLAM) | ≥50 -≤71 | No |
| E-6100 CLEAR (NON FLAM) | 30-60 | No |
| E-6100 BLACK (NON-FLAM) | 60-100 | No |
| E-6100 WHITE (NON FLAM) | 60-100 | No |
| E-6100 GRAY (NON-FLAM) | ≥50 -≤64 | No |
| E6800 | 60-100 | No |
| FRP COLUMN ADHESIVE | 30-60 | No |
| AMAZING GOOP II MAX | ≥50 -≤72 | No |
| AMAZING GOOP TRIM REPAIR | ≥50 -≤75 | No |
| E6000 SHOE DAZZLE CLEAR | ≥50 -≤72 | No |
| E6000 JEWELRY & BEAD | ≥50 -≤75 | No |
| 3M | 3M™ PB970 High Heat Resistant Spray Adhesive, Bulk | <2 | Yes |
| Hernon Manufacturing Inc. | Supertacker 357 | 60-100 | No |
| LORD Corporation (Parker Hannifin Corporation) | AUTOSEAL 3370 | 0.1-1 | Yes |
| CHEMLOK 220 | 15-20 | Yes |
| CHEMLOK 220LH | 0.1-1 | Yes |
| CHEMLOK 220X | 0.1-0.9 | Yes |
| CHEMLOK 6125 | 0.1-0.9 | Yes |
| CHEMLOK 6220 | 0.1-0.9 | Yes |
| CHEMLOK 6225 | 0.1-0.9 | Yes |
| Orenco Systems, Inc. | ADH 100 CLEAR (NON FLAM) | 60-100 | No |
| Sullivan Supply, Inc. | Primetime Adhesive | 15 | Yes |
| EZ – Comb Adhesive | 15 | Yes |
| United Laboratories, Inc. | Lexel White VOC Compliant | 60-100 | Yes |
| Adhesive and Sealants: Sealants | ACM American Construction Metals | ACM™ Gutter/Narrow Seam Sealant, Aluminum Gray | 50.6 | No |
| ACM™ Gutter/Narrow Seam Sealant, White | 49.6 | No |
| ACM™ Gutter/Narrow Seam Sealant, Clear | 50.0 | No |
| Amerimax Home Products, Inc. | AMERIMAX® SeamerMate® Professional Grade Permanent Gutter Seal Gray | ≥50-<75 | No |
| AMERIMAX® SeamerMate® Professional Grade Permanent Gutter Seal White | ≥25-<50 | No |
| Geocel Products Group (The Sherwin Williams Company) | Geocel® Instant Gutter Seal Gutter & Narrow Seam Sealant Aluminum Gray | 49.67 | Yes |
| Geocel® PRO FLEX® RV Flexible Sealant Clear | 42.70 | Yes |
| Geocel® Pro Flex® Tripolymer Sealant White | 47.37 | Yes |
| Geocel® 2000® Construction Caulking Sealant Clear | 45.51 | Yes |
| Geocel® 2300® Construction Tripolymer Sealant White | 47.37 | Yes |
| Geocel® 2320® Construction Tripolymer Gutter and Narrow Seam Sealant Clear | 49.7 | Yes |
| Geocel® 2300® MHRV Sealant Clear | 42.70 | Yes |
| Geocel® 2350 MHRV™ Sealant Bright White | 41.96 | Yes |
| Geocel® Water Shield® Caulking Sealant White | 45.35 | Yes |
| Geocel® ProCOLOR SWD™ Tripolymer Sealant WH01 | 30.16 | Yes |
| White Lightning Products | WHITE LIGHTNING® STORM BLASTER® All Season Sealant White | 47.37 | Yes |
| Adhesive and Sealants: Caulk | Sashco Inc. | Lexel White VOC Compliant | 30-60 | Yes |
| Paint and Coating Remover | Canberra Corp. | Husky 1229 Vandalism Mark & Stain Remover | 10-20% | Yes |
| Liquid and Aerosol Cleaners and Degreasers: (Automotive A/C Flush) | Mastercool Inc. | Flush Solvent | 5-7 | Yes |
| Liquid and Aerosol Cleaners and Degreasers: Auto Parts Degreaser | Zep Inc. (NM Z Parent Inc.) | Parts Cleaner | Not provided | Yes |
| Penray | Electric Motor Cleaner | Not provided | Yes |
| Sprayon | EL 703 Electric Motor Degreaser Aerosol | Not provided | No |
| Liquid and Aerosol Cleaners and Degreasers: Brake Cleaner | CRC Industries, Inc. (Berwind Corporation) | Brakleen Brake Parts Cleaner | Not provided | Yes |
| Brakleen Brake Parts Cleaner 05089 | Not provided | Yes |
| Blumenthal Brands Integrated LLC | Brake Parts Cleaner Chlorinated Fast Blast M720T | Not provided | Yes |
| NAPA | Mac s Brake Parts Cleaner | Not provided | No |
| Permatex | Pro Strength Brake and Parts Cleaner Aerosol Professional Use | Not provided | Yes |
| Pyroil | Brake Parts Cleaner | Not provided | Yes |
| Berryman | Brake Parts Cleaner 5c 4 | Not provided | Yes |
| Penray | Chlorinated Brake Cleaner | Not provided | Yes |
| Pro Chem | Knock it Off | Not provided | Yes |
| Zep Inc. (NM Z Parent Inc.) | A00733 ZEP AUTO BRAKE and PARTS CLN 20N20 | Not provided | Yes |
| Liquid and Aerosol Cleaners and Degreasers: Energized Electronic Equipment Cleaner | CRC Industries, Inc. (Berwind Corporation) | Lectra Clean Heavy Duty Electrical Parts Degreaser | Not provided | No |
| Electrical Parts Cleaner | Not provided | No |
| Lectra Motive Electric Parts Cleaner | Not provided | No |
| Electrical Parts Cleaner | Not provided | No |
| Lectra Clean 3000 Energized Electrical Equipment Cleaner | Not provided | No |
| American Industries Inc. | Rapid Solv (A) | Not provided | No |
| Electric Motor Cleaner | CRC Industries, Inc. (Berwind Corporation) | Cable Clean® RD™ | Not provided | Yes |
| Cutting Oil | Anti-Seize Technology | Cool-Cut | 90-100 | Yes |
| MSC Industrial Supply Co. | Cutting Tool Coolant | 78 | No |
| Energy Release, LLC | CTF-14 Cutting & Tapping Fluid Product | >50 | No |
| Kimball Midwest | Ultra Cut Cutting Tool Coolant | 40-60 | Yes |
| Maintenance Solutions, Inc. | Kool Tool | 60-100 | No |
| Winfield Brooks Company, Inc. (Flow Grinding Co) | Alumtap Original Formula | <10 | Yes |
| General Aerosol Degreaser | CRC Industries, Inc. (Berwind Corporation) | Coil Cleaner | Not provided | Yes |
| Heavy Duty Degreaser MUO | Not provided | Yes |
| Cleaner and Degreaser | Not provided | Yes |
| Quick Clean Safety Solvent and Degreaser | Not provided | Yes |
| Sprayon | MR 351 Mold Cleaner Aerosol | Not provided | No |
| Zep Inc. (NM Z Parent Inc.) | A07328 ZEP PARTS CLNR 003601 20N20 | Not provided | Yes |
| Liquid Auto Parts Degreaser | CRC Industries, Inc. (Berwind Corporation) | Tyme®-1 Cold Parts Cleaner | 50-60 | Yes |
| Heavy Duty Degreaser | 90-100 | Yes |
| Liquid Brake Cleaner | CRC Industries, Inc. (Berwind Corporation) | Brakleen® Brake Parts Cleaner | 90-100 | Yes |
| Liquid Carburetor Cleaner | Berryman Products, Inc. | Professional Chem-Dip Carburetor Parts Cleaner | 5-10 | Yes |
| Liquid Electric Motor Cleaner | CRC Industries, Inc. (Berwind Corporation) | Lectra Clean® Heavy Duty Energized Electrical Parts Degreaser | 90-100 | Yes |
| Lectra Clean® 3000 Energized Electrical Equipment Cleaner | 90-100 | Yes |
| Lectra-Motive® Electric Parts Cleaner | 90-100 | Yes |
| Liquid Industrial Degreaser | Zep Inc. (NM Z Parent Inc.) | Formula 300 | 30-<50 | Yes |
| Delta Foremost Chemical Corporation | Foremost 582 Safety Solvent II | Proprietary | Yes |
| Lubricant | American Industries, Inc. | ORKO | 10-30% | Yes |
| Probe | 60-80% | Yes |
| LP-650 (A) | >80 | Yes |
| Zep Inc. (NM Z Parent Inc.) | Penetrating Lube | >= 50 - < 70 | Yes |
| C K Enterprises, Inc. (Kunkel Enterprises) | C K Preserve | 51-89 | No |
| CHS Inc. | Farm OYL Rust Bluster | 40-60% | No |
| Claire Manufacturing Co. (Plz Aeroscience Corporation) | Moisture Out Penetrating Oil | 40-60% | No |
| Delta Foremost Chemical Corporation | Foremost 602-ES Dri ‘N Lube | Proprietary | No |
| Energy Release, LLC | CTF-14, Cutting & Tapping Fluid Product | >50 | No |
| K-Chem, Inc | Grease Gun in a Can® | 5-10% | No |
| Nut Buster | 34.9-57.3% | No |
| Kimball Midwest | 80-695 HEAVY DUTY SILICONE | 30-40% | Yes |
| Zep Inc. (NM Z Parent Inc.) | Moisture Guard | >=70-<90 | Yes |
| Mid-American Research Chemical Corp. | Marc 100 Pen-A-Lube | 30-60% | Yes |
| Momar Inc. | Miracle Tool Aerosol | 10-20% | Yes |
| QuestVapco | Pierce Penetrating Lubricant | 60-100% | Yes |
| Pro Chem Inc. | Pro Tools MP Penetrant Lubricant | 60-85% | Yes |
| QuestSpecialty Corporation | Loose Screw | 30-60% | Yes |
| Sprayaway | L2 Moisture Displacer/Deep Penetrant | 40-60% | No |
| Mid-American Research Chemical Corp. | Break-a-Way II | 70-90 | Yes |
| Inks and Ink Removal | Albatross USA Inc. (Albachem) | Expert Premium 303 ™ Screen Print Ink Remover | 0-10 | Yes |
| Anti-spatter | Sprayon Products Group | WL™941 Dry Weld Spatter Protectant Aerosol | Not provided | No |
| WL™942 Wet Weld Spatter Protectant Aerosol | Not provided | No |
| Mold Cleaner | CRC Industries, Inc. (Berwind Corporation) | Heavy Duty Mold Cleaner | 90-100 | No |
| Sprayon Products Group | MR™351 Mold Cleaner Aerosol | 25 | Yes |
| Plastic Process Equipment, Inc. | Mold Cleaner (MCB) | 80-90 | Yes |
| Mold Cleaner Spray (MC-16) | 85-90 | Yes |
| Jumbo Mold Cleaner Spray (MCJ-24) | 85-90 | Yes |
| Paintable Mold Release | Plastic Process Equipment, Inc. | Budget Paintable Mold Release (BPR-016) | 10-15 | Yes |
| Dry cleaning chemicals | American Niagara | Pull Out 2 – Dry White Powdered Spotter | > 40 | Yes |
| Adco Professional Products LLC | DFB Xtra | 30-40 | Yes |
| Fashion Finish Synthetic | 50-55 | Yes |

| Table 4‑2: Small Business Determination for Product Formulators by Parent Company Name | | | | | |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parent Company Name | NAICS | Revenue | Employees | SBA Small Business Threshold | Small Business Status | Number of products |
| 3M | 339112: Surgical and Medical Instrument Manufacturing | $34.23B | 92,000 | 1000 Employees | No | 1 |
| ACM American Construction Metals (ABC Supply Co Inc) | 423330: Roofing, Siding, And Insulation Material Merchant | $6B | 7,000 | 225 Employees | No | 3 |
| Adco Professional Products LLC | 424690: Other Chemical and Allied Products Merchant Wholesalers | $39.34M | 150 | 150 Employees | Small | 2 |
| American Industries, Inc. | 424690: Other Chemical and Allied Products Merchant Wholesalers | $35.47M | 4 | 175 Employees | Small | 3 |
| American Niagara | 325998: All Other Miscellaneous Chemical Product and Preparation Manufacturing | $1.49M | 10 | 500 Employees | Small | 1 |
| Amerimax Home Products, Inc. (Omnimax Holdings Inc) | 331318: Other Aluminum Rolling, Drawing, And Extruding | $854.75M | 1,784 | 750 Employees | No | 2 |
| Anti-Seize Technology | 325520: Adhesive Manufacturing | $3.47M | 12 | 500 Employees | Small | 1 |
| Berryman Products, Inc. | 325180: Other Basic Inorganic Chemical Manufacturing | $40.8M | 50 | 1000 Employees | Small | 2 |
| Blumenthal Brands Integrated LLC (B’Laster Holdings LLC) | 325998:All Other Miscellaneous Chemical Product And Preparation | $16.97M | 40 | 650 Employees | Small | 1 |
| C K Enterprises, Inc. | 425120:Wholesale Trade Agents And Brokers | $3.77M | 3 | 1000 Employees | Small | 1 |
| Canberra Corp. | 325612: Polish and Other Sanitation Good Manufacturing | $127.15M | 200 | 900 Employees | Small | 1 |
| CHS Inc. | 424510: Grain and Field Bean Merchant Wholesalers | $47.79B | 10,014 | 200 Employees | No | 1 |
| Plz Aeroscience Corporation (Pritzker Private Capital) | 523910: Miscellaneous Intermediation | $166.73M | 141 | $47m Revenue | No | 1 |
| CRC Industries, Inc. (Berwind Corporation) | 523940: Portfolio Management And Investment Advice | $425M | 3,501 | $47m Revenue | No | 19 |
| Delta Foremost Chemical Corporation | 325611:Soap And Other Detergent Manufacturing | $17.29M | 100 | 1100 Employees | Small | 2 |
| Eclectic Products, Inc. (The Willamette Valley Company LLC) | 325510: Paint And Coating Manufacturing | $815.69M | 818 | 1000 Employees | Small | 13 |
| Energy Release, LLC | 336390:Other Motor Vehicle Parts Manufacturing | $770K | 4 | 1000 Employees | Small | 2 |
| Geocel Products Group (The Sherwin-Williams Company) | 444120: Paint And Wallpaper Retailers | $22.14B | 64,366 | $34m Revenue | No | 10 |
| Hernon Manufacturing Inc. | 325520: Adhesive Manufacturing | $1.68M | 50 | 550 Employees | Small | 1 |
| K-Chem, Inc | 424690: Other Chemical And Allied Products Merchant Wholesale | $8.2M | 5 | 175 Employees | Small | 2 |
| Kimball Midwest | 423710: Hardware Merchant Wholesalers | $302.7M | 300 | 150 Employees | No | 2 |
| LORD Corporation (Parker Hannifin Corporation) | 333998: All Other Miscellaneous General Purpose Machinery | $19.06B | 62,730 | 700 Employees | No | 7 |
| Maintenance Solutions, Inc. | 423850: Service Establishment Equipment and Supplies Merchant Wholesalers | $1.97M | 6 | 100 Employees | Small | 1 |
| Mastercool Inc. | 323990: Other Miscellaneous Durable Goods Merchant Wholesale | $20.79M | 20 | 100 Employees | Small | 1 |
| Mid-American Research Chemical Corp. | 424690: Other Chemical And Allied Products Merchant Wholes | $5.7M | 3 | 175 Employees | Small | 2 |
| Momar Inc. | 325998: All Other Miscellaneous Chemical Product And Prepa | $57.1M | 100 | 650 Employees | Small | 1 |
| MSC Industrial Supply Co. | 423830 Industrial Machinery And Equipment Merchant Wholes | $3.69B | 6,880 | 100 Employees | No | 1 |
| NAPA (Genuine Parts Company) | 423120: Motor Vehicle Supplies and New Parts Merchant Wholesalers | $22.1B | 58,000 | 200 Employees | No | 1 |
| Orenco Systems, Inc. | 333310: Commercial And Service Industry Machinery Manufacturing | $4.82M | 194 | 1000 Employees | Small | 1 |
| Penray (Pritzker Private Capital) | 523910: Miscellaneous Intermediation | $166.7M | 141 | $47m Revenue | No | 2 |
| Permatex (Illinois Tool Works Inc.) | 333912: Air And Gas Compressor Manufacturing | $15.9B | 46,000 | 1000 Employees | No | 1 |
| Plastic Process Equipment, Inc. | 423830: Industrial Machinery And Equipment Merchant Wholsalers | $94.35M | 9 | 100 Employees | Small | 4 |
| Pro Chem Inc. | 423830: Industrial Machinery And Equipment Merchant Wholsalers | $24.48M | 100 | 100 Employees | Small | 2 |
| Pyroil (Highlander Partners, L.P.) | 523910: Miscellaneous Intermediation | $3.3B | 2,337 | $47m Revenue | No | 1 |
| QuestSpecialty Corporation (QuestVapco) | 3256111: Soap And Other Detergent Manufacturing | $56.1M | 60 | 1100 Employees | Small | 2 |
| Sashco Inc. | 339999: All Other Miscellaneous Manufacturing | $8.52M | 100 | 550 Employees | Small | 1 |
| Sprayaway | 325120: Industrial gas Manufacturing | $77M | 350 | 1000 Employees | Small | 1 |
| Spray On Products Group | 424690: Other Chemical And Allied Products Merchant Wholesalers | $6.76M | 3 | 175 Employees | Small | 5 |
| Sullivan Supply, Inc. | 424910: Farm Supplies Merchant Wholesalers | $3.45M | 2 | 200 Employees | Small | 2 |
| United Laboratories, Inc. | 325612: Polish and Other Sanitation Good Manufacturing | $41.63M | 244 | 900 Employees | Small | 1 |
| White Lightning Products | 423990: Other Miscellaneous Durable Goods Merchant Wholesalers | $3.65M | 4 | 100 Employees | Small | 1 |
| Winfield Brooks Company, Inc. (Flow Grinding Corp.) | 333517: Machine Tool Manufacturing | $7.46M | 41 | 500 Employees | Small | 1 |
| Zep Inc. (NM Z Parent Inc.) | 525990: Other Financial Vehicles | $980M | 2,300 | - | No | 6 |

# Use and Alternatives Analysis

This chapter discusses the uses and alternatives for PCE. Section 5.1 gives an 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. In addition, the analysis addresses the TSCA section 6(c)(2)(C) requirement for EPA to consider alternatives. This chapter focuses on the technological and economic feasibility of potential PCE alternatives. A separate analysis evaluates whether the alternatives are beneficial to human health or the environment relative to PCE ([EPA 2023a](#_ENREF_97)).

| Table 5‑1: Use Categories Considered in the Economic Analysis Mapped to the Conditions of Use (COUs) Defined in the Risk Evaluation | |
| --- | --- |
| **Use Category** | **Use Categories Considered in the Economic Analysis Mapped to the Conditions of Use (COUs) Defined in the Risk Evaluation** |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | See section 5.3, Vapor Degreasing. |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) |
| Vapor Degreasing: Web Vapor Degreasing (WVD) |
| Liquid and Spray Batch Cold Cleaning |
| Adhesives and Sealants | See sections 5.4 (Glues, Sealants, Adhesives, and Caulks: Adhesives),  5.5 (Glues, Sealants, Adhesives, and Caulks: Sealants), and 5.6 (Glues, Sealants, Adhesives, and Caulks: Caulk). |
| Aerosol Spray Cleaning/Degreasing | See sections 5.7 (Liquid and Aerosol Cleaners and Degreasers: Automotive Air Conditioner Flush), 5.8 (Liquid and Aerosol Cleaners and Degreasers: Auto Parts Degreasers), 5.9 (Liquid and Aerosol Cleaners and Degreasers: Brake Cleaning Products), 5.10 (Liquid and Aerosol Cleaners and Degreasers: Electronics Degreasers), and 5.11 (Liquid and Aerosol Cleaners and Degreasers: Energized Electrical Equipment Degreasers). |
| Wipe and Liquid Cleaning and Polishing |
| Photographic Film Use | See section 5.12, Motion Picture Film Cleaners. |
| Lubricants and Greases | See section 5.13, Lubricants and Greases. |
| Inks and Ink Removal | See section 5.14, Screen Print Ink Removers. |
| Anti-Spatter Welding Aerosol | See section 5.15, Anti-Spatter . |
| Mold Cleaning, Release and Protectants | See section 5.16, Mold Releases and Cleaners. |
| Dry Cleaning Machines | See section 5.17, Dry Cleaning Machines. |
| Spot Removers | See section 5.18, Spot Removers. |
| Manufacturing | Not considered/not applicable; see section 5.2. |
| Import/Repackage |
| Reactant/Intermediate |
| Processing Aid in Petrochemical Manufacturing |
| Production of Maskant for Chemical Milling |
| Use as Maskant for Chemical Milling |
| Processing Aid, Except Petrochemical |
| Paint and Coatings |
| Incorporation into Other Formulation, Mixture, and Reaction Products |
| Laboratory Chemicals |
| Recycling and Disposal |
| Note that some COUs map to more than one use category. | |

## 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 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, one 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.

### Substitute Chemicals

For any effort to eliminate or replace PCE, 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 PCE 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.

### 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 PCE and are shaded grey for products containing other TSCA work plan chemicals. All rows with products containing alternatives are not shaded.

#### Description

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

#### Solvent Ingredients

The solvent ingredients are provided for each of the products reviewed. The solvent names and concentrations were obtained from product 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.

#### 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 in replacement products if PCE 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 PCE. When including only products with a higher number of customer reviews, the number of alternative products excluded from the analysis was greater than for PCE products. Consequently, the current market share percentage may be overstated for the PCE products in these product categories. However, this would have no impact on the estimated market share percentage for replacement products after PCE 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 stated 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.

#### Volatile Organic Compounds Content

This section provides volatile organic compound (VOC) regulatory limits established by 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 that EPA uses is as follow: "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](#_ENREF_54)). OTC is a multi-state organization that was created under the Clean Air Act. OTC is responsible for advising 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](#_ENREF_40)). SCAQMD is the regulatory agency responsible for improving air quality for large areas of Los Angeles, Orange County, Riverside and San Bernardino counties in the state of California ([SCAQMD 2021](#_ENREF_49)). 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 PCE are VOC exempt chemicals,[[6]](#footnote-8) while 1-bromopropane (1-BP), N‑Methylpyrrolidone (NMP), and trichloroethylene are not VOC exempt chemicals. Commonly used solvents in chemical product formulations that are VOC exempt include water, acetone, dimethyl carbonate, methyl acetate, parachlorobenzotrifluoride (PCBTF), propylene carbonate, and tert butyl acetate.

#### Fire Safety

The products reviewed were mainly composed of liquid solvents. "Flash point" is defined by the U.S. Occupational Safety and Health Administration (OSHA) 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](#_ENREF_35); [U.S. Department of Transportation 2009](#_ENREF_67)). 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 2009). For the purposes of this analysis, EPA 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.

#### 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 PCE product for any given application. Thus, they do not account for differences in effectiveness between products that affect the amount of product needed per use.

#### Conclusion

The conclusion to each section summarizes findings and assesses whether any efficacy or cost barriers exist to using the alternative products as replacements for products containing PCE.

#### Additional Efficacy Factors

For certain product categories (e.g., brake cleaners), additional efficacy factors were also assessed. Examples include removal time, no damage to substrate material, and irritating odor. For removal time, if removal time test results were not available, then Hansen Solubility Parameter (HSP) data were used as a surrogate. Further information about the Hansen Solubility Parameters theory and application can be found in Appendix B. These additional efficacy factors were included only for applicable product categories.

## 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 were excluded are presented in Table 5‑2.

| Table 5‑2: Conditions of Use from the PCE TSCA Risk Evaluation That Are Not Analyzed Further in This Use and Alternatives Analysis | | |
| --- | --- | --- |
| Use Category | Conditions of Use | Explanation |
| 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 PCE 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 in Petrochemical Manufacturing | * Industrial and commercial use as a processing aid in catalyst regeneration in petrochemical manufacturing | Possible alternatives to PCE for this use are either likely to be banned through other rules for the first 10 TSCA work plan chemicals (e.g., PCE) or are likely significantly more dangerous in this use than PCE (e.g. chlorine gas). |
| Reactant/Intermediate Reactant | * Processing as a reactant/intermediate | In this use category, EPA did not find it practicable to consider whether there are alternative processes that directly replace PCE 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. The lack of known alternatives for this use is accounted for in the development of the regulatory options. |
| Production of Maskant for Chemical Milling | * Incorporation into formulation, mixture, or reaction product in paint and coating products | There are no current alternatives to the use of PCE in chemical milling. |
| Use as maskant for chemical milling | * Industrial and commercial use in paints and coatings as a maskant for chemical milling |
| Incorporation into Formulation, Mixture, or Reaction Product | * Processing: incorporation into a formulation, mixture, or reaction products * Industrial and commercial use as solvent that becomes part of a formulation or mixture | The alternatives are the processing or industrial/‌commercial use of a solvent to make products that do not contain PCE. Therefore, chemical alternatives to PCE are accounted for in later stages of the chemical’s life cycle. |
| Recycling and Disposal | * Recycling * Disposal | There are no alternatives to recycling and disposal in terms of products or alternative methods. |
| Laboratory Chemicals | * Industrial and commercial use in Laboratory Chemicals | The alternatives for laboratory chemicals would vary depending on the specific lab use. For some lab uses, using a similar solvent identified in a different product category would be practical. However, for uses such as a standard for testing, there are no alternatives. The lack of known alternatives for these use categories is accounted for in the development of the regulatory options. |
| Processing Aid, Except Petrochemical | * Industrial and commercial use as a processing aid in sectors other than petrochemical manufacturing | EPA identified one firm that appears to be using PCE as a processing aid in agricultural chemical manufacturing based on TRI data, but additional information about this use is not reasonably available. For this analysis, EPA assumes that there are economically feasible alternatives to PCE for this COU but was unable to estimate costs for switching to alternatives. |
| DOD Uses | * Industrial and commercial use in specialty DOD uses (oil analysis and water pipe repair) | DOD informed us of this use. Based on market research, EPA was unable to find current products containing PCE. EPA assumes that there are economically feasible alternatives to PCE for this COU but was unable to consider, to the extent practicable based on reasonably available information, whether these alternatives benefit health or the environment compared to this COU for PCE. |
| Paint and Coatings | * Industrial and commercial use in paints and coatings | There is evidence that PCE has historically been used in select products in this category. Based on market research, EPA was unable to find current products containing PCE, but some public comments indicate there may be some proprietary industrial use in paints and coatings. EPA assumes that there are economically feasible alternatives to PCE for this COU but was unable to consider, to the extent practicable based on reasonably available information, whether these alternatives benefit health or the environment compared to this COU for PCE. |

## Vapor Degreasing and Batch Cold Cleaning

Possible technologically and economically feasible alternative cleaning methods to the use of PCE in vapor degreasing 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 (Institute for Research and Technical Assistance [IRTA] [2016b](#_ENREF_23); [2016a](#_ENREF_22)). Three solvents sometimes used for vapor degreasing are also included in the first 10 TSCA work plan chemicals: methylene chloride, trichloroethylene, 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 vapor degreasing solvents for PCE. Some alternatives to the use of PCE in vapor degreasing are nonflammable mixes of trans-1,2-dichloroethylene and fluorinated chemicals; the availability of these chemical mixes will be impacted by 3M’s decision to cease manufacturing per- and polyfluoroalkyl substances (PFAS), including NOVEC products (mixes of trans-1,2-dichloroethylene and PFAS).

EPA consulted with critical cleaning experts Barbara Kanegsberg and Ed Kanegsberg of BFK Solutions about alternatives to PCE 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; and
* the volume of components being cleaned.

Based on research, EPA expects that current users of PCE may need to test multiple different cleaning processes before identifying a successful process, and that some users may transition from using PCE in vapor degreasing to more than one alternative cleaning chemical/method.

The critical cleaning consultants considered alternatives to the use of PCE in three sizes of degreasers used in the four cleaning categories. These are listed in the first two columns of Table 5‑3. The twelve primary cleaning methods are presented in the last column in Table 5‑3.

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.

The critical cleaning experts defined four “cleaning categories” that would need different processes and cleaning requirements for switching to an alternative cleaning method from vapor degreasing with PCE. 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.

In addition to the list of primary cleaning methods included in Table 5‑3, there are other cleaning methods such as carbon dioxide, laser, and plasma that were not included because they are unlikely to be a primary replacement for a baseline method. They may be used as supplemental methods in order to achieve required cleanliness specifications. However, each method that is used will incur equipment and process development costs.

Table 5‑4 presents the descriptions of the 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 |  | Airless Degreaser with PCE (alternative to PCE in Open-Top Vapor Degreaser) |
| 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 |  | 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 |
|  | |  |  | Airless Degreaser for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols |
|  | |  |  | Co-Solvent, Bi-Solvent |
|  | |  |  | High boiling, non-vacuum, non-rinse |
|  | |  |  | Semi-Aqueous |
|  | |  |  | Aqueous Cleaning |
|  | |  |  | Hybrid system (example: Inventec, HEMO) |

| Table 5‑4: Alternative Cleaning Methods and their Definitions | |
| --- | --- |
| Cleaning Method | Definition |
| Airless Degreaser with PCE  (alternative to PCE in Open-Top Vapor Degreaser) | 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. While an OTVD that recirculates/redistills/reuses the solvent may be described as “closed loop”, such systems have not been demonstrated to match the low level of solvent loss achieved with an airless system. |
| 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-dichloroethylene (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. Trans-DCE is currently undergoing Risk Evaluation by TSCA. 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 |
| 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, trans-1-chloro-3,3,3-trifluoropropene 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” in OTVDs currently in use for chlorinated or brominated solvents. |
| 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. 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 isopropanol 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. |
| OTVD for Very low Flashpoint (<0C) solvent |
| Airless Degreaser 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 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. |
| Co-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 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.  **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-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.  **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 alcohol. 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-solvent and co-solvent processes involve Flashpoint-inerted trans-DCE as the rinsing/displacement agent, 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 | 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 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, 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 high. Carryover of solvent into the rinse tank can be a problem. |
| Aqueous 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, the water quality can range from tap water to purified water, for example, de-ionized or reverse osmosis.  Aqueous formulations vary in their composition (organic and inorganic additives), the pH, and the concentration at which they are used. 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 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.  The cost analyses generally consider aqueous systems to consist of one or two wash tanks followed by HOW MANY rinse tanks and a dryer. Here are a few non-encompassing examples of aqueous cleaning equipment that are not a sequence of 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 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 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. 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 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. |

## Glues, Sealants, Adhesives, and Caulks: 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](#_ENREF_21)). 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.

### Solvent Ingredients

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

| Table 5‑5: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher for Reviewed Adhesives | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Supplier | Product | Appli- cation | SDS | SDS date | Solvent ingredients | Concen- tration (%) |
| 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 |
| 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_Bnv70k17zHvu9lxtD7SSSSSS--> | 5 August 2019 | Methylene Chloride | 60 - 85 |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | | |

Table 5‑6 shows the anticipated, approximate market share percentage of primary solvents in products estimated using the chemical ranking procedure. If restrictions were implemented for PCE, 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. These Benchmark 1 solvents are potential regrettable substitutions for PCE. There are numerous commercially available alternative products for adhesive products without Benchmark 1 solvents.

| Table 5‑6: Estimated Percentage Share of Solvent Ingredients for Reviewed Adhesive Applications Only | | |
| --- | --- | --- |
| Solvent | Current market share | Projections for replacement products |
| Perchloroethylene | 13% | 0% |
| Methylene Chloride | 32% | 0% |
| Trichloroethylene | 2% | 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 PCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals. | | |

### Volatile Organic Compounds Content

VOC information was reviewed in product SDSs, and summarized findings are in Table 5‑7. 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 EPA and many states. A VOC limit for acrylic-specific adhesives was not identifiable (e.g., Weld On #3 Acrylic Plastic Cement).

The product containing PCE did not have VOC information in its SDS. Two of the products containing methylene chloride and trichloroethylene 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).

| Table 5‑7: VOC Content for Adhesives Based on Information in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| E6000 | E6000 MV Clear Industrial Strength Adhesive | No information in SDS |
| 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 |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | |

### Fire Safety

Flash points and flammability ratings were reviewed in product SDSs, and summarized findings are in Table 5‑8. The product containing PCE was rated non-flammable. The alternative products were rated non-flammable, flammable, or extremely flammable. Restricting PCE 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 5‑8: Flash Point and Flammability Ratings for Adhesives Based on Information in SDSs or Technical Data Sheets | | | |
| --- | --- | --- | --- |
| Supplier | Product | Flash Point | Flammability Rating |
| E6000 | E6000 MV Clear Industrial Strength Adhesive | >230 °F (>110 °C) | Non-flammable |
| IPS | Weld On #3 Acrylic Plastic Cement | None | Non-flammable |
| 3M | 3M Hi-Strength Non-Flammable 98NF Bulk Adhesive | No flash point | 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | |

### 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 5‑9. 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 PCE, methylene chloride, and trichloroethylene ranged from $0.43 (3M Hi-Strength Non-Flammable 98NF Bulk Adhesive) to $4.24 per ounce. Note that the lowest priced product had a volume of 54 gallons. 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 PCE, methylene chloride, and trichloroethylene.

Two of the products containing PCE, methylene chloride, and trichloroethylene 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 PCE. However, the average rating of alternative products was 4.4, indicating overall customer satisfaction with these products.

| Table 5‑9: 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 |
| 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 |
| 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 |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

### Conclusion

The market review of adhesives was limited to three representative types of adhesives. The review included one product containing PCE, one product containing methylene chloride, one product containing both trichloroethylene and methylene chloride, 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 PCE 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 PCE. Average customer ratings of alternative products were slightly lower than that of products containing a PCE. Customer satisfaction was still high for alternative product ratings, as average ratings were 4.4 out of 5 stars.

Note that there may be some safety-critical applications, such as adhesives used in aviation, where alternatives would need to undergo extensive safety reviews and testing before they could replace the PCE adhesives.

## Glues, Sealants, Adhesives, and Caulks: Sealants

The terms "caulk" and "sealant" are often used interchangeable since both are used for sealing joints and gaps. The key difference is that caulks are more rigid when cured than sealants. Therefore, sealants provide more elasticity and water resistance for applications with weather fluctuation and high moisture levels ([Oatey 2021](#_ENREF_33)).

Sealants are used to block passage of fluids, dusts, sound, or heat in materials. Sealants can be permanent or temporary but are not considered adhesives. Sealants are classified as chemically reactive, physically reactive, or non-reactive, and offer different properties based on their classification. They are often sold in squeeze tubes or cartridges in sizes ranging from 5 ounces to 10 ounces. This is a broad category with many products designed for specific applications; the review selected a variety of products designed for gutters, doors and windows, gaskets, or concrete and masonry.

### Solvent Ingredients

The review included one product containing methylene chloride and two products containing PCE. EPA also reviewed four products containing alternative solvents including benzene, xylenes, PCBTF, Stoddard solvent, and petroleum distillates. Table 5‑10 shows the list of products reviewed for this report and their major solvent ingredients.

| Table 5‑10: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher for Reviewed Sealants | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | SDS | SDS date | Solvent ingredients | Concentration (%) |
| Amerimax Home Products, Inc. | AMERIMAX® SeamerMate® Professional Grade Permanent Gutter Seal Gray | https://images.homedepot-static.com/catalog/pdfImages/ef/ef514f3d-2e47-4d05-8089-fbe122799797.pdf | 01 May 2015 | Perchloroethylene | ≥50 - <75 |
| Geocel Products Group | Geocel® Instant Gutter Seal Gutter & Narrow Seam Sealant Aluminum Gray | https://www.paintdocs.com/docs/webPDF.jsp?SITEID=GEOCEL&prodno=GC29102&doctype=SDS | 16 January 2021 | Perchloroethylene | 50 |
| ITW Permatex | PX 101MA Copper Gasket Sealant | <http://www.permatex.com/wp-content/uploads/tech_docs/sds/01_USA-English/80697.pdf> | 06 February 2019 | Methylene Chloride | 10 - 30 |
| Acetone | 10 - 30 |
| Ethyl acetate | 3 - 7 |
| Solvent Naphtha | 1 - 5 |
| OSI | OSI GS121 Clear Synthetic Polymer Gutter Sealant | <https://images.thdstatic.com/catalog/pdfImages/ef/ef67d334-e411-47cf-80ca-552684ba1083.pdf> | 28 October 2014 | Benzene, ethenyl-, polymer with (1- methylethenyl)benzene, hydrogenated | 10 - 30 |
| Xylenes | 10 - 30 |
| Stoddard solvent, <0.1% Benzene | 10 - 30 |
| Ethylbenzene | 5 -- 10 |
| DAP | Dynaflex 230 Window, Door, & Trim Sealant | <https://images.thdstatic.com/catalog/pdfImages/bf/bf8c1582-9e86-47eb-8e5f-2b6ae1984b5a.pdf> | 23 October 2018 | Petroleum distillates | 1 - 5 |
| Loctite | PL S10 Concrete Crack and Masonry Polyurethane Sealant | <https://images.thdstatic.com/catalog/pdfImages/90/90c9a532-dcfb-4cfd-8ca5-327f298a32ce.pdf> | 28 October 2014 | Petroleum distillates | 1 - 5 |
| OSI | Quad Window, Door, and Siding VOC Advanced Formula Sealant | <https://images.thdstatic.com/catalog/pdfImages/e4/e4c70688-06bd-4830-b68c-c021c0d9d7ce.pdf> | 13 October 2014 | PCBTF | 10 - 30 |
| Aliphatic hydrocarbon | 10 - 30 |
| Xylenes | 1 - 5 |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

Table 5‑11 shows the anticipated, approximate market share percentage of primary solvents in products estimated using the chemical ranking procedure. The current market share percentage for PCE may be skewed higher since there are many more products without PCE that were not included in the review. After potential chemical restrictions, it is anticipated that acetone and petroleum-based chemicals will be the most used solvents in sealant products.

| Table 5‑11: Estimated Percentage Share of Solvent Ingredients for Reviewed Sealants | | |
| --- | --- | --- |
| Solvent | Current market share | Projections for replacement products |
| Perchloroethylene | 37% | 0% |
| Methylene chloride | 10% | 0% |
| Acetone | 10% | 19% |
| PCBTF | 10% | 19% |
| Petroleum distillates | 11% | 21% |
| Xylene | 7% | 13% |
| Ethylbenzene | 6% | 11% |
| Stoddard solvent | 6% | 11% |
| Other | 1% | 3% |
| 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 PCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals. | | |

### Volatile Organic Compounds Content

VOC information was reviewed in product SDSs, and summarized findings are in Table 5‑12. The VOC limit for sealants in most U.S. states is 4 percent by weight. The products containing PCE or methylene chloride did not have VOC content information in their SDSs, likely because they are below the 4 percent limit. Three of the alternative products (Dynaflex 230; PL S10 Concrete Crack and Masonry Polyurethane Sealant; and Quad Window, Door, and Siding VOC Advanced Formula Sealant) had VOC content lower than the 4 percent limit. OSI GS121 Clear Synthetic Polymer Gutter Sealant had the highest VOC content at 37.2 percent. Restricting use of PCE in sealants is unlikely to affect availability of low VOC products, as there are alternative sealant products on the market with VOC percentage below the 4 percent limit.

| Table 5‑12: VOC Content for Sealants Based on Information in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| Amerimax Home Products, Inc. | Amerimax SeamerMate Professional Grade Permanent Gutter Seal Gray | No information in SDS |
| Geocel Products Group | Geocel Instant Gutter Seal Gutter & Narrow Seam Sealant Aluminum Gray | No information in SDS |
| ITW Permatex | PX 101MA Copper Gasket Sealant | No information |
| OSI | OSI GS121 Clear Synthetic Polymer Gutter Sealant | 37.2%, 337 g/l |
| DAP | Dynaflex 230 Window, Door, & Trim Sealant | 1.9%, 27 g/L |
| Loctite | PL S10 Concrete Crack and Masonry Polyurethane Sealant | 2.89%, 33 g/l |
| OSI | Quad Window, Door, and Siding VOC Advanced Formula Sealant | 1.49%, 194 g/l |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | |

### Fire Safety

EPA reviewed flash points and flammability ratings in product SDSs and summarized findings in Table 5‑13. Two products had flammability ratings other than non-flammable, PX 101MA Copper Gasket Sealant (methylene chloride) and OSI GS121 Clear Synthetic Polymer Gutter Sealant (alternative solvent). Quad Window, Door, and Siding VOC Advanced Formula Sealant is sold as a solid and does not have a flammability rating. All other products had a non-flammable rating. Based on the product reviews, restricting PCE in this product category is unlikely to affect availability of non-flammable products on the market.

| Table 5‑13: Flash Point and Flammability Ratings for Sealants Based on Information in SDSs or Technical Data Sheets | | | |
| --- | --- | --- | --- |
| Supplier | Product | Flash Point | Flammability Rating |
| Amerimax Home Products, Inc. | AMERIMAX SeamerMate Professional Grade Permanent Gutter Seal Gray | >199.9°F (>93.3°C) | Non-flammable |
| Geocel Products Group | Geocel Instant Gutter Seal Gutter & Narrow Seam Sealant Aluminum Gray | No information in SDS | No information in SDS |
| ITW Permatex | PX 101MA Copper Gasket Sealant | -155°F (-104°C) | Extremely flammable |
| OSI | OSI GS121 Clear Synthetic Polymer Gutter Sealant | 80.01°F (26.67°C) | Flammable |
| DAP | Dynaflex 230 Window, Door, & Trim Sealant | 212°F (100°C) | Non-flammable |
| Loctite | PL S10 Concrete Crack and Masonry Polyurethane Sealant | 192.2°F (89°C) | Non-flammable |
| OSI | Quad Window, Door, and Siding VOC Advanced Formula Sealant | Product is a solid. Burn Rate: <2.2 mm/second | No information in SDS |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | |

### Pricing and Customer Reviews

Pricing and customer review information was accessed on publicly available websites in July 2021, and the summarized findings are in Table 5‑14. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Products containing PCE ranged from $0.80 per ounce to $1.35 per ounce. Alternative product pricing ranged from $0.49 per ounce to $0.78 per ounce. The pricing for all products containing PCE was higher than for the alternative products.

All products considered in the review had at least 80 customer ratings. The higher number of reviews allows for a more accurate understanding of consumer opinions. The products containing PCE or methylene chloride had customer ratings ranging from 4.3 (Geocel Instant Gutter Seal Gutter & Narrow Seam Sealant Aluminum Gray) to 4.7 (PX 101MA Copper Gasket Sealant) with an average customer rating of 4.5. Ratings for the products with alternative solvents ranged from 3.9 (OSI GS121 Clear Synthetic Polymer Gutter Sealant) to 4.6 (Quad Window, Door, and Siding VOC Advanced Formula Sealant), with an average customer rating of 4.2. Overall, the average rating of products containing an alternative solvent is lower than that of products containing a PCE. However, an average 4.2 rating indicates that customers are satisfied with their experience using alternative products. Based on the customer rating information reviewed, restricting PCE in this product category is unlikely to limit effective options on the market that work well for consumers.

| Table 5‑14: Pricing and Customer Review Information for Sealants Based on Manufacturer and Retailer Web Pages | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | Retail information | Price per ounce | Customer ratings (out of 5) | Number of customer reviews |
| Amerimax Home Products, Inc. | AMERIMAX SeamerMate Professional Grade Permanent Gutter Seal Gray | <https://www.homedepot.com/p/Amerimax-Home-Products-10-oz-Gutter-Sealant-85148/100011940> | $0.80 | 4.4 | 127 |
| Geocel Products Group | Geocel Instant Gutter Seal Gutter & Narrow Seam Sealant Aluminum Gray | <https://www.amazon.com/Geocel-Corp-29102-Instant-Gutter/dp/B0007PNOBA> | $1.35 | 4.3 | 80 |
| ITW Permatex | PX 101MA Copper Gasket Sealant | <https://www.amazon.com/Permatex-Gasket-Hi-Temp-Adhesive-Sealant/dp/B07KKN1NMT> | $1.22 | 4.7 | 710 |
| OSI | OSI GS121 Clear Synthetic Polymer Gutter Sealant | <https://www.homedepot.com/p/OSI-GS121-10-fl-oz-Clear-Gutter-Sealant-1943973/303223987> | $0.70 | 3.9 | 123 |
| DAP | Dynaflex 230 Window, Door, & Trim Sealant | <https://www.homedepot.com/p/DAP-Dynaflex-230-10-1-oz-White-Premium-Elastomeric-Exterior-Interior-Window-Door-and-Trim-Sealant-18275/100035980> | $0.49 | 4.2 | 598 |
| Loctite | PL S10 Concrete Crack and Masonry Polyurethane Sealant | <https://www.homedepot.com/p/Loctite-PL-S10-10-fl-oz-Concrete-Crack-and-Masonry-Polyurethane-Sealant-1618522/203156788> | $0.78 | 4.2 | 354 |
| OSI | Quad Window, Door, and Siding VOC Advanced Formula Sealant | <https://www.homedepot.com/p/OSI-QUAD-Advanced-Formula-10-fl-oz-Brown-253-Exterior-Window-Door-and-Siding-Sealant-2012156/206156408> | $0.63 | 4.6 | 788 |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

### Conclusion

The market review of sealants selected a sampling of products designed for a variety of applications and included a product containing methylene chloride, two products containing PCE, and four products containing a variety of alternative solvents. This review did not find any barriers related to fire safety, pricing, or customer satisfaction that could be caused by restricting use PCE in this product category. VOCs were more difficult to compare, as none of the products containing PCE had VOC information in their SDSs. However, most of the alternative products had VOC content lower than the 4 percent limit, showing that there are alternative low VOC options on the market. Most of the alternative products reviewed were rated non-flammable. The pricing for all products containing PCE was higher than for the alternative products. Average customer ratings of alternative products were slightly lower than those of products containing PCE. Customer satisfaction was still high for alternative product ratings, as average ratings were over 4 out of 5 stars.

## Glues, Sealants, Adhesives, and Caulks: Caulk

Caulks are waterproof materials made from a flexible polymer such as latex or rubber, used to fill and seal joints between building materials. They create a waterproof seal able to expand with changes in temperature. Caulks are sold in a variety of colors, including clear, white, almond, grey, and others. Caulks are typically sold in squeeze tubes around 5 ounces or in tubes designed for use in caulk guns, around 10 ounces. Many caulks are available in hardware stores for commercial use, though some caulks are marketed for industrial or professional use. The terms “caulk” and “sealant” are often used interchangeably since both are used for sealing joints and gaps. The key difference is that caulks are more rigid when cured than sealants. Therefore, sealants provide more elasticity and water resistance for applications with weather fluctuation and high moisture levels ([Oatey 2021](#_ENREF_33)).

### Solvent Ingredients

The review included one product containing PCE and six products containing alternative solvents, including toluene, petroleum distillates, and ethylene glycol. Table 5‑15 shows the list of products reviewed and their primary solvent ingredients.

| Table 5‑15: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher  for Reviewed Caulk Products | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | SDS | SDS date | Solvent ingredients | Concentration (%) |
| Sashco Inc. | Lexel white VOC compliant | <https://www.sashco.com/hi/pdfs/LexelWhiteVOC_SDS.pdf> | 28 August 2018 | Perchloroethylene | 30 – 60 |
| Naphtha (petroleum), hydrotreated light | 1 – 5 |
| Sashco Inc. | Lexel clear paintable solvent caulk | <https://www.sashco.com/hi/pdfs/LXLClear_SDS.pdf> | 19 June 2020 | Toluene | 10 – 15 |
| DAP | Alex Plus white paintable latex caulk | <https://www.dap.com/media/3427/1000201english.pdf> | 23 October 2018 | Petroleum distillates | 1 – 5 |
| White Lightning | 3006 Advanced formula all-purpose white paintable latex caulk | <https://www.paintdocs.com/docs/webPDF.jsp?SITEID=WHITELIGHT&prodno=W12002010&doctype=SDS&lang=2> | 14 April 2021 | Ethylene glycol | ≤3 |
| GE | Paintable silicone supreme | <https://sds.momentive.com/ehswww/testEbiz/e/result/report.jsp?P_LANGU=E&P_SYS=1&P_SSN=1841&P_REP=00000000000000000006&P_RES=1809&winTitle=MSET%203.1> | 25 January 2019 | Distillates, petroleum, hydrotreated middle | 10 - <20 |
| DAP | Commercial kitchen 100% silicone caulk | <https://gesealants.com/products/paintable-silicone-supreme-window-door-sealant/> | 14 December 2018 | Hydrotreated middle distillate | 3 – 7 |
| GE | All-purpose silicone sealant caulk clear | <https://gesealants.com/products/all-purpose-silicone-1-sealant/> | 25 August 2020 | Distillates, petroleum, hydrotreated middle | 10 - <15 |
| Note: Orange shaded rows indicate products that contain PCE. | | | | | |

Table 5‑16 shows the anticipated, approximate market share percentage of primary solvents in products estimated using the chemical ranking procedure. It should be noted that only a small sample of products was reviewed, which may artificially skew the current market share toward the one product with PCE. After restrictions, it is anticipated that petroleum-based chemicals and toluene will be the most used solvents in caulk products.

| Table 5‑16: Estimated Percentage Share of Solvent Ingredients for Reviewed Caulk Products | | |
| --- | --- | --- |
| Solvent | Caulk Products  (current) | Caulk products  (projected after restrictions) |
| Perchloroethylene | 48% | 0% |
| Petroleum based chemical | 41% | 80% |
| Toluene | 8% | 16% |
| Ethylene glycol | 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 PCE. | | |

### Volatile Organic Compounds Content

State VOC limitations were found for caulk products. VOC information was reviewed in product SDSs, and summarized findings are in Table 5‑17. The VOC limit for caulks in most U.S. states is 4 percent by weight. The product containing PCE, Lexel white VOC compliant caulk, was marketed as VOC compliant, and contained 4 percent VOCs. At least one of the alternative products also had VOC content at or lower than the 4 percent limit (Commercial Kitchen 100% Silicone Caulk, 3.1 percent). Lexel clear paintable solvent caulk had the highest VOC content, at 43 percent. The 3006 Advanced formula all-purpose white paintable latex caulk did not have VOC information, likely because it is a water-based product. If PCE were restricted in caulks, users could use existing products on the market with VOC content at or lower than the 4 percent limit.

| Table 5‑17: VOC Content for Caulk Products Based on Information in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| Sashco Inc. | Lexel white VOC compliant caulk | 4%, 40.7 g/L |
| Sashco Inc. | Lexel clear paintable solvent caulk | 43%, 380 g/L |
| DAP | Alex Plus white paintable latex caulk | 1.6%, 27 g/L, |
| White Lightning | 3006 Advanced formula all-purpose white paintable latex caulk | No information in SDS |
| GE | Paintable silicone supreme | 40 g/L |
| DAP | Commercial kitchen 100% silicone caulk | 3.1%, 31 g/L |
| GE | All-purpose silicone sealant caulk clear | 36 g/L |
| Note: Orange shaded rows indicate products that contain PCE. | | |

### Fire Safety

Flash points and flammability ratings were reviewed in product SDSs, and summarized findings are in Table 5‑18. The two Sashco products, Lexel white VOC compliant caulk and Lexel clean paintable solvent caulk, were rated as flammable. All other products had a non-flammable rating (assuming the water-based 3006 Advanced formula all-purpose white paintable latex caulk is non-flammable). Based on the product reviews, restricting PCE in this product category is unlikely to affect availability of non-flammable products on the market.

| Table 5‑18: Flash Point and Flammability Ratings for Caulk Products Based on Information  in SDSs or Technical Data Sheets | | | |
| --- | --- | --- | --- |
| Supplier | Product | Flash Point | Flammability Rating |
| Sashco Inc. | Lexel white VOC compliant | >173 °F (78.3 °C) | Flammable (this rating is inconsistent with flash point data) |
| Sashco Inc. | Lexel clear paintable solvent caulk | 48 °F (8.9°C) | Flammable |
| DAP | Alex Plus white paintable latex caulk | 212 °F (100°C) | Non-flammable |
| White Lightning | 3006 Advanced formula all-purpose white paintable latex caulk | Not applicable | Not applicable (water-based) |
| GE | Paintable silicone supreme | >199 °F (> 93 °C) | Non-flammable |
| DAP | Commercial kitchen 100% silicone caulk | No information in SDS | Non-flammable |
| GE | All-purpose silicone sealant caulk clear | >200 °F (> 93.3 °C) | Non-flammable |
| Note: Orange shaded rows indicate products that contain PCE. | | | |

### Pricing and Customer Reviews

Pricing and customer review information was accessed on publicly available websites in July 2021, and the findings are summarized in Table 5‑19. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Lexel white VOC compliant caulk containing PCE was the most expensive product reviewed at $1.74 per ounce. Prices for alternative products ranged from $0.27 per ounce (3006 Advanced formula all-purpose white paintable latex caulk) to $1.20 per ounce (Commercial kitchen 100% silicone caulk). All products with alternative solvents had a lower price per ounce than the product containing PCE.

All products considered in the review had at least 40 customer ratings. The higher number of reviews allows for a more accurate understanding of consumer opinions. The product with PCE had a customer rating of 4.6 based on a 5-star rating system. Ratings for the products with alternative solvents ranged from 4.2 (Alex Plus white paintable latex caulk) to 4.8 (All-purpose silicone sealant caulk clear). The average customer rating for all alternative products was 4.6, the same as the rating for the product containing PCE. Based on the customer rating information reviewed, products containing alternative solvents may have similar customer satisfaction to products containing PCE.

| Table 5‑19: Pricing and Customer Review Information for Caulk Products Based on  Manufacturer and Retailer Web Pages | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | Retail information | Price per ounce | Customer ratings (out of 5) | Number of customer reviews |
| Sashco Inc. | Lexel white VOC compliant | <https://www.amazon.com/SASHCO-13080-Lexel-Synthetic-Rubber/dp/B00DU1O1UG> | $1.74 | 4.6 | 60 |
| Sashco Inc. | Lexel clear paintable solvent caulk | <https://www.lowes.com/pd/Lexel-10-5-fl-oz-Clear-Paintable-Solvent-Caulk/4714985> | $0.93 | 4.6 | 315 |
| DAP | Alex Plus white paintable latex caulk | <https://www.lowes.com/pd/DAP-Alex-Plus-10-1-oz-White-Paintable-Latex-Caulk/3053791> | $0.28 | 4.4 | 412 |
| White Lightning | 3006 Advanced formula all-purpose white paintable latex caulk | <https://www.lowes.com/pd/White-Lightning-10-oz-Paintable-Caulk/1002702038> | $0.27 | 4.5 | 46 |
| GE | Paintable silicone supreme | <https://www.lowes.com/pd/GE-Supreme-Paintable-Silicone-10-1-fl-oz-White-Paintable-Advanced-Sealant-Caulk/5001891831> | $0.97 | 4.7 | 87 |
| DAP | Commercial kitchen 100% silicone caulk | <https://www.amazon.com/DAP-7079808658-Commercial-Silicone-Building/dp/B00K5Y3S3W> | $1.20 | 4.7 | 103 |
| GE | All-purpose silicone sealant caulk clear | <https://www.lowes.com/pd/GE-All-Purpose-Silicone-1-10-1-oz-Clear-Silicone-Caulk/5001888135> | $0.59 | 4.8 | 722 |
| Note: Orange shaded rows indicate products that contain PCE. | | | | | |

### Conclusion

The market review of caulks included a product containing PCE and a variety of alternative solvents. This review did not find any barriers related to VOC content, fire safety, pricing, or customer satisfaction that could be caused by restricting use of PCE in this product category. Most of the alternative products had similar or lower VOC content compared to the product containing PCE. The products containing at least 90 percent water were likely to have low VOC content as well. Most of the products reviewed were rated non-flammable. All products with alternative solvents had a lower price per ounce than the product containing PCE. Customer ratings were similar for the PCE product and products using alternative solvents.

## Liquid and Aerosol Cleaners and Degreasers: Automotive Air Conditioner Flush

An automotive air conditioner (A/C) system flush clears contaminants that restrict the flow of refrigerants and oil in A/C systems that may lead to lower efficiency of the compressor. A specialized manifold is used, generally by trained technicians, to evacuate old fluid and inject new fluid. Flush fluids are sold for consumer and commercial use and sold in a wide range of volumes. Consumers may also purchase flush fluid as part of a kit with a "canister gun" included to replace used fluid. Containers of flush fluid on the market that were evaluated were sold independently of a kit.

### Solvent Ingredients

The review included one product containing 1-bromopropane and one product with PCE. Four products were also reviewed containing alternative solvents including d-limonene, polyol ester, heptane, isopropyl alcohol, and petroleum distillates. Table 5‑20 shows the list of products reviewed and their primary solvent ingredients.

| Table 5‑20: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher for Reviewed Automotive A/C Flush Products | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | SDS | SDS date | Solvent ingredients | Concentration (%) |
| Mastercool | A/C Flush Solvent 91049-128 | <https://www.mastercool.com/wp-content/uploads/bsk-pdf-manager/2020/10/SDS-91049.pdf> | 16 March 2020 | Perchloroethylene | 5 - 7 |
| Johnsen's | Premium A/C Flush Non- Flammable | https://www.johnsens.com/content/products/sds/6644.pdf | 26 March 2012 | 1-Bromopropane | > 90 |
| Interdynamics | Certified A/C PRO® Power Clean & Flush | <http://cazierexcavating.com/wp-content/uploads/2019/01/MSDS-AC-Pro-Aerosol-Power-Clean-Flush.pdf> | 20 June 2011 | D-Limonene | <25 |
| Aliphatic Petroleum Distillate | <75 |
| FJC | FJC 2032 A/C Flush | <https://fjcinc.com/wp-content/uploads/2019/01/2032.pdf> | 03 January 2019 | Polyol ester | 100 |
| Four Seasons | Super Flush 69994 | <https://www.4s.com/media/3659/69994_sds_en.pdf> | 05 Aug 2015 | Heptane | 60 - 100 |
| Isopropyl alcohol | 15 - 40 |
| Supercool | 22779 Flash Flush | <https://ehs.cranesville.com/msds.pdfs/MSDS(S081).pdf> | 29 October 2014 | Heptane | 80 - 100 |
| Isopropyl alcohol | 10 - 20 |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

Table 5‑21 shows the anticipated, approximate market share percentage of primary solvents in products estimated using the chemical ranking procedure. If restrictions are placed on PCE and 1‑bromopropane, then heptane, polyol ester, and petroleum distillates would have the highest anticipated use.

| Table 5‑21: Estimated Percentage Share of Solvent Ingredients for Reviewed Automotive A/C Flush Products | | |
| --- | --- | --- |
| Solvent | Current market share | Projections for replacement products |
| Perchloroethylene | 2% | 0% |
| 1-Bromopropane | 15% | 0% |
| Heptane | 31% | 37% |
| Polyol ester | 25% | 31% |
| Petroleum distillates | 15% | 18% |
| Isopropyl alcohol | 6% | 8% |
| D-limonene | 5% | 6% |
| 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 PCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals. | | |

### Volatile Organic Compounds Content

VOC information was reviewed in product SDSs, and summarized findings are in Table 5‑22. There is no VOC limit for automotive A/C flush products in the United States. Out of the two products reviewed with 1-bromopropane and PCE, only Premium A/C Flush Non-Flammable containing 1‑bromopropane had VOC information in the SDS. The VOC content of this product was 100 percent. VOC information was only available for two of the alternative products; both Super Flush 69994 and 22779 Flash Flush also had 100 percent VOC content. If 1-bromopropane and PCE were to be restricted in this product category, it is unclear how the market may be affected in terms of low VOC products on the market, as a number of products lacked VOC information and others had 100 percent VOC content.

| Table 5‑22: VOC Content for Automotive A/C Flush Products Based on Information in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| Mastercool | A/C Flush Solvent 91049-128 | No information in SDS |
| Johnsen’s | Premium A/C Flush Non- Flammable | 100% |
| Interdynamics | Certified A/C PRO Power Clean & Flush | No information in SDS |
| FJC | FJC 2032 A/C Flush | Not applicable |
| Four Seasons | Super Flush 69994 | 100% |
| Supercool | 22779 Flash Flush | 100% |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | |

### Fire Safety

EPA reviewed flash points and flammability ratings in product SDSs and summarized findings in Table 5‑23. Both products containing 1-bromopropane and PCE, Premium A/C Flush Non- Flammable and A/C Flush Solvent 91049-128, were non-flammable. One of the alternative products, FJC 2032 A/C flush, was also non-flammable. The other three alternative products, Certified A/C PRO Power Clean & Flush, Super Flush 69994, and 22779 Flash Flush, were rated as combustible or flammable. Restricting PCE in this product category may leave products on the market with a variety of flammability ratings, including non-flammable.

| Table 5‑23: Flash Point and Flammability Ratings for Automotive A/C Flush Products Based on  Information in SDSs or Technical Data Sheets | | | |
| --- | --- | --- | --- |
| Supplier | Product | Flash Point | Flammability Rating |
| Mastercool | A/C Flush Solvent 91049-128 | 171°F (77°C) | Non-flammable |
| J’hnsen's | Premium A/C Flush Non-Flammable | None by ASTM D-93 | Non-flammable |
| Interdynamics | Certified A/C PRO Power Clean & Flush | 120°F (48.8°C) | Combustible |
| FJC | FJC 2032 A/C Flush | > 266°F (130°C) | Non-flammable |
| Four Seasons | Super Flush 69994 | 20°F (-6°C) | Flammable |
| Supercool | 22779 Flash Flush | 25°F (-4°C) | Flammable |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | |

### Pricing and Customer Reviews

EPA accessed pricing and customer review information on publicly available websites in July 2021 and summarized the findings in Table 5‑24. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Pricing for products containing 1‑bromopropane or PCE was slightly lower than for alternative products, ranging from $0.27 per ounce (A/C Flush Solvent 91049-128) to $0.76 per ounce (Premium A/C Flush Non-Flammable). Alternative product pricing ranged from $0.49 per ounce (22779 Flash Flush) to $1.03 per ounce (Certified A/C PRO Power Clean & Flush). Alternative products reviewed in this report have a price range that overlaps with products containing PCE.

The product containing PCE had an overall customer rating of 3.9 (A/C Flush Solvent 91049-128). All the alternative products had at least 60 reviews and ratings ranging from 4.5 (Certified A/C PRO Power Clean & Flush and FJC 2032 A/C Flush) to 4.6 (Super Flush 69994 and 22779 Flash Flush) with an average rating of 4.6. The average rating of products containing an alternative solvent is higher than that of the product containing 1-bromopropane or PCE. The average rating of alternative products was also over 4.5, indicating that customers were satisfied with their experiences using alternative products. Based on the customer rating information reviewed, restricting PCE in this product category is unlikely to limit effective options on the market that work well for consumers.

| Table 5‑24: Pricing and Customer Review Information for Automotive A/C Flush Products  Based on Manufacturer and Retailer Web Pages | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | Retail information | Price per ounce | Customer ratings (out of 5) | Number of customer reviews |
| Mastercool | A/C Flush Solvent 91049-128 | <https://www.amazon.com/Mastercool-91049-128-Yellow-Solvent-gallon/dp/B00RVZ6GC8> | $0.27 | 3.9 | 9 |
| Johnsen's | Premium A/C Flush Non- Flammable | https://www.amazon.com/Johnsens-6644-Premium-Non-Flammable-Complete/dp/B00C874TN2/ | $0.76 | None | None |
| Interdynamics | Certified A/C PRO Power Clean & Flush | <https://shop.advanceautoparts.com/p/interdynamics-certified-a-c-pro-power-clean-flush-1.06-lbs.-ca-compliant-ca-1/7010021-p> | $1.03 | 4.5 | 66 |
| FJC | FJC 2032 A/C Flush | <https://www.amazon.com/FJC-2032-Flush-fl-oz/dp/B000HTNPLU> | $0.59 | 4.5 | 253 |
| Four Seasons | Super Flush 69994 | <https://www.amazon.com/Four-Seasons-69994-Super-Solvent/dp/B004AEQSE4> | $0.56 | 4.6 | 206 |
| Supercool | 22779 Flash Flush | <https://www.amazon.com/TSI-Supercool-22779-Solvent-Based-Gallon/dp/B00SQUIUV2> | $0.49 | 4.6 | 79 |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

### Conclusion

The market review of automotive A/C flush products included one product containing 1‑bromopropane, one product with PCE, and four products containing a variety of alternative solvents. This review did not find any barriers related to pricing or customer satisfaction that could be caused by restricting use of PCE in this product category. Comparing VOC content for products with and without PCE was somewhat difficult. Only one product containing 1-bromopropane had VOC information in its SDS, measuring 100 percent. Two alternative products also had 100 percent VOC content. The other products reviewed did not have VOC information in their SDSs. One of the alternative products was rated non-flammable, indicating some market share of alternative non-flammable products. Alternative products reviewed in this report have a price range that overlaps with products containing PCE. The average customer rating of alternative products was higher than the rating for the one product containing PCE with reviews. Customer satisfaction was high for alternative product ratings, as average ratings were between 4.5 and 4.6 out of 5 stars. Therefore, A/C flush product alternatives are expected to have satisfactory efficacy and price, and at least one commercially available product with comparable VOC content and flammability.

## Liquid and Aerosol Cleaners and Degreasers: Auto Parts Degreasers

Auto parts degreasers are used to clean buildup and grime off automotive parts, including engines, intake valves, throttles, and more. Products are available in a range of volumes for commercial and consumer use and are sold as aerosols or liquids. Aerosol products ranging from 10 to 20 ounces were reviewed in the report. It is important to note that users also have the option to switch to non-aerosol products, although they were not reviewed.

### Solvent Ingredients

The review included one product with PCE (Electric Motor Cleaner). Six alternative products were also reviewed containing alternative organic solvents, including acetone, toluene, petroleum distillates, and others, as well as one aqueous product. Table 5‑25 shows the list of products reviewed for this report and their primary solvent ingredients.

| Table 5‑25: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher  for Reviewed Auto Parts Degreasers | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | SDS | SDS date | Solvent ingredients | Concentration (%) |
| Penray | Electric Motor Cleaner | <https://penray.com/wp-content/uploads/2020/05/1000039937.pdf> | 31 May 2014 | Perchloroethylene | 60 - 100 |
| Gumout | Regane Parts Cleaner Degreaser 540001 | <https://3enoro1q5ve12ubndv13jkpk-wpengine.netdna-ssl.com/wp-content/uploads/2017/05/540001-Gumout-Regane-Auto-Parts-Cleaner-Degreaser.pdf> | 13 May 2015 | Acetone | 60 - 100 |
| Toluene | 5- 10 |
| Blumenthal Brands Integrated LLC | Instant Parts Cleaner And Degreaser Ultra Fast Dry PCD14T | <https://solvewithb.com/sds/PCD14T_EN.pdf> | 31 May 2020 | Acetone | 80 - <90 |
| Heptanes (cyclic and linear) | 5 - <10 |
| CRC | GDI IVD Intake Valve And Turbo Cleaner | <http://docs.crcindustries.com/msds/1003763E.pdf> | 28 August 2019 | Liquefied petroleum gas | 30 - 40 |
| Distillates (petroleum), hydrodesulfurized middle | 20 - 30 |
| Distillates (petroleum), hydrotreated light | 20 - 30 |
| CRC | Throttle Body And Air Intake Cleaner | <http://docs.crcindustries.com/msds/1003688E.pdf> | 22 August 2017 | Acetone | 80 - 90 |
| CRC | Heavy Duty Pro-Strength Degreaser All Purpose Water-Based Degreaser | <http://docs.crcindustries.com/msds/1003816E.pdf> | 12 September 2019 | Water | 70 - 80 |
| 2-butoxyethanol | 3- 5 |
| Alcohols, C9-11, ethoxylated | 3- 5 |
| Blumenthal Brands Integrated LLC | Gunk Engine Brite Engine Degreaser | <https://solvewithb.com/sds/EB1CA_EN.pdf> | 13 April 2020 | Distillates (petroleum), hydrotreated light | 40 - <50 |
| Petroleum distillate aliphatic | 20 - <30 |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

Table 5‑26 shows the anticipated, approximate market share percentage of primary solvents in products estimated using the chemical ranking procedure. If restrictions were implemented for PCE, then it is anticipated that acetone and petroleum distillates would be the most prevalent solvents used in replacement products.

| Table 5‑26: Estimated Percentage Share of Solvent Ingredients for Reviewed Auto Parts Degreasers | | |
| --- | --- | --- |
| Solvent | Current market share | Projections for replacement products |
| Perchloroethylene | 14% | 0% |
| Acetone | 36% | 42% |
| Petroleum distillates | 24% | 28% |
| Water | 14% | 16% |
| Alcohols, C9-11, ethoxylated | 11% | 12% |
| Other | 1% | 2% |
| 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 PCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals. | | |

### Volatile Organic Compounds Content

VOC information was reviewed in product SDSs, and summarized findings are in Table 5‑27. A 75 percent VOC content limit set by EPA was identified for all engine degreasers, which are sold in the category of auto parts degreasers. Several states also have regulatory VOC limits for aerosol (10–35 percent) and non-aerosol (5 percent) degreasers. Electric Motor Cleaner (containing PCE) did not have VOC information in the SDS, but it is likely to have low VOC content since it contains 60–100 percent PCE. Five of the alternative products had VOC content under 10 percent. GDI IVD Intake Valve and Turbo Cleaner had the highest VOC content at 50.8 percent. Restricting use of PCE in auto parts degreasers is unlikely to limit low VOC products, as most of the alternative aerosol products reviewed met the regulatory VOC limits for EPA and states.

| Table 5‑27: VOC Content for Auto Parts Degreasers Based on Information in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| Penray | Electric Motor Cleaner | No information in SDS; likely low VOC content since 60–100% PCE |
| Gumout | Regane Parts Cleaner Degreaser 540001 | 9.50% |
| Blumenthal Brands Integrated LLC | Instant Parts Cleaner And Degreaser Ultra Fast Dry PCD14T | < 8% estimated |
| CRC | GDI IVD Intake Valve And Turbo Cleaner | 50.8%, 440.4 g/L |
| CRC | Throttle Body And Air Intake Cleaner | 9.1% |
| CRC | Heavy Duty Pro-Strength Degreaser All Purpose Water-Based Degreaser | 9.7% |
| Blumenthal Brands Integrated LLC | Gunk Engine Brite Engine Degreaser | 8.9% |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | |

### Fire Safety

Flash points and flammability ratings were reviewed in product SDSs, and the summarized findings are in Table 5‑28. Electric Motor Cleaner was rated non-flammable. Three of the alternative products were rated non-flammable, and three were rated extremely flammable. Though the review included a few alternative products rated as extremely flammable, there were non-flammable alternatives on the market. It is unlikely that the restriction of PCE will limit availability of non-flammable auto parts degreasers on the market.

| Table 5‑28: Flash Point and Flammability Ratings for Auto Parts Degreasers Based on  Information in SDSs or Technical Data Sheets | | | |
| --- | --- | --- | --- |
| Supplier | Product | Flash Point | Flammability Rating |
| Penray | Electric Motor Cleaner | No information in SDS | Non-flammable |
| Gumout | Regane Parts Cleaner Degreaser 540001 | -4 °F (-20 °C) | Extremely flammable |
| Blumenthal Brands Integrated LLC | Instant Parts Cleaner And Degreaser Ultra Fast Dry PCD14T | 4 °F (-15.6°C) | Extremely flammable |
| CRC | GDI IVD Intake Valve And Turbo Cleaner | 187 °F (86 °C) | Non-flammable |
| CRC | Throttle Body And Air Intake Cleaner | < 0 °F (< -17.8 °C) | Extremely flammable |
| CRC | Heavy Duty Pro-Strength Degreaser All Purpose Water-Based Degreaser | None | Non-flammable |
| Blumenthal Brands Integrated LLC | Gunk Engine Brite Engine Degreaser | 473 °F (244.8 °C) | Non-flammable |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | |

### Pricing and Customer Reviews

Pricing and customer review information was accessed on publicly available websites in August 2021, and the summarized findings are in Table 5‑29. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Electric Motor Cleaner cost $3.25 per ounce. Prices for alternatives ranged from $0.20 (Gunk Engine Brite Engine Degreaser) to $1.54 (GDI IVD Intake Valve and Turbo Cleaner) per ounce. The prices for alternative products were all lower than the price of the product containing PCE based on the product review.

All the reviewed products had customer ratings, though Electric Motor Cleaner had fewer than 10 reviews. Electric Motor Cleaner was rated 3.5, and the average rating for alternative products was 4.6. Customer satisfaction is unlikely to be affected by restrictions on PCE, as average ratings for alternative products were higher and close to 5 out of 5.

| Table 5‑29: Pricing and Customer Review Information for Auto Parts Degreasers Based on  Manufacturer and Retailer Web Pages | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | Retail information | Price per ounce | Customer ratings (out of 5) | Number of customer reviews |
| Penray | Electric Motor Cleaner | <https://www.amazon.com/Penray-7014-Electric-Motor-Cleaner/dp/B00DDMQIKS> | $3.15 | 3.5 | 5 |
| Gumout | Regane Parts Cleaner Degreaser 540001 | <https://www.autozone.com/miscellaneous-cleaners-and-degreasers/cleaner-degreaser/gumout-parts-cleaner-aerosol-spray-16oz/848343_0_0> | $0.47 | 4.7 | 26 |
| Blumenthal Brands Integrated LLC | Instant Parts Cleaner And Degreaser Ultra Fast Dry PCD14T | <https://www.amazon.com/Gunk-PCD14T-Instant-Cleaner-Fluid_Ounces/dp/B0776NTS62> | $1.21 | 4.2 | 28 |
| CRC | GDI IVD Intake Valve And Turbo Cleaner | <https://www.amazon.com/CRC-05319-Intake-Valve-Cleaner/dp/B00PHNQKR2> | $1.54 | 4.6 | 707 |
| CRC | Throttle Body And Air Intake Cleaner | <https://www.amazon.com/CRC-05078-Throttle-Air-Intake-Cleaner/dp/B000M8PYO2> | $0.83 | 4.8 | 1024 |
| CRC | Heavy Duty Pro-Strength Degreaser All Purpose Water-Based Degreaser | <https://www.autozone.com/miscellaneous-cleaners-and-degreasers/cleaner-degreaser/p/crc-heavy-duty-pro-strength-degreaser-20oz/943143_0_0> | $0.35 | 4.8 | 29 |
| Blumenthal Brands Integrated LLC | Gunk Engine Brite Engine Degreaser | <https://www.walmart.com/ip/GUNK-Original-Engine-Degreaser-15-oz/16816129> | $0.20 | 4.6 | 47 |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

### Conclusion

The limited market review of auto parts degreasers included one product containing PCE and six products containing alternative solvents. This review did not find any barriers related to VOC content, fire safety, price, or customer satisfaction that may be caused by restricting use of PCE in this product category. Five of the alternative products were under 10 percent VOC, meeting all of the regulatory VOC limits. VOC content could not be compared between the PCE product and alternatives due to lack of VOC information for Electric Motor Cleaner. Three of the alternative products reviewed were rated non-flammable. The prices for alternative products were all lower than the price of the product containing PCE based on the product review. The average rating for alternative products was 4.6, suggesting overall customer satisfaction with these products.

## Liquid and Aerosol Cleaners and Degreasers: Brake Cleaning Products

Brake cleaning products are used to clean contaminants (e.g., brake fluid, brake dust, dirt, grease, oil) off brake pads, linings, drums, calipers, clutches, and cylinders. Many brake cleaning products are provided in aerosol form and are sprayed on the brake elements to be cleaned. The products can also be used for "off label" cleaning such as hard-to-reach engine parts. Aqueous brake cleaning systems are also available. These include ultrasonic washers as well as enzymatic (bio-based) washers. Ultrasonic washers use an aqueous cleaner with cavitation bubbles. Enzymatic washers use microbes to break down contaminants ([PPRC 2021](#_ENREF_41)).

Brake cleaning products are sold to both do-it-yourself retail consumers and commercial customers. Packaging sizes available include 14 ounces, 19 ounces, 1 gallon, 5 gallons, and 55 gallons. In general, the products in package sizes such as 14 ounces and 19 ounces are in aerosol format with a propellant such as carbon dioxide, and the larger package sizes such as 1 gallon, 5 gallons, and 55 gallons are in liquid form and do not contain a propellant. The larger package sizes are less expensive per application and can be used by shops that conduct a high volume of brake cleaning jobs. A barrel pump can be used to extract the brake cleaning fluid from the 55-gallon barrel and then used to fill pressurized handheld sprayers. Both aqueous and solvent based brake cleaning products are also available in large stationary and mobile units.

TURI worked with the auto shop program of a Massachusetts technical high school to eliminate their use of an aerosol brake cleaning product containing perchloroethylene. The school switched to a "SmartWasher" system with "OzzyJuice" degreasing solution. The washing system cleans parts using a particulate trap and a degreasing solution in a parts washer. The particulate trap catches the large particles washed off the car parts. The degreasing solution contains microbes that break down oils and greases washed off the car parts. This approach (though not necessarily using the same brand of washing equipment) is a practical option for many auto shops ([TURI 2019](#_ENREF_52)). In another example, an auto shop in Oregon switched from a chlorinated solvent-based brake cleaner to an ultrasonic cleaning system using an all-purpose cleaner certified under EPA's Safer Choice program. In addition to health and environmental benefits, TURI found that the change improved efficiency and yielded substantial financial savings ([PPRC 2021](#_ENREF_42)). The aqueous system significantly reduced labor time required for cleaning. Additional case study information is available from the Minnesota Technical Assistance Program ([MnTAP 2017](#_ENREF_29)).

### Solvent Ingredients

The most common solvents found as primary ingredients in brake cleaning products are PCE for chlorinated products and acetone for non-chlorinated products. One brake cleaning product containing methylene chloride was found. A variety of non-chlorinated co-solvents are also used (e.g., xylene, heptane, ethyl benzene, cyclohexane, methanol, toluene, and methyl acetate). Auto shops often rely on one vendor for all their product needs when possible, or staff bring in their products of choice. Certain alternative solvents used in brake cleaners have been regrettable substitutions and the source of serious adverse health effects in workers ([UCB 2010](#_ENREF_101)). California and New Jersey have banned the use of chlorinated brake cleaning products. Table 5‑30 shows the list of products reviewed for this report and their primary solvent ingredients.

| Table 5‑30: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher  for Reviewed Brake Cleaning Products | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | SDS | SDS Date | Solvent ingredients | Concentration (%) |
| Berryman | Brake Parts Cleaner 5C-4 1420 | <https://www.berrymanproducts.com/assets/5C-4-aerosol-1420-SDS.pdf> | 28 May 2015 | Methylene Chloride | 60 - 70 |
| Toluene | 15 - 25 |
| Perchloroethylene | 10 - 15 |
| CRC | Brake Parts Cleaner Brakleen 05089 | <http://docs.crcindustries.com/msds/1003707E.pdf> | 15 September 2020 | Perchloroethylene | 90 - 100 |
| 3M | High Power Brake Cleaner 08880 | <https://multimedia.3m.com/mws/mediawebserver?mwsId=SSSSSuUn_zu8l00xm82UPY_1lv70k17zHvu9lxtD7SSSSSS--> | 24 June 2020 | Heptane | 50 - 60 |
| Xylene | 15 - 30 |
| Ethyl benzene | 1 – 11 |
| Methanol | 5 - 10 |
| Kelly-Heartt | True- guard Brake Cleaner | <https://s3.us-east-2.amazonaws.com/keller-heartt-assets/Data+Sheets/TRUEGARD/Truegard%20%20Brake%20Cleaner.pdf> | 12 November 2014 | Naphtha | 75 - 100 |
| Ethanol | 2.5 - 10 |
| 3M | High Power Brake Cleaner 08180 | <https://multimedia.3m.com/mws/mediawebserver?mwsId=SSSSSuUn_zu8l00xm8_SmxtG4v70k17zHvu9lxtD7SSSSSS> | 23 May 2018 | Acetone | 40 - 70 |
| 3M | High Power Brake Cleaner 08179 | <https://multimedia.3m.com/mws/mediawebserver?mwsId=SSSSSuUn_zu8l00xm8_ZMYt9Pv70k17zHvu9lxtD7SSSSSS--> | 4 March 2020 | Acetone | 60 - 100 |
| CRC | Non-Chlorinated Brake Parts Cleaner Brakleen 05054 | <https://docs.crcindustries.com/msds/1003670E.pdf> | 4 October 2017 | Acetone | 80 - 90 |
| CRC | Ozzy Juice SW-4 Heavy Duty Degreasing Solution | http://docs.crcindustries.com/msds/1004853E.pdf | 5 May 2020 | Water | 90 - 100 |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

Table 5‑31 shows the anticipated, approximate market share percentage of primary solvents in products estimated using the chemical ranking procedure. If restrictions were implemented for PCE, then it is anticipated that acetone and water would be the most prevalent solvents used in replacement products. There are several solvents used in alternative products that contain GreenScreen Benchmark 1 chemicals such as toluene, xylene, and naphtha. In the past, hexane has been in used in alternative products and has been responsible for severe cases of occupational disease and disability when used in brake cleaners ([UCB 2010](#_ENREF_101)). These Benchmark 1 solvents are potential regrettable substitutions for PCE. There are numerous commercially available alternative products for brake cleaning products without Benchmark 1 solvents.

| Table 5‑31: Estimated Percentage Share of Solvent Ingredients for Reviewed Brake Cleaning Products | | |
| --- | --- | --- |
| Ingredient | Current market share | Projections for replacement products |
| Perchloroethylene | 22% | 0% |
| Methylene Chloride | 12% | 0% |
| Acetone | 31% | 47% |
| Water | 10% | 16% |
| Naphtha | 9% | 13% |
| Heptane, branched, cyclic, and linear | 6% | 9% |
| Xylene | 3% | 4% |
| Toluene | 3% | 4% |
| All other solvents | 4% | 7% |
| 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 PCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals | | |

### Volatile Organic Compounds Content

VOC regulations for brake cleaning products are present at the state and regional level, but not at the federal level. The VOC regulations are not present in all states, but mostly for states covered by OTC and a few other states such as California. There are four different levels of VOC requirements for brake cleaning products ([ISSA 2019](#_ENREF_25)):

* States with no VOC requirements
* States with a VOC limit of 45 percent by weight such as Massachusetts, Illinois, Ohio, and New York
* States with a VOC limit of 10 percent by weight such as California, Connecticut, and Delaware
* South Coast region of California with a VOC limit of 25 g/L per Rule 1171

Table 5‑32 lists the VOC content for several brake cleaning products, based on information provided in the SDS.

| Table 5‑32: VOC Content for Brake Cleaning Products | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight) |
| Berryman | Brake Parts Cleaner 5C-4 1420 | 21% |
| CRC | Brake Parts Cleaner Brakleen 05089 | 0% |
| 3M | High Power Brake Cleaner 08179 | 9% |
| CRC | Non-Chlorinated Brake Parts Cleaner Brakleen 05054 | 9.2% |
| 3M | High Power Brake Cleaner 08180 | 43.2% |
| 3M | High Power Brake Cleaner 08880 | 96% |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | |

Non-chlorinated brake cleaning products are commercially available to satisfy the various VOC regional and state regulations**.** For example, the 3M High Power Brake Cleaner 08180 product has VOC content of 43.2 percent by weight and would satisfy the state regulations requiring a VOC limit of 45 percent by weight. Also, the 3M High Power Brake Cleaner 08179 product has VOC content of 9 percent and would satisfy the state regulations requiring a VOC limit of 10 percent by weight**.** This reduced VOC content is a result of the product being composed of a significant percentage of a VOC exempt solvent – in this case acetone.

If PCE were restricted from brake cleaning products, there should not be any barriers to attaining VOC compliant products since several PCE free commercially available products are already using VOC exempt solvents. Acetone seems to be the VOC exempt solvent of choice for brake cleaning products. Therefore, if VOC exemption limits are further tightened in the future for brake cleaning products, then the concentration of acetone in products will likely increase.

### Fire Safety

The flash point and flammability ratings are provided in Table 5‑33 for non-aqueous brake cleaning products.

| Table 5‑33: Flash Point and Flammability Ratings for Non-Aqueous Products | | | |
| --- | --- | --- | --- |
| Supplier | Product | Flash point | Flammability rating |
| Berryman | Brake Parts Cleaner 5C-4 1420 | None | Non-flammable |
| CRC | Brake Parts Cleaner Brakleen 05089 | None | Non-flammable |
| 3M | High Power Brake Cleaner 08180 | ≥ -156 F | Extremely Flammable |
| CRC | Non-Chlorinated Brake Parts Cleaner Brakleen 05054 | < 0 F | Extremely Flammable |
| 3M | High Power Brake Cleaner 08179 | > 0 F | Extremely Flammable |
| 3M | High Power Brake Cleaner 08880 | ≥ 15 F | Extremely Flammable |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | |

Methylene chloride and PCE are non-flammable solvents, and brake cleaning products using high concentrations of these solvents are typically non-flammable. Most solvents used as alternatives to methylene chloride and PCE in brake cleaning products have low flash points, and their use results in products that are extremely flammable (flash point less than 20°F). For example, the CRC Brake Parts Cleaner 05054 has a flash point less than 0°F and has an "extremely flammable" rating. Aqueous brake cleaners, on the other hand, eliminate this flammability concern.

Since the non-chlorinated brake cleaning products commercially available are extremely flammable, there is a potential barrier to replacing methylene chloride and PCE based products in aerosol brake cleaning applications based upon fire safety requirements. However, non-aerosol products do not pose the same fire safety concerns and are also effective.

### Removal Time

The brake cleaning products must either dissolve and wash away the target contaminants or sufficiently soften the target material so that it can be removed with a brush, microfiber cloth, or rag. Removal time is the amount of time required for the target contaminants to either dissolve or be softened by continual spraying of the aerosol product onto the target contaminants. In general, the faster the brake cleaning product works, the faster the brake cleaning project will be finished, and the less the amount of cleaner fluid required to complete the project. Two major factors that affect removal time are: 1) the efficiency of the brake cleaning solvents to dissolve the brake residue, and 2) the power of the spray emitted by the product. There is no publicly available information to evaluate spraying power for the various brake cleaning products.

3M has provided results for a comparison of removal time performance for two of its products and an unnamed competitor product ([3M 2021](#_ENREF_1)). The test was conducted for aerosol brake cleaning products used with oil as the target contaminant on a metal substrate. The removal time performance results are provided in Table 5‑34.

| Table 5‑34: Removal Time Performance | | | |
| --- | --- | --- | --- |
| Supplier | Product | VOC Content | Removal Time |
| 3M | High Power Brake Cleaner 08880 | 96% | 4 seconds |
| 3M | High Power Brake Cleaner 08179 | 10% | 20 seconds |
| Unnamed 3M competitor | Unnamed 3M competitor product | Not provided | 70 seconds |

To provide additional insight into any possible barriers related to removal time, the HSP theory (See Appendix B: Hansen Solubility Parameters) can be used to predict which solvents will be able to quickly dissolve and/or soften the target solutes. Since data on brake contaminant removal time and the power of the spray emitted from the product are typically not available for brake cleaning products, the HSP theory for quantifying solvent efficiency was used as the sole surrogate to estimate contaminant removal time.

The brake contaminants that need to be cleaned primarily consist of brake fluid, brake dust (including asbestos), dirt, grease, and lubricating oil. The dirt and dust are often found within the brake fluid, grease, and lubricating oil and will rinse away when the brake fluid, grease, and lubricating oil are dissolved or softened. Therefore, this analysis will focus on dissolving or softening the brake fluid, grease, and lubricating oil used on brake systems.

Triethylene glycol monobutyl ether appears to be the most common primary ingredient for DOT 3 brake fluids that are used in most modern cars and trucks since they work well with anti-lock braking systems. Table 5‑35 has a listing of brake fluid products and the concentration of triethylene glycol monobutyl ether. For each of the brake fluid products listed in Table 5‑35, triethylene glycol monobutyl ether was listed in the SDS as the ingredient with the highest concentration, and therefore the HSP value for this chemical was used to represent the HSP value for brake fluids. The HSP value for triethylene glycol monobutyl ether was found to be 16.2, 6.1, 9.1, based upon using its simplified molecular-input line-entry system (SMILES) chemical structure notation with the Hansen Solubility Parameters in Practice software.

| Table 5‑35: Brake Fluid Product Ingredients | | | |
| --- | --- | --- | --- |
| Supplier | Product | Safety Data Sheet | Concentration of Triethylene glycol monobutyl ether |
| Chevron | Brake and Clutch Fluid DOT 3, 4 | March 11, [2021](C:\\Users\\amonroe\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\HYZEIE0O\\2021https:\\cglapps.chevron.com\\sdspds\\SDSDetailPage.aspx?docDataId=428068&docForm)  [https://cglapps.chevron.com/sdspds/SDSDetailPage.aspx?docDataId=428068&docForm](C:\\Users\\amonroe\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\HYZEIE0O\\2021https:\\cglapps.chevron.com\\sdspds\\SDSDetailPage.aspx?docDataId=428068&docForm)at=PDF | 20 – 30% |
| NAPA | Duty DOT 3 Brake Fluid | April 2, 2015  <https://ebpaving.com/wp-content/uploads/2013/09/Brake-fluid-DOT-3.pdf> | 5 – 50% |
| STP | Heavy Duty Brake Fluid DOT 3 | January 30, 2018  <https://www.stp.com/sites/default/files/STP%C2%AE-Heavy-Duty-Brake-Fluid-DOT-3-32oz-SDS.pdf> | 23 – 35% |

Table 5‑36 lists some lubricating oil products used for brake systems. The petroleum distillates used for these types of products are often a mixture of heavy, naphthenic hydrocarbons. For example, CAS number 64742-52-5 is a mixture of heavy, naphthenic hydrocarbons in the range of C20 to C50. Since CAS number 64742-52-5 is a variable mixture of hydrocarbons, it does not have a specific HSP value. Therefore, the HSP value of cyclotriacontane (C30) was used as a surrogate for lubricating oil products. The HSP value for cyclotriacontane was found to be 17.5, 0.1, 0.1, based upon using its SMILES chemical structure notation with the Hansen Solubility Parameters in Practice software.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 5‑36: Lubricating Oil Products Use for Braking Systems | | | |
| Supplier | Product | Safety Data Sheet | Petroleum-based ingredient |
| 3M | Anti Seize Brake Lube | December 20, [2017](C:\\Users\\amonroe\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\HYZEIE0O\\2017https:\\multimedia.3m.com\\mws\\mediawebserver?mwsId=SSSSSuUn_zu8lZNUMYtx5x21Nv70k17zHvu9lxtD7SS)  [https://multimedia.3m.com/mws/mediawebserver?mwsId=SSSSSuUn\_zu8lZNUMYtx5x21Nv70k17zHvu9lxtD7SS](C:\\Users\\amonroe\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\HYZEIE0O\\2017https:\\multimedia.3m.com\\mws\\mediawebserver?mwsId=SSSSSuUn_zu8lZNUMYtx5x21Nv70k17zHvu9lxtD7SS)SSSS-- | Heavy naphthenic 64641-96-4  (30 – 60%) |
| Dynatex | Brake & Caliper Lubricant | October 30, [2019](C:\\Users\\amonroe\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\HYZEIE0O\\2019https:\\accumetricinc.com\\uplimg\\dynatex\\MSDS\\1434)  [https://accumetricinc.com/uplimg/dynatex/MSDS/1434](C:\\Users\\amonroe\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\HYZEIE0O\\2019https:\\accumetricinc.com\\uplimg\\dynatex\\MSDS\\1434)93.pdf | Heavy naphthenic  64742-52-5  (60 – 80%) |

Table 5‑37 lists some grease products used for brake systems and their ingredients.

| Table 5‑37: Grease Products Used for Braking Systems | | | |
| --- | --- | --- | --- |
| Supplier | Product | Safety Data Sheet | Petroleum based ingredient |
| CRC | Heavy Duty Drum Brake Wheel Bearing Grease | August 13, [2015](C:\\Users\\amonroe\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\HYZEIE0O\\2015https:\\img2.fastenal.com\\infp360pmm\\medias\\docus\\162\\SDS86600)  [https://img2.fastenal.com/infp360pmm/medias/docus/162/SDS86600](C:\\Users\\amonroe\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\HYZEIE0O\\2015https:\\img2.fastenal.com\\infp360pmm\\medias\\docus\\162\\SDS86600)14.pdf | Heavy naphthenic  64742-52-5 (60 – 70%)  Heavy paraffinic 64742-65-0 (20 – 30%) |
| Plews/ Edelmann | Lubrimatic Disc/Drum Brake Wheel Bearing Grease | January 18, 2010  <https://bishopsorchards.com/wp-content/uploads/2017/06/LUBRIMATIC-DISCDRUM-BRAKE-WHEEL-BEARING-www.msdsxchange.com_english_show_msds.cfm_filepath_GENERALPDF_PRESECTION1_1256448.pdf> | Heavy naphthenic  64742-52-5 (30 – 50%)  Heavy paraffinic 64741-88-4 (10 – 30%) |

The petroleum distillates used for grease products are often a mixture of heavy, naphthenic hydrocarbons and heavy, paraffinic hydrocarbons. For example, CAS number 64741-88-4 is a mixture of heavy, paraffinic hydrocarbons in the range of C20 to C50. Therefore, the HSP value of triacontane (C30) was used as a surrogate for heavy, paraffinic hydrocarbons. The HSP value for triacontane was found to be 16.0, 0.1, 0.1, based upon using its SMILES chemical structure notation with the Hansen Solubility Parameters in Practice software. The HSP value for cyclotriacontane was used as a surrogate for heavy, naphthenic hydrocarbon. The formulation ratio for grease products is approximately two parts heavy, naphthenic hydrocarbons to one part heavy, paraffinic hydrocarbons. The HSP value (17.0, 0.1, 0.1) used to represent grease products is calculated in Table 5‑38.

| Table 5‑38: HSP Calculation for Grease Products | | | | | |
| --- | --- | --- | --- | --- | --- |
| Chemical | CAS | Dispersion Force | Polar Force | Hydrogen Bonding Force | Concentration |
| Cyclotriacontane | 297-35-8 | 17.5 | 0.1 | 0.1 | 67% |
| Triacontane | 638-68-6 | 16 | 0.1 | 0.1 | 33% |
| Grease blend |  | 17.0 | 0.1 | 0.1 |  |

The HSP value (16.9, 2.1, 3.1) for the overall brake contaminant is calculated in Table 5‑39. It is assumed that the brake contaminant is composed of equal parts brake fluid, grease, and lubricating oil.

| Table 5‑39: HSP Calculation for Brake Contaminants | | | | |
| --- | --- | --- | --- | --- |
| Chemical | Dispersion Force | Polar Force | Hydrogen Bonding Force | Concentration |
| Brake fluid | 16.2 | 6.1 | 9.1 | 33.3% |
| Lubricating oil | 17.5 | 0.1 | 0.1 | 33.3% |
| Grease | 17 | 0.1 | 0.1 | 33.3% |
| Blend | 16.9 | 2.1 | 3.1 | 100% |

For the purposes of this report, the HSP value (16.9, 2.1, 3.1) for brake contaminants was used as the target solute HSP value for an effective brake cleaner. The HSP values for several products are provided in Table 5‑40. The HSP distance between the different brake cleaning products and the brake contaminants is also provided. The smaller the HSP distance to the brake contaminants, the better the anticipated removal time performance. HSP calculations are provided in Appendix B.

| Table 5‑40: HSP Values for Brake Cleaning Products | | | |
| --- | --- | --- | --- |
| Supplier | Product | HSP | HSP Distance to Brake Contaminants |
| 3M | High Power Brake Cleaner 08880 | 16.0, 1.5, 3.0 | 1.9 |
| Kelly-Heartt | True-Guard Brake Cleaner | 15.5, 0.9, 1.9 | 3.3 |
| Berryman | Brake Parts Cleaner 5C-4 1420 | 17.4, 5.9, 5.0 | 4.4 |
| 3M | High Power Brake Cleaner 08180 | 15.4, 6.4, 4.5 | 5.4 |
| CRC | Brake Parts Cleaner Brakleen 05089 | 18.3, 5.7, 0.0 | 5.5 |
| 3M | High Power Brake Cleaner 08179 | 15.6, 8.9, 6.1 | 7.9 |
| CRC | Non-Chlorinated Brake Parts Cleaner Brakleen 05054 | 15.5, 9.4, 6.3 | 8.5 |
| CRC | Ozzy Juice SW-4 Heavy Duty Degreasing Solution | 15.5, 16, 42.3 | 41.7 |

In general, the lower the VOC content of non-chlorinated products, the greater the HSP distance from the brake contaminants. However, this depends upon the solvents used in the formulation.

The PCE and methylene-chloride-based products have a range of HSP distances between 4.4 to 5.5. There are non-chlorinated brake cleaning products (3M 08880 and 3M 08180) commercially available with HSP values that predict similar or better removal time compared to PCE and methylene-chloride-based products. If PCE and methylene chloride were restricted from brake cleaning products, there should not be barriers due to removal time.

### Drying Time

After the brake parts have been cleaned, they can either be air dried or wiped dry with a clean rag, or the brake job can be completed with the surface still wet. Fast drying can be an advantage for shops that prefer a dry surface before completing the brake job. Fast drying time also implies rapid evaporation of the solvents into the work space, with potential consequences for occupational exposures. Many brake cleaning products tout their fast drying time. For example, the Cyclo C111 non-chlorinated brake cleaning product has a reported dry time of 6 seconds. (Cyclo, 2021), The Cyclo C111 product is composed of 30–40 percent toluene, 30–40 percent heptane, and 20–30 percent acetone (Cyclo, 2007).

Relative evaporation rate is the rate at which a material will evaporate compared to the rate of vaporization of a specific known material. This quantity is a ratio, and it is unitless. The relative evaporation rate of solvents is often compared to the evaporation rate of butyl acetate, which has a value of 100. As points of reference, xylene has a relative evaporation rate of 70 and is slower to evaporate than butyl acetate, and acetone has a relative evaporation rate of 630 and evaporates approximately six times as fast as butyl acetate.

To better understand the potential drying time for the various brake cleaning products, the relative evaporation rates for individual solvents are presented in Table 5‑41. If a solvent blend is used for the formulation of a product, then each solvent will evaporate at its own relative evaporation rate. Therefore, the solvent (including water) with the lowest relative evaporation rate within a formulation will determine the drying time for a solvent blend formulated product.

| Table 5‑41: Relative Evaporation Rate | |
| --- | --- |
| Solvent | Relative Evaporation Rate |
| D-limonene | 12 |
| Water | 30 |
| Xylene | 70 |
| Perchloroethylene | 87 |
| Ethyl benzene | 89 |
| Toluene | 190 |
| Methanol | 300 |
| Methyl cyclohexane | 300 |
| Trichloroethylene | 308 |
| Heptane | 390 |
| Cyclohexane | 560 |
| Acetone | 630 |
| Hexane | 830 |
| Methyl acetate | 1,180 |
| Methylene Chloride | 1,450 |

PCE has a relative evaporation rate of 87. If PCE were restricted from brake cleaning products, there should not be any barriers to attaining faster drying times since alternative solvents have faster drying times.

Methylene chloride has a relative evaporation rate of 1,450, and all commonly used solvents in brake cleaning products have a lower relative evaporation rate than methylene chloride. The Cyclo C111 non-chlorinated product dries in 6 seconds, so the additional drying time compared to methylene chloride would only be a few seconds. If methylene chloride were restricted from brake cleaning products, it is not anticipated that drying times would present a barrier since PCE and acetone are currently the predominant solvents used in brake cleaning products, and products with both types of solvents receive high customer satisfaction ratings.

### Performance Factor: No Damage to Substrate Material

The product should not stain, discolor, or alter the substrate or corrode a metal substrate. In general, the chlorinated and non-chlorinated brake cleaning products are marketed as being compatible with braking systems’ substrate materials. If PCE and methylene chloride were restricted from brake cleaning products, there should not be any barriers to replacing these products with non-chlorinated alternatives, including water-based products, potential damage to substrate material.

### Irritating Odor

Brake cleaning products that emit strong and/or irritating odors may be unpleasant to the user. It should be noted that products containing hazardous solvents should be used with proper ventilation and personal protective equipment. Further, the unpleasant odor of hazardous solvents can serve as a warning of inhalation exposure to the hazardous solvent. Each solvent has an odor detection threshold and a concentration level that becomes irritating to humans. Table 5‑42 provides a listing of odor detection thresholds and irritating concentration levels for common solvents and solvents used in brake cleaning products ([Ruth 1986](#_ENREF_46)).

| Table 5‑42: Low Odor Detection Threshold and Irritating Concentrations of Solvents | | |
| --- | --- | --- |
| Solvent | Lowest Odor Detection Threshold Concentration (mg/m3) | Irritating Concentration (mg/m3) |
| Hydrogen sulfide | 0.0007 | 14 |
| Acetic acid | 2.5 | 25 |
| Formic acid | 0.045 | 27 |
| Naphthalene | 1.5 | 75 |
| Xylene | 0.35 | 435 |
| Acetone | 47.5 | 475 |
| Toluene | 8.0 | 750 |
| Trichloroethylene | 1.1 | 864 |
| Ethyl benzene | 8.7 | 870 |
| Cyclohexane | 1.4 | 1,050 |
| Perchloroethylene | 31.4 | 1,340 |
| Methylene Chloride | 540 | 8,280 |
| Methanol | 13.1 | 22,875 |
| Methyl acetate | 610 | 30,497 |

Solvents with low irritating concentration levels (such as below 100 mg/m3), such as hydrogen sulfide, acetic acid, and formic acid, are often considered strong and offensive.

The lowest odor detection levels and irritating concentration levels were not found in the literature for many solvents used in brake cleaning products such as d-limonene and naphtha. However, these odor levels were found for many other solvents used in brake cleaning products such as xylene, acetone, ethyl benzene, cyclohexane, methanol, toluene, and methyl acetate. The range of odor detection levels for these solvents was from 0.35 mg/m3 (xylene) to 610 mg/m3 (methyl acetate). The range of irritating concentration levels for these solvents was 435 mg/m3 (xylene) to 30,497 mg/m3 (methyl acetate).

Some brake cleaner solvents such as xylene have lower odor detection and irritating concentration levels than PCE. Some solvents such as methyl acetate have higher odor detection and irritating concentration levels than PCE. Acetone provides a comparable odor detection threshold and irritating concentration to PCE. Therefore, if PCE were restricted from brake cleaning products, there should not be any barriers to replacing the PCE product based upon odor requirements.

### Pricing and Customer Reviews

Pricing and customer review information was accessed on publicly available websites during February 2021, and the findings are summarized in Table 5‑43. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce.

Table 5‑43 provides a representative, but not exhaustive, listing of commercially available brake cleaning products, including the supplier name, product name, URL for product information, customer reviews, and pricing information. A high level of customer satisfaction was achieved for both chlorinated and non-chlorinated brake cleaning products based on customer ratings of 4.6 or higher using a 5-star rating system.

| Table 5‑43: Commercially Available Brake Cleaning Products | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | Product Information | Price per ounce | Customer rating | Customer reviews |
| Berryman | Brake Parts Cleaner 5C-4 1420 | https://www.amazon.com/Berryman-1420-Brake-Cleaner-Compliant/dp/B0002JM886 | $0.55 | 5 | 4 |
| CRC | Brake Parts Cleaner Brakleen 05089 | <https://www.homedepot.com/p/CRC-19-oz-Brake-Parts-Cleaner-Brakleen-05089/205021970> | $0.26 | 4.8 | 15 |
| <https://www.amazon.com/CRC-05089-BRAKLEEN-Brake-Cleaner/dp/B000LDR9HI> | $0.21 | 4.8 | 9,081 |
| <https://www.grainger.com/product/5YK77> | $0.41 | None | None |
| CRC | Non-Chlorinated Brake Parts Cleaner Brakleen 05054 | <https://www.homedepot.com/p/CRC-14-fl-oz-Non-Chlorinated-Brake-Parts-Cleaner-Brakleen-05054/205021971> | $0.30 | 5 | 4 |
| <https://www.amazon.com/CRC-05084-BRAKLEEN-Brake-Cleaner-Non-Chlorinated-14/dp/B000BXKZUQ> | $0.70 | 4.7 | 666 |
| 3M | High Power Brake Cleaner 08880 | <https://www.amazon.com/3M-08880-Power-Brake-Cleaner/dp/B0002FU44K/ref=sr_1_3?dchild=1&keywords=3m+brake+cleaner+08880&qid=1612798683&sr=8-3> | $0.62 | 4.6 | 480 |
| <https://shop.advanceautoparts.com/p/3m-high-power-brake-cleaner-14-oz-08880/7670001-P> | $0.39 Regular,  $0.25  Sale | 4.9 | 63 |
| 3M | High Power Brake Cleaner 08180 | <https://www.amazon.com/3M-08180-Power-Brake-Cleaner/dp/B002WQHY9K> | $0.62 | 4.6 | 480 |
| 3M | High Power Brake Cleaner 08179 | <https://www.amazon.com/3M-08179-Power-Brake-Cleaner/dp/B005RNCZ4E> | $0.71 | 4.6 | 480 |
| Kelly-Heartt | True- guard Brake Cleaner | <https://www.amazon.com/TRUEGARD-Brake-Cleaner-55-Gallon-Drum/dp/B01LW6L1CS> | $0.08 | 4.5 | 8 |
| CRC | 14740 SW-23 Smart Washer Mobile SW-4 Ozzyjuice | <https://www.amazon.com/CRC-14740-Gallon-Smart-Washer/dp/B01AP9UXEI> | $1,673  Reusable system | 4.3 | 5 |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

The CRC brake cleaning product containing PCE has a price range of $0.21 per ounce (Amazon) to $0.41 per ounce (Grainger). The Berryman brake cleaning product containing methylene chloride has a price of $0.55 per ounce. The non-chlorinated, solvent-based brake cleaning products have a price range of $0.25 per ounce to $0.71 per ounce. The reusable aqueous brake cleaning product CRC 14740 is non-aerosol and requires a heating element since the Ozzy juice temperature must be maintained at 105–115°F. An OzzyMat is used as a filter and needs to be changed every 30 days. A price per ounce for the aqueous system was not calculated, but case studies by TURI and other state programs have documented overall savings at auto shops that shifted to this system.

Since at least one non-chlorinated brake cleaning product (3M 08880) that is high performing (in terms of removal time) has a price level in the range of products containing methylene chloride or PCE, there does not appear to be a cost barrier to restricting the use of methylene chloride and PCE brake cleaning products.

### Conclusion

There are alternative brake cleaners available in both aerosol and non-aerosol forms that perform the tasks needed for brake cleaning. Based upon this limited evaluation of the current market for brake cleaning products, it appears that there is a potential fire safety barrier to moving from PCE or methylene-chloride-based brake cleaning products to alternative solvent-based aerosol products, although non-aerosol and aqueous products provide alternatives that offer greater fire safety and prevent worker inhalation of asbestos, still present in some brakes and clutches, or other dusts that become airborne during the brake cleaning process.

## Liquid and Aerosol Cleaners and Degreasers: Electronics Degreasers

Electronic degreasers and cleaners are used to remove soil, grease, oils, oxides, and handling contamination from electronics. These degreasers are made to be used on more delicate electrical contacts, conductive connectors, switches, and other components used in electronics. The products reviewed in this report are in aerosol form in volumes around 15 ounces and are available for consumer purchase. There are other industrial electronic degreasers on the market, but they were not included in this review.

### Solvent Ingredients

The review included three products with PCE, and one with 1-bromopropane. Five products containing alternative solvents were also included, including trans-1,2-dichloroethylene (trans-DCE), ethanol, petroleum distillates, isohexane, and others. Table 5‑44 shows the list of products reviewed for this report and their primary solvent ingredients.

| Table 5‑44: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher  for Reviewed Electronics Degreasers | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | SDS | SDS date | Solvent ingredients | Concentration (%) |
| CRC | Lectra Clean Heavy Duty Electrical Parts Degreaser | <http://docs.crcindustries.com/msds/1003177E.pdf> | 01 November 2017 | Perchloroethylene | 90 - 100 |
| CRC | Electrical Parts Cleaner | <http://docs.crcindustries.com/msds/1003236E.pdf> | 25 October 2017 | Perchloroethylene | 90 - 100 |
| CRC | Lectra Motive Electric Parts Cleaner | <http://docs.crcindustries.com/msds/1003634E.pdf> | 30 June 2021 | Perchloroethylene | 90 - 100 |
| ITW Pro Brands | LPS NoFlash NU | <https://www.itwprobrands.com/sds-results?sds-term=noflash> | 13 February 2018 | 1-Bromopropane | 60 - 70 |
| Ethane, 1,1,1,2-tetrafluoro-(hfc-134a) | 30 - 40 |
| 3M | Novec Electronic Degreaser1 | <https://www.3m.com/3M/en_US/p/d/b00034083/> | 21 July 2021 | Trans-1,2-DCE | 65 - 75 |
| Methyl nonafluoroisobutyl ether | 16.5 - 27 |
| Methyl nonafluorobutyl ether | 3 - 13.5 |
| Chemtronics | Electro Wash PX Degreaser | https://www.chemtronics.com/content/msds/ES810,%20ES1210A,%20ES1210\_United%20States%20(US)%20SDS%20HCS%202012\_English%20(US)%202021.pdf | 1 June 2021 | Ethanol | ≥10 - ≤25 |
| Isopropyl alcohol | ≤5 |
| CRC | QD Electronic Cleaner | <http://docs.crcindustries.com/msds/1003719E.pdf> | 22 March 2019 | Distillates (petroleum), hydrotreated light | 40 - 50 |
| 1,1-difluoroethane | 20 - 30 |
| 2-methylpentane | 20 - 30 |
| n-hexane | 3 - 5 |
| Radio Shack | Precision Electronics Cleaner | <https://cdn.shopify.com/s/files/1/0953/5270/files/SDS-E-6404345C_v30.pdf?14399150985781470012> | 10 June 2015 | Isohexane | 60 - 100 |
| Difluorethane | 10 - 30 |
| Ethanol | 1 - 5 |
| CRC | Lectra Clean II Non Chlorinated Heavy Duty Degreaser | <http://docs.crcindustries.com/msds/1003209E.pdf> | 16 February 2016 | Distillates (petroleum), hydrotreated light | 50 - 60 |
| dipropylene glycol methyl ether acetate | 5 - 10 |
| 1Note that 3M has recently announced that they will discontinue this product by 2025.  Note: Orange shaded rows indicate products that contain perchloroethylene. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

Table 5‑45 shows the anticipated, approximate market share percentage of primary solvents in products estimated using the chemical ranking procedure. If restrictions were implemented for PCE, then it is anticipated that petroleum distillates and trans-DCE would be the most prevalent solvents used in replacement products. It should also be noted that several of the alternative products contain fluorinated solvents, including HFCs and hydrofluoroether chemicals (HFEs).

| Table 5‑45: Estimated Percentage Share of Solvent Ingredients for Reviewed Electronics Degreasers | | |
| --- | --- | --- |
| Solvent | Current market share | Projections for replacement products |
| Perchloroethylene | 40% | 0% |
| 1-Bromopropane | 8% | 0% |
| Petroleum distillates | 13% | 26% |
| trans-1,2-DCE | 8% | 15% |
| Isohexane | 7% | 14% |
| Ethane, 1,1,1,2-tetrafluoro-(hfc-134a) | 6% | 11% |
| 1,1-difluoroethane | 4% | 8% |
| Difluoroethane | 3% | 5% |
| Methyl nonafluoroisobutyl ether | 2% | 4% |
| Other | 9% | 17% |
| 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 PCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals. | | |

### Volatile Organic Compounds Content

VOC information was reviewed in product SDSs, and summarized findings are in Table 5‑46. Regulatory VOC limits were identified for electronics cleaners in a number of states (75 percent), but there are no U.S. federal limits. Three of the products containing PCE had 0 percent VOC content. The product containing 1-bromopropane had around 70 percent VOC content. Three of the products containing alternative solvents had VOC information in their SDSs ranging from 75 percent (QD Electronic Cleaner), to 96 percent (Lectra Clean II Non Chlorinated Heavy Duty Degreaser), all at or over the state restrictions of 75 percent. Restricting use of PCE may affect the availability of low VOC electronic degreasers on the market, especially for states with regulatory VOC limits. However, the market search was limited and may have excluded low VOC alternatives.

| Table 5‑46: VOC Content for Electronics Degreasers Based on Information in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| CRC | Lectra Clean Heavy Duty Electrical Parts Degreaser | 0% |
| CRC | Electrical Parts Cleaner | 0% |
| CRC | Lectra Motive Electric Parts Cleaner | 0% |
| ITW Pro Brands | LPS NoFlash NU | 70.10% |
| 3M | Novec Electronic Degreaser1 | No information in SDS |
| Chemtronics | Electro Wash PX Degreaser | No information in SDS |
| CRC | QD Electronic Cleaner | 75%, 495 g/L |
| Radio Shack | Precision Electronics Cleaner | >94% |
| CRC | Lectra Clean II Non Chlorinated Heavy Duty Degreaser | 96% |
| 1Note that 3M has recently announced that they will discontinue this product by 2025.  Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | |

### Fire Safety

Flash points and flammability ratings were reviewed in product SDSs, and summarized findings are in Table 5‑47. The three products containing PCE were rated non-flammable, and the 1-bromopropane product was rated combustible. Two of the alternative products were rated non-flammable, and three were rated extremely flammable. Though the review included a number of alternative products rated as extremely flammable, there are non-flammable alternatives on the market. It is unlikely that the restriction of PCE will limit availability of non-flammable electronic degreasers on the market.

| Table 5‑47: Flash Point and Flammability Ratings for Electronics Degreasers Based on Information  in SDSs or Technical Data Sheets | | | |
| --- | --- | --- | --- |
| Supplier | Product | Flash Point | Flammability Rating |
| CRC | Lectra Clean Heavy Duty Electrical Parts Degreaser | None | Non-flammable |
| CRC | Electrical Parts Cleaner | None | Non-flammable |
| CRC | Lectra Motive Electric Parts Cleaner | None | Non-flammable |
| ITW Pro Brands | LPS NoFlash NU | <140 °F (60 °C) | Combustible |
| 3M | Novec Electronic Degreaser1 | None | Non-flammable |
| Chemtronics | Electro Wash PX Degreaser | -20 °F (-29 °C) | Extremely flammable |
| CRC | QD Electronic Cleaner | <0 °F (< -17.8 °C) | Extremely flammable |
| Radio Shack | Precision Electronics Cleaner | 15 °F (-9.4 °C) | Extremely flammable |
| CRC | Lectra Clean II Non Chlorinated Heavy Duty Degreaser | 185.0 °F (85.0 °C) | Non-flammable |
| 1Note that 3M has recently announced that they will discontinue this product by 2025.  Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | |

### Pricing and Customer Reviews

Pricing and customer review information was accessed on publicly available websites in August 2021 and the summarized findings are in Table 5‑48. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Pricing for products containing perchloroethylene and 1-bromopropane ranged from $0.42 (Lectra Clean Heavy Duty Electrical Parts Degreaser) to $2.92 (LPS NoFlash NU) per ounce. Prices for alternatives ranged from $0.45 (QD Electronic Degreaser) to $3.87 (Novec Electronic Degreaser) per ounce. The price range for alternative products had considerable overlap with products containing PCE.

All of the reviewed products had customer satisfaction information, though LPS NoFlash Nu and Electro Wash PX Degreaser had fewer than 10 reviews. The average rating for products containing PCE is 4.7, and about the same for alternative products at 4.6. Customer satisfaction is unlikely to be affected by restrictions on PCE, as average ratings for all products reviewed are similar and close to 5 out of 5.

| Table 5‑48: Pricing and Customer Review Information for Electronics Degreasers Based on  Manufacturer and Retailer Web Pages | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | Retail information | Price per ounce | Customer ratings (out of 5) | Number of customer reviews |
| CRC | Lectra Clean Heavy Duty Electrical Parts Degreaser | <https://www.homedepot.com/p/CRC-19-oz-Lectra-Clean-Heavy-Duty-Degreaser-02018-6/100111937> | $0.42 | 4.8 | 33 |
| CRC | Electrical Parts Cleaner | <https://www.amazon.com/CRC-Electrical-Liquid-Cleaner-Aerosol/dp/B000P1HKFW> | $0.96 | 4.3 | 55 |
| CRC | Lectra Motive Electric Parts Cleaner | <https://www.amazon.com/CRC-05018-Lectra-Motive-Electric-Cleaner/dp/B000BXHWCA> | $0.57 | 4.7 | 76 |
| ITW Pro Brands | LPS NoFlash NU | <https://www.amazon.com/Flash-Electro-Contact-Cleaners-Flammable/dp/B06XKTGJTG> | $2.92 | 5 | 3 |
| 3M | Novec Electronic Degreaser1 | <https://www.amazon.com/3M-Chemicals-Degreaser-12-oz/dp/B005T8U51W> | $3.87 | 4.4 | 14 |
| Chemtronics | Electro Wash PX Degreaser | <https://www.amazon.com/Cleaner-Degreaser-Size-12-5-oz/dp/B000B603RS> | $3.53 | 4.6 | 5 |
| CRC | QD Electronic Cleaner | <https://www.amazon.com/CRC-05103-Electronic-Cleaner-11/dp/B000BXOGNI> | $0.45 | 4.7 | 6,039 |
| Radio Shack | Precision Electronics Cleaner | <https://www.radioshack.com/products/precision-electronics-cleaner> | $2.00 | 5 | 12 |
| CRC | Lectra Clean II Non Chlorinated Heavy Duty Degreaser | <https://www.amazon.com/CRC-Lectra-Non-Chlorinated-Degreaser-Aerosol/dp/B000E2559K> | $1.00 | 4.4 | 16 |
| 1Note that 3M has recently announced that they will discontinue this product by 2025.  Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

### Conclusion

The market review of electronic degreasers included three products containing PCE, one containing 1-bromopropane, and five products containing alternative solvents. This review did not find any barriers related to fire safety or customer satisfaction that could be caused by restricting use of PCE in this product category. Three of the four products containing PCE and 1-bromopropane contained 0 percent VOCs, where alternative products were at or over the 75 percent VOC limit in a number of states. Two of the alternative products reviewed had a non-flammable rating, showing evidence that there are non-flammable products on the market containing alternative solvents. The price range for alternative products had considerable overlap with products containing PCE. The average customer satisfaction ratings were similar for both groups of products, around 4.6, suggesting overall customer satisfaction with their experiences using alternative products.

## Liquid and Aerosol Cleaners and Degreasers: 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 similar to 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.

### Solvent Ingredients

The review included one product with trichloroethylene and two products with PCE. EPA also reviewed two products containing alternative solvents, including trans-DCE and methylcyclohexane.

Table 5‑49 shows the list of products reviewed for this analysis and their primary solvent ingredients.

| Table 5‑49: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher for Reviewed Energized Electrical Equipment Degreasers | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | SDS | SDS date | Solvent ingredients | Concentration (%) |
| 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 |
| Berryman | Energized Electrical Parts Cleaner | https://www.berrymanproducts.com/assets/5B-1520-1540-SDS-R02.pdf | 22 December 2020 | Trichloroethylene | >90 |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

Table 5‑50 shows the anticipated, approximate market share percentage of primary solvents in products estimated using the chemical ranking procedure. PCE is currently the most used solvent in energized electrical equipment degreaser products. If restrictions were implemented for PCE, then it is anticipated that trans-DCE with methylcyclohexane would be the most prevalent solvents used in replacement products.

| Table 5‑50: Estimated Percentage Share of Solvent Ingredients for Reviewed Energized Electrical Equipment Degreasers | | |
| --- | --- | --- |
| Solvent | Current market share | Projections for replacement products |
| Perchloroethylene | 65% | 0% |
| Trichloroethylene | 25% | 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 PCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals. | | |

### Volatile Organic Compounds Content

EPA reviewed VOC information in product SDSs and summarized findings in Table 5‑51. No regulatory VOC limits were identified that were specifically for energized electrical equipment degreasers; however, regulatory VOC limits were identified for electronics cleaners in a number of states (75 percent). The two products containing PCE, Lectra Clean Heavy Duty Energized Electrical Parts Degreaser and Electrical Parts Cleaner, had 0 percent VOCs, and Energized Electrical Parts Cleaner containing trichloroethylene contained less than 90 percent VOCs. 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 by restrictions on PCE in this product category.

| Table 5‑51: VOC Content for Energized Electrical Equipment Degreasers Based on Information in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| CRC | Lectra Clean Heavy Duty Energized Electrical Parts Degreaser | 0% |
| CRC | Electrical Parts Cleaner | 0% |
| Berryman | Energized Electrical Parts Cleaner | >90% |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | |

### Fire Safety

EPA reviewed flash points and flammability ratings in product SDSs and summarized findings in Table 5‑52. All five of the products reviewed were rated non-flammable. However, there is regulatory uncertainty with several substitutes for PCE in this use. For example, EPA has determined that trichloroethylene presents an unreasonable risk under TSCA. Given the regulatory uncertainty which EPA considers risk management options, this analysis assumes this trichloroethylene would not be adopted as an alternative solvent for PCE. Trans-DCE is a high-priority chemical under TSCA. Public comments on the proposed rule state alternative products containing trans-DCE present flammability concerns because they are mixtures of flammable trans-DCE and non-flammable chemicals. Therefore, even though energized electrical degreasers are formulated to have non-flammable properties, restricting PCE in this product category may affect non-flammable options currently on the market.

| Table 5‑52: 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 |
| CRC | Lectra Clean Heavy Duty Energized Electrical Parts Degreaser | None | Non-flammable |
| CRC | Electrical Parts Cleaner | None | Non-flammable |
| Berryman | Energized 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | |

### 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 5‑53. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Pricing for products containing PCE or trichloroethylene 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 PCE.

It was not possible to compare customer satisfaction between products containing PCE or trichloroethylene and alternative products, as only two products, both containing PCE or trichloroethylene, 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 5‑53: 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 |
| 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 |
| Berryman | Energized Electrical Parts Cleaner | https://www.amazon.com/Berryman-Products-1540-Energized-Electric/dp/B072JSKVD2 | $0.57 | 5 | 4 |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

### Conclusion

The review included two products containing PCE, one product containing trichloroethylene, and two products containing alternative solvents. .It was not possible to compare VOC content 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 PCE, which may be a barrier. However, the review was limited, and there may be more affordable electronics degreasers on the market that contain alternative solvents and can be used on energized equipment, similar to CRC’s Electrical Parts Cleaner.

## Motion Picture Film Cleaners

Cellulose acetate, nitrocellulose, and polyethylene terephthalate are the most common substrate materials used for motion picture films. Over time, dirt and grease can accumulate on the motion picture film surface during handling operations and from static electrical charge. Dirt and grease can cause blemishing of the projected image and cause physical damage to the image or film base. The two types of cleaning processes used to remove the dirt and grease are solvent based cleaning and ultrasonic cleaning.

Ultrasonic cleaners are efficient for removing a low level of dirt and grease. The motion picture film is transported through a tank of slightly heated solvent. Ultrasonic transducers are fitted to the outside of the tank and pulse sound waves through the tank.

Media Migration Technology (MMT) is the successor to the Lipsner Smith Company, a major provider of motion picture film cleaning machines for 60 years. MMT designs, manufactures, and supports a range of ultrasonic film cleaners. In addition, MMT offers certified, factory rebuilt ultrasonic film cleaners originally manufactured by Lipsner Smith.  Other manufacturers of motion picture film cleaning machines include Kodak and CMT.

### Solvent Ingredients

1,1,1-trichloroethane (CAS# 71-55-6) was initially used for solvent-based systems but was discontinued due to ozone depletion concerns. Perchloroethylene and other solvents are now used for the cleaning process. The review included one product system containing PCE and eight product systems containing alternative solvents including hydrofluoroether chemicals such as HFE-7200 and HFE-8200. 3M™ Novec™ 8200 Engineered Fluid is a clear, low-odor fluid intended to replace 1,1,1‑trichloroethane and perchloroethylene in film cleaning applications.[[7]](#footnote-9) HFE substances are non-flammable and have lower global warming potentials than HFCs and hydrochlorofluorocarbons (HCFCs). However, there is increasing evidence that documents HFEs breaking down in the environment to hazardous per- and polyfluoroalkyl substances that persist in the environment. These solvents are under review in Europe for persistence and bioaccumulative impacts based on specific physicochemical properties that have raised concern.

The National Film and Sound Archive of Australia (NFSA) has provided a list of 12 solvents that have varying levels of effectiveness for cleaning **motion picture film. These solvents are listed in** Table 5‑54**. Product system information was found for three of the solvents listed: PCE, isopropanol, and HFE 7200.**

| Table 5‑54: Solvent Effectiveness for Cleaning Motion Picture Film | |
| --- | --- |
| Solvent | Efficiency |
| Perchloroethylene (PCE, Tetrachloroethylene) | Good |
| HFE 7100 (3M) Methyl Nonafluorobutyl ether/Methyl Nonafluoroisobutyl ether[[8]](#footnote-10) | Adequate |
| HFE 7200 (3M) Ethyl Perfluoroisobutyl ether/ Ethyl Perfluorobutyl ether[[9]](#footnote-11) | Adequate |
| HFC 43-10 mee (Dupont) (1,1,1,2,3,4,4,5,5,5-decafluoro Pentane) | Adequate |
| Asahi Klin AK-225 (Asahi) (3,3-dichloro-1,1,1,2,2-pentafluoropropane) | Good |
| Isopropanol (2-propanol, secondary propyl alcohol, dimethyl carbinol, petrohol) | Good |
| Isobutylbenzene (2-methylpropyl benzene, methyl-1-phenylpropane) | Good |
| Actrel 1064 L (Exxon) (Mixture of hydrocarbons) | Good |
| Hydrotreated Naptha (Signal Inc.) Hydrocarbon Type Film Cleaner 40 | Excellent |
| Isopar® G Naptha Exxon Chemical | Excellent |
| Exxsol® D3135 Naptha Exxon Chemical | Excellent |
| Soltrol® 100 Phillips Chemical | Excellent |
| Source : ([NFSA](#_ENREF_31)) | |

Table 5‑55shows the list of product systems reviewed for this report and their primary solvent ingredients.

| Table 5‑55: Product Systems Reviewed for Motion Picture Film Cleaning | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | Product Information | Cleaning Technology | Solvent ingredients | Concentration (%) |
| Media Migration Technology (MMT) | CF9300P | <https://img1.wsimg.com/blobby/go/1a2fd565-228d-42b1-af3b-19cd6ffa38a6/downloads/MMT_brochure_2021_web.pdf?ver=1662451193476> | Ultrasonic | Perchloroethylene | 100 |
| Media Migration Technology (MMT) | CF9400HFE | <https://img1.wsimg.com/blobby/go/1a2fd565-228d-42b1-af3b-19cd6ffa38a6/downloads/MMT_brochure_2021_web.pdf?ver=1662451193476> | Ultrasonic | HFE not specified | 100 |
| Media Migration Technology (MMT) | Excel 1400 | <https://mmtfilm.com/excel-film-cleaners-1> | Not defined | Isopropanol | Not defined |
| Lipsner Smith Company | **CF9200** | <https://img1.wsimg.com/blobby/go/1a2fd565-228d-42b1-af3b-19cd6ffa38a6/downloads/CF9200%20HFE%20brochure%20MMT.pdf?ver=1662451193476> | Ultrasonic | **3M Novec Engineered Fluid HFE-8200**1 | 100 |
| Lipsner Smith Company | **CF8200P** | <https://img1.wsimg.com/blobby/go/1a2fd565-228d-42b1-af3b-19cd6ffa38a6/downloads/CF8200%20Brochure%20MMT.pdf?ver=1662451193476> | Ultrasonic | **3M Novec Engineered Fluid HFE-8200**1  **Or PCE** | 100 |
| Lipsner Smith Company | **CF 7200** | <https://img1.wsimg.com/blobby/go/1a2fd565-228d-42b1-af3b-19cd6ffa38a6/downloads/CF7200%20brochure%20MMT.pdf?ver=1662451193476> | Ultrasonic | Solvent not specified | 100 |
| Lipsner Smith Company | **CF 3000 MK V** | <https://img1.wsimg.com/blobby/go/1a2fd565-228d-42b1-af3b-19cd6ffa38a6/downloads/CF3000%20Brochure%20MMT.pdf?ver=1662451193476> | Ultrasonic | Solvent not specified | 100 |
| Kodak | **P-200** | <https://www.kodak.com/content/products-brochures/Film/P200-Film-Cleaning-System-brochure-A4.pdf> | Solvent | HFE-7200 | 100 |
| CTM | **Ultraclean Film Cleaner** | <https://ctmgroup.fr/wp-content/uploads/2019/02/ULTRACLEAN.pdf> | Ultrasonic | PCE or HFE | 100 |
| 1Note that 3M has recently announced that they will discontinue this product by 2025.  Note: Orange shaded rows indicate products that contain PCE. | | | | | |

### Volatile Organic Compounds Content

VOC information was reviewed in chemical SDSs, and summarized findings are in Table 5‑56. EPA has designated PCE and Novec HFE-7200 as VOC exempt solvents. Novec HFE-8200 has been excluded by EPA from the definition of a VOC on the basis that this compound has negligible contribution to tropospheric ozone formation. Four of the alternative product systems have 0 percent VOC content. Four of the alternative product systems do not specify the solvent and/or concentration used, and therefore the VOC content cannot be determined.

| Table 5‑56: VOC Content for Motion Picture Film Cleaning Products Based on Information  in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| Media Migration Technology (MMT) | CF9300P | 0% (PCE) |
| Media Migration Technology (MMT) | CF9400HFE | HFE Solvent not specified |
| Media Migration Technology (MMT) | Excel 1400 | Isopropanol (concentration not specified) |
| Lipsner Smith Company | **CF9200** | 0% (HFE-8200\*) |
| Lipsner Smith Company | **CF8200P** | 0% (PCE or HFE-8200\*) |
| Lipsner Smith Company | CF 7200 | Solvent not specified |
| Lipsner Smith Company | **CF 3000 MK V** | Solvent not specified |
| Kodak | **P-200** | 0% (HFE-7200) |
| CTM | **Ultraclean Film Cleaner** | 0% (PCE or HFE) |
| \* Novec HFE-8200 has been excluded by EPA from the definition of a VOC on the basis that this compound has negligible contribution to tropospheric ozone formation. Note that 3M has recently announced that they will discontinue this product by 2025.  Note: Orange shaded rows indicate products that contain PCE. | | |

### Fire Safety

Flash points and flammability ratings were reviewed in chemical SDSs, and summarized findings are in Table 5‑57. The product containing perchloroethylene, CF9300P, was rated as non-flammable. Three of the alternative products (CF9200, CF8200P, and P-200) were also rated as non-flammable. Five of the alternative systems do not specify the solvent used or concentration and therefore the flash point and flammability rating cannot be determined.

| Table 5‑57: Flash Point and Flammability Ratings for Motion Picture Film Cleaning Products  Based on Information in SDSs or Technical Data Sheets | | | |
| --- | --- | --- | --- |
| Supplier | Product | Flash Point | Flammability Rating |
| Media Migration Technology (MMT) | CF9300P (PCE) | No flash point | Non flammable |
| Media Migration Technology (MMT) | CF9400HFE | HFE Solvent not specified | Not applicable |
| Media Migration Technology (MMT) | Excel 1400 | Isopropanol (concentration not specified) | Not applicable |
| Lipsner Smith Company | **CF9200 (HFE-8200)** | No flash point | Non flammable |
| Lipsner Smith Company | **CF8200P (HFE-8200)** | No flash point | Non flammable |
| Lipsner Smith Company | CF 7200 | Solvent not specified | Not applicable |
| Lipsner Smith Company | **CF 3000 MK V** | Solvent not specified | Not applicable |
| Kodak | **P-200 (HFE-7200)** | No flash point | Non flammable |
| CTM | **Ultraclean Film Cleaner** | HFE (unspecified or PCE) | Not applicable |
| Note: Orange shaded rows indicate products that contain PCE. | | | |

### Pricing and Customer Reviews

Pricing information was collected on publicly available websites when available. To assist in comparing prices across various products and product sizes, separate prices are provided for the cleaning system and the cleaning solvent. Pricing was collected in September/October 2022 and is summarized in Table 5‑58. Alternative product systems pricing ranged from $22,000 (CF8200P) to $51,520 (CF9200). Pricing was only found for one alternative solvent at $640 for 5 liters. System pricing for the product containing PCE (CF9300P) was not found.

Customer review information was not available for all products in this product category, as products are often sold business-to-business or through specialty third party contractors.

| Table 5‑58: Pricing and Customer Review Information for Motion Picture Film Cleaning Products Based on Manufacturer and Retailer Web Pages | | | |
| --- | --- | --- | --- |
| Supplier | Product | Retail or general product  information | Price |
| Media Migration Technology (MMT) | CF9300P (PCE) | No online system pricing found  https://www.fishersci.com/shop/products/tetrachloroethylene-99-extra-pure-thermo-scientific/AC138010025 | System: Not found  Solvent: PCE |
| Media Migration Technology (MMT) | CF9400HFE (solvent not specified) | No online system pricing found | System: Not found |
| Media Migration Technology (MMT) | Excel 1400 | No online system pricing found | System: Not found |
| Lipsner Smith Company | **CF9200**  **(HFE-8200)** | <https://www.bcs.tv/store/prod_search_results.cfm?category_search=1077>  No online solvent pricing found | System: $51,520  Solvent: not found |
| Lipsner Smith Company | **CF8200P**  **(HFE-8200)** | <https://www.ebay.com/itm/273839603324?_trkparms=amclksrc%3DITM%26aid%3D1110006%26algo%3DHOMESPLICE.SIM%26ao%3D1%26asc%3D20200818143230%26meid%3De15725a4ca314512a74edfeda4d73958%26pid%3D101224%26rk%3D4%26rkt%3D5%26sd%3D401464600383%26itm%3D273839603324%26pmt%3D0%26noa%3D1%26pg%3D2047675%26algv%3DDefaultOrganicWeb%26brand%3DSmith&_trksid=p2047675.c101224.m-1>  No online solvent pricing found | System: $22,000  Solvent: not found |
| Lipsner Smith Company | CF 7200 (solvent not specified) | No online system pricing found | System: Not found |
| Lipsner Smith Company | **CF 3000 MK V** (solvent not specified) | No online system pricing found | System: Not found |
| Kodak | **P-200** | <https://125px.com/docs/motionpicture/kodak_2018/discontinuation_notices/Kodak-Motion-Picture-Products-Price-Catalog-US-Prices_March_2018_V6.pdf> | System: $37,500  Solvent: $640.00/ 5 litres |
| CTM | **Ultraclean Film Cleaner** | No online system pricing found | System: Not found |
| Note: Orange shaded rows indicate products that contain PCE. | | | |

### Conclusion

The market review included one product system containing perchloroethylene, and eight product systems containing alternative solvents. This review did not find any barriers related to VOC content or fire safety that could be caused by restricting use of perchloroethylene in this product category. Several of the alternative products reviewed have 0 percent VOC content. Also, several of the alternative products reviewed were rated non-flammable. Pricing for the product containing perchloroethylene was not found, so it cannot be determined if the alternative product systems are financially comparable.

## 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 from 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.

### Solvent Ingredients

The review included products with PCE and trichloroethylene. Four products were also reviewed containing alternative solvents, including heptane, LVP Aliphatic Hydrocarbon, C9-11-iso-alkanes, petroleum distillates, and others. Table 5‑59 shows the list of products reviewed for this analysis and their primary solvent ingredients.

| Table 5‑59: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher for  Reviewed Multi-Purpose Lubricants | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | SDS | SDS date | Solvent ingredients | Concentration (%) |
| Sprayway | L2 Moisture Displacer Deep Penetrant | https://www.spraywayinc.com/sites/all/themes/theme687/msds/sw290.pdf | 09 December 2019 | Perchloroethylene | 50 - <100 |
| 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\*](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 |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

Table 5‑60 shows the anticipated, approximate market share percentage of primary solvents in products estimated using the chemical ranking procedure. Petroleum distillates are currently the most used solvents in lubricants. If restrictions were implemented for PCE, then it is anticipated that petroleum distillates would be the most prevalent solvents used in replacement products.

| Table 5‑60: Estimated Percentage Share of Solvent Ingredients for Reviewed Multi-Purpose Lubricants | | |
| --- | --- | --- |
| Solvent | Current market share | Projections for replacement products |
| Perchloroethylene | 24% | 0% |
| Trichloroethylene | 11% | 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 PCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals. | | |

### Volatile Organic Compounds Content

EPA reviewed VOC information in product SDSs and summarized findings in Table 5‑61. EPA identified VOC limits for several lubricant types in a number of states, including multipurpose (25–50 percent) and silicone multipurpose lubricants (60 percent) excluding dry lubricants (such ’s CRC's Dry Graphite Lube), and penetrants (25–50 percent). The two products containing PCE and trichloroethylene products 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 percent, and WD-40 Multi-Use Product Aerosol had lower VOC content (around 24 percent). VOC content for products containing PCE and trichloroethylene could not be compared with that of alternative products due to lack of VOC data for alternatives. At least one lubricant product (WD-40 Multi-Use Product Aerosol) PCE or trichloroethylene meets VOC requirements, but more research is needed to fully determine if low VOC alternatives are available.

| Table 5‑61: VOC Content for Multi-Purpose Lubricants Based on Information in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| Sprayway | L2 Moisture Displacer Deep Penetrant | No information in SDS |
| Zep | Zep 45 | 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | |

### Fire Safety

Flash points and flammability ratings in product SDSs were reviewed, and summarized findings are in Table 5‑62. The six products reviewed had mixed flammability ratings. The two products containing perchloroethylene and trichloroethylene, 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); two were rated combustible. It is unclear how restriction of trichloroethylene 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 5‑62: Flash Point and Flammability Ratings for Multi-Purpose Lubricants Based on Information in SDSs | | | |
| --- | --- | --- | --- |
| Supplier | Product | Flash Point | Flammability Rating |
| Sprayway | L2 Moisture Displacer Deep Penetrant | >106°F (> 41°C) | Combustible |
| Zep | Zep 45 | None | Non-flammable |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | |

### Pricing and Customer Reviews

Pricing and customer review information was assessed on publicly available websites in May 2022, and a summary of the findings is in Table 5‑63. To assist in comparing the prices across various products and product sizes, the prices were normalized to price per ounce. Pricing for products containing PCE and trichloroethylene 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 PCE.

All products in the review had customer reviews. The ratings for products containing PCE and trichloroethylene ranged from 4.1 (L2 Moisture Displacer Deep Penetrant, which 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 to products containing PCE.

| Table 5‑63: 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 |
| Sprayway | L2 Moisture Displacer Deep Penetrant | https://www.amazon.com/Sprayway-SW290-Moisture-Displacer-Penetrant/dp/B001JN0VIS | $1.08 | 4.1 | 3 |
| Zep | Zep 45 | <https://www.amazon.com/Zep-Lubricant-Penetrant-Aerosol-374301/dp/B082Q6DNLV> | $1.21 | 4.8 | 34 |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

### Conclusion

The review focused only on multi-purpose lubricants and penetrants in liquid spray or aerosol form and included one product containing trichloroethylene, one product containing PCE, and four products containing alternative solvents. This review did not find any barriers related to pricing and customer satisfaction. It was not possible to compare VOC content due to lack of VOC information in SDSs for products containing PCE and trichloroethylene. Three alternative products (Silicone Lubricant, WD-40, and Super Lube) had lower prices than the product containing PCE. Average customer satisfaction ratings were similar between the product with PCE and products using alternative solvents.

## Screen Print Ink Removers

Plastisol ink is the most widely used ink in apparel screen printing. It is made up of PVC particles suspended in a liquid plasticizer. Screen print ink removers are used to remove cured plastisol inks from screens, equipment, and textile materials.

### Solvent Ingredients

It was difficult finding products containing perchloroethylene on the market with cost and SDS information. The review included one product containing perchloroethylene and methylene chloride, and five products containing alternative solvents including d-limonene, naphtha, citrus terpene, and others. Table 5‑64 shows the list of products reviewed for this report and their primary solvent ingredients.

| Table 5‑64: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher for Reviewed Screen Print Ink Removal Products | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | SDS | SDS date | Solvent ingredients | Concentration (%) |
| Albatross USA Inc. (Albachem) | Expert Premium 303 ™ Screen Print Ink Remover | https://albachem.com/content/SDS/1210.pdf | 1 August 2022 | Methylene chloride | 80 - 90 |
| Perchloroethylene | 0 - 10 |
| Ethanol | 0 - 5 |
| N Propyl acetate | 0 - 5 |
| Isopropanol | 0 - 5 |
| Franmar | Plastisol Ink Remover (Bean-E-Doo) | <https://franmar.com/file/804/RVO_SDS.pdf> | 21 May 2019 | Vegetable, Fatty acid methyl ester | 97 - 99 |
| Proprietary, non-hazardous, non-regulated ethoxylated alcohol surfactant trade secret | 0.8 - 2 |
| Easiway | Plastisolv 842 Screen and Press Wash | https://www.screenprintsupplies.com/wp-content/uploads/2020/03/PLASTISOLV\_842\_MSDS-1.pdf | 1 July 2009 | Aliphatic Hydrocarbon (64742-48-9) | 60 - 80 |
| d-Limonene | 7 - 13 |
| Chemical Consultants Inc. | Envirowipe | <https://www.advancedscreenprintsupply.com/NEW%20SITE%20SDS/CCI-SDS/envirowipe.pdf> | 23 April 2015 | Citrus terpene | 40 - 60 |
| Chemical Consultants Inc. | Multiwash | <https://www.ccidom.com/media/productattachments/files/MULTI-WASH_US_.pdf> | 2 February 2018 | 2-(2-methoxyethoxy) ethanol (111-77-3) | 30 – 50 |
| Alcohols, C12-14-secondary, ethoxylated (84133-50-6) | 1 – 10 |
| Methyl succinate (106-65-0) | 1 – 10 |
| Ecotex | Plastisol Press Wash | <https://cdn.shopify.com/s/files/1/0013/3998/1877/files/Ecotex_Plastisol_Press_Wash_US_a6c16093-85a8-4fcc-97f4-2edc70036397.pdf?v=1625783978> | 5 November 2018 | Naphtha (petroleum), hydrotreated heavy (CAS 64742-48-9) | 60 – 80 |
| Dipropylene glycol monomethyl ether acetate | 25 -45 |
| D-Limonene | 1 - 10 |
| Note: Orange shaded rows indicate products that contain PCE. | | | | | |

There is a solvent used in two alternative products that is a GreenScreen Benchmark 1 chemical: naphtha (CAS # 64742-48-9). There are other commercially available alternative products for screen print ink remover products without this Benchmark 1 solvent.

### Volatile Organic Compounds Content

VOC information was reviewed in product SDSs, and summarized findings are in Table 5‑65. No federal or state VOC regulatory limits were identified for screen print ink removers. The Franmar alternative product has lower VOC content than the Albachem product with perchloroethylene and methylene chloride. The Easiway, Multiwash, and Ecotex products have higher VOC content than the Albachem product with perchloroethylene and methylene chloride.

| Table 5‑65: VOC Content for Screen Print Ink Removal Products Based on Information in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| Albatross USA Inc. (Albachem) | Expert Premium 303 ™ Screen Print Ink Remover | 13%, 106.6 g/L |
| Franmar | Plastisol Ink Remover (Bean-E-Doo) | 2.3%, 20 g/L |
| Easiway | Plastisolv 842 Screen and Press Wash | 800 g/L |
| Chemical Consultants Inc. | Envirowipe | Not listed on SDS |
| Chemical Consultants Inc. | Multiwash | 904 g/L |
| Ecotex | Plastisol Press Wash | 833 g/L |
| Note: Orange shaded rows indicate products that contain PCE. | | |

### Fire Safety

Flash points and flammability ratings were reviewed in product SDSs, and summarized findings are in Table 5‑66. The Albachem product containing PCE and methylene chloride was rated as combustible. Three of the alternative products (Easiway, Envirowipe, and Ecotex) were also labeled combustible, and two alternative products (Franmar and Multiwash) are non-flammable. Based on the product reviews, there is a mix of flammability ratings for alternative products on the market, including at least two non-flammable options.

| Table 5‑66: Flash Point and Flammability Ratings for Screen Print Ink Removal Products Based on Information in SDSs or Technical Data Sheets | | | |
| --- | --- | --- | --- |
| Supplier | Product | Flash Point | Flammability Rating |
| Albatross USA Inc. (Albachem) | Expert Premium 303 ™ Screen Print Ink Remover | > 141°F | Combustible |
| Franmar | Plastisol Ink Remover (Bean-E-Doo) | Above 200°F | Non-flammable |
| Easiway | Plastisolv 842 Screen and Press Wash | 142°F | Combustible |
| Chemical Consultants Inc. | Envirowipe | 109°F | Combustible |
| Chemical Consultants Inc. | Multiwash | 188.6°F | Non-flammable |
| Ecotex | Plastisol Press Wash | 145°F | Combustible |
| Note: Orange shaded rows indicate products that contain PCE. | | | |

### Pricing and Customer Reviews

Pricing information was collected on publicly available websites when available. To assist in comparing prices across various products and product sizes, the prices were normalized to price per gallon. Pricing was collected in September/October 2022 and summarized in Table 5‑67. Alternative product pricing ranged from $39.95 per gallon (Easiway) to $62.15 per gallon (Chemical Consultants). Pricing for the product containing perchloroethylene and methylene chloride, Albachem, was higher than all reviewed alternative products at $64.95 per gallon. Customer review information was not available for all products in this product category.

| Table 5‑67: Pricing and Customer Review Information for Screen Print Ink Removal Products Based on Manufacturer and Retailer Web Pages | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | Retail or general product  information | Price per gallon | Customer rating level (out of 5 stars) | Number of customer ratings |
| Albatross USA Inc. (Albachem) | Expert Premium 303 ™ Screen Print Ink Remover | <https://dtgmart.com/products/albachem-expert-premium-303-screen-print-ink-remover> | $64.95 | None provided | None provided |
| Franmar | Plastisol Ink Remover (Bean-E-Doo) | <https://www.amazon.com/NeverTheLess-Franmar-Plastisol-Remover-Bean/dp/B09CHDMLPN/ref=sr_1_6?gclid=CjwKCAjwpqCZBhAbEiwAa7pXeXnc9x2-zMChgW-MIlZuQiYNbO2Y3SpO77ANXhb1LD9Gt9NFhuHnGhoC-3AQAvD_BwE&hvadid=192115004290&hvdev=c&hvlocphy=9001891&hvnetw=g&hvqmt=e&hvrand=2061976240231111437&hvtargid=kwd-301258406346&hydadcr=11870_9726528&keywords=screen%2Bprinting%2Bink%2Bremover&qid=1663621063&sr=8-6&th=1> | $49.95 | 3.4 | 3 |
| Easiway | Plastisolv 842 Screen and Press Wash | <https://www.onesourcesupply.com/store/p612/PlastiSolv_842_Screen_%26_Press_Wash.html> | $39.95 | None provided | None provided |
| Chemical Consultants Inc. | Envirowipe | <https://www.advancedscreenprintsupply.com/product2099.html> | $62.15 | 5.0 | 1 |
| Chemical Consultants Inc. | Multiwash | <https://www.ccidom.com/multi-wash-stain-remover-recirculating-wash.html> | $51.90 | None provided | None provided |
| Ecotex | Plastisol Press Wash | <https://screenprintdirect.com/products/ecotex-screen-printing-plastisol-press-wash?variant=32311933010003> | $47.94 | 4.6 | 244 |
| <https://www.amazon.com/Ecotex-PLASTISOL-Press-WASH-Degradent/dp/B079DY9H3S/ref=sr_1_14?crid=SWTYNVXFKTVA&keywords=screen%2Bprinting%2Bink%2Bremover&qid=1663679266&sprefix=screen%2Bprinting%2Bink%2Bremover%2Caps%2C418&sr=8-14&th=1> | $59.38 |
| Note: Orange shaded rows indicate products that contain PCE. | | | | | |

### Conclusion

The market review included one product containing perchloroethylene and methylene chloride, and five products containing alternative solvents. This review did not find any barriers related to pricing, VOC content, or fire safety that could be caused by restricting the use of perchloroethylene in this product category. All alternative products reviewed were rated either non-flammable or combustible, which is equivalent to or better than the product containing PCE and methylene chloride. The VOC content for one alternative product was lower than the VOC content for the product containing PCE and methylene chloride. Pricing for the product containing PCE and methylene chloride was higher than for all reviewed alternative products.

## Anti-Spatter Coatings

"Spatter" is a term used to describe droplets of molten material generated from gas metal arc welding. The spatter material can stick and harden when it unintentionally splashes on to worktables or other surfaces, and it is difficult remove. Anti-spatter coatings can be applied to welding projects, work areas, or welding torches or nozzles beforehand to prevent spatter from sticking to surfaces. Spatter landing on areas coated with anti-spatter spray can be wiped or gently scrubbed clean. Anti-spatter coatings typically contain petroleum or water-based solvents and are available in aerosol, liquid, or gel forms.

Anti-spatter products may be purchased for consumer use but seem to be available mainly through business-to-business retailers, such as Grainger and Airgas. Products found in the review were available in aerosol, liquid, or gel forms in volumes ranging from 14 ounces to 5 gallons. Larger volumes were also available on the market.

### Solvent Ingredients

The review included one product containing PCE; four products containing methylene chloride; and five products containing alternative solvents, including water, coconut diethanolamide, dimethylether, nonylphenoxypolyethoxyethanol, dimethyl ether, lactic acid, or triethanolamine. Table 5‑68 shows the list of products reviewed for this report and their primary solvent ingredients.

| Table 5‑68: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher for  Reviewed Anti-Spatter Products | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | SDS | SDS date | Solvent ingredients | Concentration (%) |
| Sprayon | WL™941 Dry Weld Spatter Protectant Aerosol | https://www.paintdocs.com/docs/webpdf.jsp?siteid=so&doctype=sds&lang=en&prodno=075577759378&cntry=us | 15 October 2020 | Perchloroethylene | ≥50 - ≤75 |
| Acetone | ≤10 |
| CANTESCO | Cantesco® Heavy Duty Solvent Based Anti-spatter | <https://www.cantesco.com/fileadmin/Products/Antispatter/CANTESCO%20HEAVY%20DUTY%20SOLVENT%20BASED%20ANTI-SPATTER/SDS_CANTESCO_HEAVY_DUTY_SOLVENT_BASED_ANTI-SPATTER_EN.pdf> | 01 May 2018 | Methylene Chloride | 60 - 100 |
| Weld-Aid | Heavy Duty Aerosol Spray Can | <http://docs.crcindustries.com/msds/1008284e.pdf> | 26 June 2019 | Methylene Chloride | 80 - 90 |
| High oleic safflower oil | 5 - 10 |
| CRC Industries, Inc. | NOZZLE-KLEEN® #2® | <http://docs.crcindustries.com/msds/1008283e.pdf> | 26 June 2019 | Methylene Chloride | 90 - 100 |
| High oleic safflower oil | 3 - 5 |
| Hot Max | Hot Max 23000 Anti-Spatter Spray, Silicone Free | <https://www.hotmaxtorches.com/download/msds/23000%20anti%20spatter%20msds.pdf> | 08 Oct 2013 | Methylene Chloride | 60 - 100 |
| Weld-Aid | Heavy Duty Nozzle Dip HD gel | <https://weldaid.com/wp-content/uploads/2019/03/1008238e.pdf> | 19 June 2018 | Water  Water based gel:  <https://www.airgas.com/product/Welding-Products/Welding-Support-Equipment/Chemicals---Spatters-%26-Gels/p/WAP007094>  and https://weldaid.com/nozzle-kleen/ | 74% assumed  All other SDS ingredients total 26% |
| CRC Industries, Inc. | Welder's Anti Spatter | <http://docs.crcindustries.com/msds/1003349e.pdf> | 16 June 2015 | Water | 60 - 70 |
| Lactic acid | 5 - 10 |
| Radnor | Radnor Water Based Anti-Spatter (Aerosol) | <https://www.airgas.com/msds/004197.pdf> | 26 March 2019 | Water  In product name | 70%  Assumed  All other SDS ingredients total 30% |
| CRC Industries, Inc. | WELD-KLEEN® 350® Anti-Spatter | <https://weldaid.com/wp-content/uploads/2018/07/1008275e.pdf> | 04 May 2018 | Water | 90 - 100 |
| Simple Green | Simple Green Anti-Spatter | <https://cdn.simplegreen.com/downloads/sds_en-us_simplegreenantispatter.pdf> | 15 June 2021 | Water | > 90.1 |
| Triethanolamine | < 5 |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

Table 5‑69 shows the anticipated, approximate market share percentage of primary solvents in products estimated using the chemical ranking procedure. If restrictions were implemented for PCE, then it is anticipated that water would be the most prevalent solvent used in replacement products.

| Table 5‑69: Estimated Percentage Share of Solvent Ingredients for Reviewed Anti-Spatter Products | | |
| --- | --- | --- |
| Solvent | Current market share | Projections for replacement products |
| Perchloroethylene | 5% | 0% |
| Methylene Chloride | 45% | 0% |
| Water | 47% | 94% |
| High oleic safflower oil | 1% | 2% |
| Other | 3% | 6% |
| 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 PCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals. | | |

### Volatile Organic Compounds

EPA reviewed VOC information in product SDSs and summarized findings in Table 5‑70. There are no VOC regulations for anti-spatter products. Three of the four products containing methylene chloride (Cantesco Heavy Duty Solvent Based Anti-spatter, Heavy Duty Aerosol Spray Can, and NOZZLE-KLEEN #2) had VOC content of 0 percent. Two of the alternative products had VOC information: Radnor Water Based Anti-Spatter, made with dimethylether and nonylphenoxypolyethoxyethanol, had the lowest VOC content of all products with VOC information at 18.29 percent. ’elder's Anti Spatter had VOC content of 25.3 percent. Weld-Kleen 350 and Simple Green Anti-spatter did not have VOC information. However, both products are made with at least 90 percent water and likely to have low VOC content. If PCE were restricted in this product type, consumers could use existing products on the market with VOC content below 30 percent.

| Table 5‑70: VOC Content for Anti-Spatter Products Based on Information in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| Sprayon | WL 941 Dry Weld Spatter Protectant Aerosol | No information in SDS |
| CANTESCO | Cantesco Heavy Duty Solvent Based Anti-spatter | 0% |
| Weld-Aid | Heavy Duty Aerosol Spray Can | 0% |
| CRC Industries, Inc. | NOZZLE-KLEEN #2 | 0% |
| Hot Max | Hot Max 23000 Anti-Spatter Spray, Silicone Free | 90% |
| Weld-Aid | Heavy Duty Nozzle Dip HD gel | No information in SDS |
| CRC Industries, Inc. | ’elder's Anti Spatter | 25.3% |
| Radnor | Radnor Water Based Anti-Spatter (Aerosol) | 18.29% |
| CRC Industries, Inc. | WELD-KLEEN 350 Anti-Spatter | No information in SDS |
| Simple Green | Simple Green Anti-Spatter | No information in SDS |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | |

### Fire Safety

Flash points and flammability ratings were reviewed in product SDSs, and summarized findings are in Table 5‑71. Sprayon, containing PCE and acetone, and the alternative product, Radnor Water Based Anti-Spatter made with dimethylether and nonylphenoxypolyethoxyethanol, were both rated as extremely flammable. All other products containing target solvents or alternative solvents had a non-flammable rating. Based on the product reviews, restricting PCE in anti-spatter products is unlikely to affect availability of non-flammable products on the market.

| Table 5‑71: Flash Point and Flammability Ratings for Anti-Spatter Products Based on Information  in SDSs or Technical Data Sheets | | | |
| --- | --- | --- | --- |
| Supplier | Product | Flash Point | Flammability Rating |
| Sprayon | WL 941 Dry Weld Spatter Protectant Aerosol | -20.2°F (-29°C) | Extremely flammable |
| CANTESCO | Cantesco Heavy Duty Solvent Based Anti-spatter | No information in SDS | Non-flammable |
| Weld-Aid | Heavy Duty Aerosol Spray Can | None | Non-flammable |
| CRC Industries, Inc. | NOZZLE-KLEEN #2 | None | Non-flammable |
| Hot Max | Hot Max 23000 Anti-Spatter Spray, Silicone Free | None | Non-flammable |
| Weld-Aid | Heavy Duty Nozzle Dip HD gel | > 201°F (> 93.9°C) | Non-flammable |
| CRC Industries, Inc. | ’elder's Anti Spatter | > 265°F (> 129.4°C) | Non-flammable |
| Radnor | Radnor Water Based Anti-Spatter (Aerosol) | -42°F (-41.1°C) | Extremely flammable |
| CRC Industries, Inc. | WELD-KLEEN 350 Anti-Spatter | 212°F (100°C) | Non-flammable |
| Simple Green | Simple Green Anti-Spatter | > 212°F | Non-flammable |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | |

### Pricing and Customer Reviews

Pricing and customer review information was accessed on publicly available websites in July 2021, and the findings are summarized in Table 5‑72. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Prices for products containing target solvents ranged from $0.49 (WL 941 Dry Weld Spatter Protectant Aerosol) to $1.13 per ounce (Hot Max 23000 Anti-Spatter Spray, Silicone Free). Prices for alternative products ranged from $0.13 per ounce (Weld Kleen 350 Anti-Spatter) to $0.83 per ounce (Welder's Anti Spatter). Weld Kleen 350 Anti-Spatter was sold in a larger volume than all other products (5 gallons), which likely affected the price per ounce. However, a 14-ounce container of Simple Green Anti-Spatter had the next lowest price of the alternative products at $0.18 per ounce.

Only four of the 10 products reviewed had customer ratings. Two methylene chloride products, Cantesco Heavy Duty Solvent Based Anti-spatter and Hot Max 23000 Anti-Spatter Spray, had customer ratings of 4.6 and 4.2, respectively, based on a 5-star rating system. There were no customer ratings available for the PCE product. The two rated products with alternative solvents, Heavy Duty Nozzle Dip HD gel and Simple Green Anti-Spatter, had ratings of 4.5 and 4.1 respectively.

| Table 5‑72: Pricing and Customer Review Information for Anti-Spatter Products Based on  Manufacturer and Retailer Web Pages | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | Retail information | Price per ounce | Customer ratings (out of 5) | Number of customer reviews |
| Sprayon | WL 941 Dry Weld Spatter Protectant Aerosol | https://www.grainger.com/product/6KDT4 | $0.49 | None | None |
| CANTESCO | Cantesco Heavy Duty Solvent Based Anti-spatter | <https://www.amazon.com/CANTESCO-AS-16-Solvent-Anti-Spatter-Aerosol/dp/B008BJCY1K> | $0.55 | 4.6 | 314 |
| Weld-Aid | Heavy Duty Aerosol Spray Can | <https://www.grainger.com/product/24A416> | $0.51 | None | None |
| CRC Industries, Inc. | NOZZLE-KLEEN #2 | <https://www.airgas.com/product/Welding-Products/Welding-Support-Equipment/Chemicals---Spatters-%26-Gels/p/WAP007022> | $0.56 | None | None |
| Hot Max | Hot Max 23000 Anti-Spatter Spray, Silicone Free | <https://www.amazon.com/Hot-Max-23000-Anti-Spatter-Silicone/dp/B005UUQJD2> | $1.13 | 4.2 | 24 |
| Weld-Aid | Heavy Duty Nozzle Dip HD gel | <https://www.grainger.com/product/24A413> | $0.52 | 4.5 | 895 |
| CRC Industries, Inc. | Welder's Anti Spatter | <https://www.grainger.com/product/2F137> | $0.83 | None | None |
| Radnor | Radnor Water Based Anti-Spatter (Aerosol) | <https://www.airgas.com/product/Welding-Products/Welding-Support-Equipment/Chemicals---Spatters-%26-Gels/p/RAD64000110> | $0.41 | None | None |
| CRC Industries, Inc. | WELD-KLEEN 350 Anti-Spatter | <https://www.amazon.com/Weld-Aid-Weld-Kleen-350-Anti-Spatter-Liquid/dp/B008RA5H76> | $0.13 | None | None |
| Simple Green | Simple Green Anti-Spatter | <https://www.amazon.com/Simple-Green-1410000413454-Anti-Spatters-Clear/dp/B00IHGOJ3I> | $0.18 | 4.1 | 70 |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

### Conclusion

The market review of anti-spatter products included products containing methylene chloride, PCE, and a variety of alternative solvents. This review did not find any barriers related to VOC content, fire safety, or pricing that could be caused by restricting use of PCE in this product category. Some products with alternative solvents had similar VOC content to those products with PCE. There were at least two alternative products on the market with a VOC content below 30 percent. The products containing at least 90 percent water were likely to have low VOC content as well. Most of the products reviewed were rated non-flammable. The price range per ounce of products containing alternative solvents was lower than that of products with methylene chloride or PCE. Customer ratings were limited but were similar between products containing methylene chloride or PCE and products containing alternative solvents.

## Mold Releases and Cleaners

Mold releases and cleaners were combined by category, 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.

### Solvent Ingredients

The review included one product containing trichloroethylene (White 2000 Non-Flammable Mold Cleaner), one product containing PCE (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 5‑73 shows the list of products reviewed for this report and their primary solvent ingredients.

| Table 5‑73: Reviewed Mold Release and Mold Cleaner Products: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | SDS | SDS date | Solvent ingredients | Concentration (%) |
| CRC Industries, Inc. | Heavy Duty Mold Cleaner | http://docs.crcindustries.com/msds/1003500E.pdf | 13 September 2017 | Perchloroethylene | 90 - 100 |
| 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. | 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 rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

Table 5‑74 shows the anticipated, approximate market share percentage of primary solvents in products estimated using the chemical ranking procedure. If restrictions were implemented for PCE, then it is anticipated that dimethyl ether would be the most prevalent solvent used in replacement products.

| Table 5‑74: Estimated Percentage Share of Solvent Ingredients for Reviewed Mold Release and Mold Cleaner Products | | |
| --- | --- | --- |
| Solvent | Current market share | Projections for replacement products |
| Perchloroethylene | 39% | 0% |
| 1-Bromopropane | 6% | 0% |
| 1-Methyl-2-pyrrolidone | 2% | 0% |
| Dimethyl ether | 41% | 78% |
| D-limonene | 9% | 18% |
| Other | 3% | 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 PCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals. | | |

### Volatile Organic Compounds Content

VOC information was reviewed in product SDSs, and summarized findings are in Table 5‑75. EPA did not identify any federal or state VOC regulatory limits for mold release or mold cleaner products. Three products containing 1-bromopropane, PCE, and N-Methyl-2-pyrrolidone had VOC information in their SDSs. Heavy Duty Mold Cleaner had 0 percent VOC content, whereas General Purpose Silicone Mold Release and Slide Resin Remover Aerosol both had VOC content around 100 percent. There was VOC information for three of the five alternative products, ranging from 48.4 percent (Heavy Duty Silicone Mold Release) to 59.6 percent (Food Grade Silicone Mold Release. The one product with PCE had VOC content of 0 percent; the others containing 1-bromopropane and N-Methyl-2-pyrrolidone were near 100 percent. The alternative products with VOC information all had much lower VOC content, though none were below 40 percent.

| Table 5‑75: VOC Content for Mold Release and Mold Cleaner Products Based on Information in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| CRC Industries, Inc. | Heavy Duty Mold Cleaner | 0%, 0 g/L  Technical product sheet:  <http://api.crcindustries.com/auto-services/get-pds/03315> |
| IMS Company | White 2000 Non-Flammable Mold Cleaner | No information in SDS |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | |

### Fire Safety

EPA reviewed flash points and flammability ratings in product SDSs, and summarized findings are in Table 5‑76. White 2000 Non-Flammable Mold Cleaner, which contains trichloroethylene, was rated non-flammable. Heavy Duty Mold Cleaner, which contained PCE, was also rated 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, restricting PCE in mold release and cleaner products is unlikely to limit non-flammable options on the market.

| Table 5‑76: 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 |
| CRC Industries, Inc. | Heavy Duty Mold Cleaner | None | Non-flammable |
| IMS Company | White 2000 Non-Flammable Mold Cleaner | None | Non-flammable |
| CRC Industries, Inc. | General Purpose Silicone Mold Release | Not available | None |
| Slide Products Inc. | Slide Resin Remover Aerosol | No information in SDS | No information in SDS |
| 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 | No information in SDS | No information in SDS |
| CRC Industries, Inc. | Food Grade Silicone Mold Release | > 572°F (> 300°C) | Non-flammable |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | |

### Pricing and Customer Reviews

Pricing and customer review information was assessed on publicly available websites in August 2021, and summarized findings are in Table 5‑77. To assist in comparing prices across various products and product sizes, the prices were normalized to price per ounce. Pricing for products containing trichloroethylene 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 PCE 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 5‑77: 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 |
| CRC Industries, Inc. | Heavy Duty Mold Cleaner | <https://www.amazon.com/CRC-Heavy-Duty-Cleaner-Aerosol/dp/B00CSX3RO8> | $0.91 | 4 | 2 |
| IMS Company | White 2000 Non-Flammable Mold Cleaner | https://imscompany.com/product/118308 | $0.29 | None | None |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

### Conclusion

The market review of mold release and mold cleaning products included one product containing PCE; three products containing trichloroethylene, 1-bromopropane, and N-Methyl-2-pyrrolidone; and five products containing alternative solvents. This review did not find any barriers related to VOC content, fire safety, or customer satisfaction that could be caused by restricting use of PCE in this product category. Alternative products had VOC content between 45 and 59 percent. All the alternative products with flammability information were rated non-flammable. The price per ounce of products varied considerably, with a slightly lower price range for PCE-containing products than for the alternative solvent products. Average customer ratings of alternative products were higher than those of products containing PCE and indicated overall customer satisfaction with an average rating of 4.5 out of 5.

## Dry Cleaning Machines

A [2012](#_ENREF_51) report by the Toxics Use Reduction Institute (TURI), *Assessment of Alternatives to Perchloroethylene for the Dry Cleaning Industry,* includes a comprehensive assessment of the primary alternatives to PCE in dry cleaning. This report considered the following alternatives to PCE dry cleaning:

* Wet Cleaning
* Carbon Dioxide
* High Flash Point Hydrocarbons
* Acetal
* Propylene Glycol Ethers
* DS Siloxane
* n-Propyl Bromide (1-bromopropane).

Figure 5‑1 presents the summary table comparing the alternatives from [TURI 2012](#_ENREF_51" \o "Toxics Use Reduction Institute (TURI), 2012 #42)). Industry has informed the Agency that by far the most popular of these alternatives is high flash point hydrocarbons. This is because the dry cleaning process is similar to that of PCE and high flash hydrocarbons are likely the least expensive alternative and have relatively low toxicity (except for aquatic toxicity).

EPA also considered one additional alternative, Sensene, based on increased availability after the 2012 report was published.

| Figure 5‑1: Summary Table of PCE Alternatives from TURI’s [Toxics Use Reduction Institute (TURI)](#_ENREF_51)  Report | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Key Assessment Criteria | | PCE | Wet Cleaning | Carbon Dioxide | Sensene1 | High Flash Point Hydro-Carbons | Acetal | Propylene Glycol Ethers | D5 Siloxane | n-Propyl Bromide |
| Technical Performance | Cycle Time (min) | 45 | 20 - 40 | 35 - 45 | Similar to PCE | 60 - 75 | 60 - 65 | >45 | 53 - 58 | 45 |
| Load Capacity (lbs) | 50 | 20 - 75 | 60 | Similar to PCE | 35 - 90 | 40 - 90 | 43 | 55 | 50 |
| Materials system may have difficulty with | Leather, Suedes, Beads, Delicates | Leather, Suede and Fur | Triacetates, Specially Dyed Acetates | None Identified | Vinyl Appliqués | Appliqués or Decorations Glued to Fabric | None Identified | None Identified | Leather, Suedes, Beads, Delicates |
| Spotting Requirements | Moderate | Low | High | Similar to PCE | Moderate | Low | Low | High | Low |
| Financial | Equipment | $40,000 - $65,000 | $36,000 - $61,000 | $100,000 - >$150,000 | $100,000 - >$120,000 | $38,000 - $75,000 | $50,000 - $100,000 | $56,000 | $30,500 - $55,000 | $40,000 - $60,000 or Retrofit Cost |
| Chemical Cost Per Gallon | $17 | $0.007/gal (water); $25 - $31/gal (detergent) | $0.18/lb (CO2); $40/gal (detergent) | $107 | $14 - $17 | $28 - $34 | $25 - $30 | $22 - $28 | $40 - $64 |
| Cost Per Pound Cleaned (Range and Average) | $0.63 - $1.94  Avg: $1.02 | $0.57 - $1.32 Avg: $1.10 | $1.40 | Unavailable | $0.73 - $1.02 Avg: $0.88 | Unavailable | $1.14 | $1.08 - $2.33 Avg: $1.71 | Unavailable |
| Electricity Usage (kWh/100 lb) | 26.6 | 9.3 | 30.9 | Similar to PCE | 35.5 | Similar to Hydrocarbon | Unavailable | 54.2 | Unavailable |
| Environmental | Persistence (Water, Soil, Sediment and/or Air) | M (Water), H (Soil, Sed, Air) | L (Water, Soil, Air), M (Sed) | N/A | Unavailable | L (Water, Soil, Air), M (Sed) | L (Water, Soil, Air), M (Sed) | L (Water, Soil, Air), M (Sed) | L (Water), M (Soil), H (Sed, Air) | L (Water, Soil), M (Sed), H (Air) |
| Bioaccumulation | Low | Low | N/A | Low | Moderate | Low | Low | Moderate | Low |
| Aquatic Toxicity | Moderate | Low to Moderate | Low | Low | High | Moderate | Low | High | High |
| Human Health | Recommended Exposure Limits | 25 ppm | NE | 5000 ppm | 20 ppm | 100 ppm | NE | NE | 10 ppm | 10 ppm |
| Central Nervous System Effects | Yes | No | No | Some Evidence | Yes | No Data Available | Yes | Some Evidence | Yes |
| Carcinogenicity | Probable Human Carcinogen | Not Classified by IARC | Not Classified by IARC | IARC Group 2B: Possibly carcinogenic to humans | Not Classified by IARC | Not Classified by IARC | Not Classified by IARC | Some Evidence | Clear Evidence in Animal Studies by NTP |
| Reproductive/Developmental Toxicity | Yes | Negligible | No Data Available | No | No Data Available | No Data Available | No | Studies Indicate Concern | Yes |
| Physical Safety | Flash Point/Flammability | N/A or Not Flammable | N/A or Not Flammable | N/A or Not Flammable | 149°F/ Combustible Liqui– | 140 - 145°F/ Combustible Liquid | 144°F/ Combustible Liqui– | 160 - 212°F/ Combustible Liquid | 171°F/ Combustible Liquid | NA or 72°F (Flammability Dependent on Test Method) |
| Applicable Regulatory | Clean Air Act Hazardous Air Pollutant (HAP) | Yes, HAP | No | No | No | No | No | No | No | No |
| Clean Air Act NAAQS VOC | No, Exempt | No | No | No Data Available | VOC | VOC | VOC | No, Exempt | VOC |
| Massachusetts Regulated (TURA, ERP) | TURA Higher Hazard Substance, ERP | No | No | No | No | No | No | No | TURA |
| Hazardous Waste Disposal Require– | Yes - Listed Hazardous Waste | No | No | No | Yes; Waste Oil = Hazardous Waste in MA | No | No | No | No; Monitor for Residual PCE if Using Retrofitted Machine |
| Wastewater | No Wastewater | Discharge to Sewer or Holding Tank | No Wastewater | No Wastewater | No Wastewater | No Wastewater | No Wastewater | No Wastewater | No Wastewater |
| 1The Sensene column was added by EPA using information provided by the National Cleaners Association.  N/A = Not Applicable; NE = Not Established  Source: [TURI 2012](#_ENREF_51)  Available [here: https://www.turi.org/content/download/7399/134622/file/2012+M%26P+Report+27+Assessment+of+Safer+Alternatives+to+Perchloroethyle](here:%20https://www.turi.org/content/download/7399/134622/file/2012+M%26P+Report+27+Assessment+of+Safer+Alternatives+to+Perchloroethyle)ne.pdf | | | | | | | | | | |

## Spot Removers

Spot removers are used to treat stains or spots on textiles. Spot removers are available for a wide range of textiles, and they are formulated for use with commercial wet and dry cleaning solvents, or for residential use. This review focused on carpet and laundry spot removers 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 PCE are geared toward commercial or specialty “difficult to clean” applications, whereas consumer general purpose laundry and carpet products do not contain PCE.

### Solvent Ingredients

The review included two dry cleaning spot removers that contained PCE, and one that contained PCE and methylene chloride. It also included a carpet spot cleaner containing 1-bromopropane and one dry cleaning spot cleaner containing trichloroethylene. The review also included six spot cleaner products containing alternative solvents, including 2-(2 propoxyethoxy) ethanol, water, 2-butoxy-ethanol, ethoxylated isotridecyl alcohol, and others. Table 5‑78 shows the list of products reviewed and their primary solvent ingredients.

| Table 5‑78: Safety Data Sheets and Solvent Ingredients with Concentrations of 5 Percent or Higher for Reviewed Spot Removers | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | SDS | SDS date | Solvent ingredients | Concentration (%) |
| American Niagara | Pull Out 2 - Dry White Powdered Spotter | https://www.american-niagara.com/assets/images/SDS/SDS-PULL%20OUT%202.pdf | 21 December 2014 | Petroleum Gases, liquified, sweetened | 28 - 46 |
| Methylene Chloride | 21 - 34 |
| Perchloroethylene | 16 - 26 |
| Adco Professional Products LLC | DFB Xtra | https://www.fabricleansupply.com/msds/0415.pdf | 29 April 2015 | Perchloroethylene | 30 - 40 |
| Adco Professional Products LLC | Fashion Finish Synthetic | https://a-1products.com/wp-content/uploads/2016/06/Fashion-Finish-Synthetic-GHS.pdf | 28 July 2015 | Perchloroethylene | 50 - 55 |
| 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 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 |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

Table 5‑79 shows the anticipated, approximate market share percentage of primary solvents in products estimated using the chemical ranking procedure. The current market share percentage for PCE, methylene chloride, 1-bromopropane, and trichloroethylene 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 PCE, then it is anticipated that water would be the most prevalent solvent used in replacement products.

| Table 5‑79: Estimated Percentage Share of Solvent Ingredients for Reviewed Spot Removers | | |
| --- | --- | --- |
| Solvent | Current market share | Projected after restrictions |
| Perchloroethylene | 7% | 0% |
| Methylene Chloride | 2% | 0% |
| 1-Bromopropane | 13% | 0% |
| Trichloroethylene | 3% | 0% |
| Water | 50% | 66% |
| Ethanol 2-(2-butoxyethoxy) | 6% | 8% |
| Other | 19% | 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 PCE. Grey shading indicates another one of the first 10 TSCA work plan chemicals. | | |

### Volatile Organic Compounds Content

VOC information was reviewed in product SDSs, and summarized findings are in Table 5‑80. EPA does not have a VOC limit in spot removers. However, several states have limits for aerosol spot removers (15-25 percent VOC) and non-aerosol spot removers (3-8 percent VOC). Only one of the product SDSs included VOC information, which makes it difficult to ascertain whether any of these products are compliant with state VOC regulations. The product containing both PCE and methylene chloride had a VOC content of 43.6 percent. The two products containing PCE did not have information in their SDSs. Two alternative products (Chem-Dry and Seventh Generation) contain significant amounts of water and likely have low VOC content.

| Table 5‑80: VOC Content for Spot Removers Based on Information in SDSs or Technical Data Sheets | | |
| --- | --- | --- |
| Supplier | Product | VOC  (% weight, g/L) |
| American Niagara | Pull Out 2 - Dry White Powdered Spotter | 43.6%, 301.9 g/L |
| Adco Professional Products LLC | DFB Xtra | No information in SDS |
| Adco Professional Products LLC | Fashion Finish Synthetic | No information in SDS |
| 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 Dry | No information in SDS; likely high VOC content sin–e 50 - 90% non-VOC exempt ingredients |
| 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | |

### Fire Safety

Flash points and flammability ratings were reviewed in product SDSs, and summarized findings are in Table 5‑81. For products containing PCE, Pull Out 2 was rated flammable, while the other two did not have information in their SDSs. All products with alternative solvents were rated non-flammable. Based on the review there are numerous non-flammable alternatives.

| Table 5‑81: Flash Point and Flammability Ratings for Spot Removers Based on Information  in SDSs or Technical Data Sheets | | | |
| --- | --- | --- | --- |
| Supplier | Product | Flash Point | Flammability Rating |
| American Niagara | Pull Out 2 - Dry White Powdered Spotter | No information available | Flammable, aerosol |
| Adco Professional Products LLC | DFB Xtra | >230°F (110°C) | No information available |
| Adco Professional Products LLC | Fashion Finish Synthetic | None | No information available |
| Pettyjohn's Solutions | Pettyjohn's Solutions Homerun Cleaning Fluid | None | Non-flammable |
| A.L. Wilson Chemical Co. | TarGo Dry | 116° F (46.7°C) | Combustible |
| 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 | None | Non-flammable |
| Seventh Generation | Laundry Stain Remover | No information available | Non-flammable |
| Note: Orange shaded rows indicate products that contain PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | |

### Pricing and Customer Reviews

Pricing and customer review information was accessed on publicly available websites in August 2021, and summarized findings are in Table 5‑82. List prices for A.L. Wilson Chemical Co. were not available online, and EPA reached out to a sales associate 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 PCE ranged from $0.37 (Fashion Finish Synthetic) to $0.64 (Pull Out 2) 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 target PCE.

None of the product containing PCE had 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 there was not enough information to compare customer reviews between products with PCE and alternative products, the average rating for alternative products was well above 4, indicating overall customer satisfaction with these alternative products.

| Table 5‑82: Pricing and Customer Review Information for Spot Removers Based on  Manufacturer and Retailer Web Pages | | | | | |
| --- | --- | --- | --- | --- | --- |
| Supplier | Product | Retail information | Price per ounce | Customer ratings (out of 5) | Number of customer reviews |
| American Niagara | Pull Out 2 - Dry White Powdered Spotter | https://www.superkleendirect.com/anc-pull-out-2/ | $0.64 | None | None |
| https://www.unitedtps.com/American-Niagra-Pull-Out-2-Spray-White-Powder-Stain-Remover\_p\_3090.html | $0.53 |
| https://drycleansupply.com/product/pull-out-2-20oz-9013/ | $0.49 |
| Adco Professional Products LLC | DFB Xtra | https://garmentcleaningsupply.com/d-f-b-xtra-1-gal-adco.html | $0.61 | None | None |
| https://www.fabricleansupply.com/index.jsp?path=product&title=adco.dfb&part=490 | $0.63 |
| Adco Professional Products LLC | Fashion Finish Synthetic | https://garmentcleaningsupply.com/chemicals/adco/fashion-finish-synthetic-1-gal-adco.html | $0.37 | 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 Dry | <https://www.alwilson.com/products/targo_dry/index.html> | $0.82 | 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 PCE. Grey shaded rows indicate products that contain another one of the first 10 TSCA work plan chemicals. | | | | | |

### Conclusion

The spot cleaner review included one dry cleaning spot remover containing PCE and methylene chloride, two dry cleaning spot removers containing PCE, a carpet spot cleaner containing 1‑bromopropane, one dry cleaning spot cleaner containing trichloroethylene, and six spot removers containing alternative solvents. This review did not find any barriers related to fire safety, pricing, or customer satisfaction that could be caused by restricting use of PCE 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 have low VOC content and would be an improvement over products containing PCE. All the alternative products reviewed were rated non-flammable. There are four alternative products with prices lower than the products containing PCE. Products containing PCE did not have customer review information. Customer satisfaction was high for alternative product ratings, as average ratings were over 4 out of 5 stars.

# Baseline Analysis

This chapter presents the estimated baseline consumption levels for perchloroethylene (PCE) (section 6.1) and the estimated number of firms and individuals with occupational exposure to PCE (section 6.2). The estimated numbers of firms 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.

## Baseline PCE Consumption Volumes by Use Category

This section presents estimates for the amount of PCE consumed for each use category considered in the economic analysis. EPA’s Risk Evaluation for PCE indicates that approximately 324 million lbs of PCE are produced each year, based on 2016 Chemical Data Reporting (CDR) data. It further indicates that approximately 65 percent of PCE production is used as an intermediate in industrial gas manufacturing, 15 percent is used as a solvent in dry cleaning facilities, 10 percent is used as a vapor degreasing solvent, and 10 percent is attributed to other uses ([EPA 2020h](#_ENREF_91)). Because the risk evaluation does not include consumption estimates for all uses covered under the rule, this section presents methodology used to estimate PCE consumption volumes for the more detailed use categories used throughout this analysis.

EPA used several sources to derive the 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 the PCE consumption volume associated with each use category.

|  |
| --- |
| Figure 6‑1: Overview of Approach |
|  |

### Point Source Only

The analysis uses emissions estimates reported by the 2017 National Emissions Inventory (NEI) ([EPA 2020a](#_ENREF_84)) to estimate PCE consumption for the following use categories:

* Liquid and spray batch cold cleaning[[10]](#footnote-12)
* Photographic film use
* Vapor degreasing

The approach for these uses consisted of the following steps:

1. Estimate an emissions factor for each use category in order to convert 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 PCE consumption for each use category

The first step is to estimate an emissions factor that will allow for the conversion of PCE emissions to PCE consumption. These emission factors are presented in Table 6‑1 and are compiled from several sources.

* *Facility-submitted NEI data (*[*EPA 2020a*](#_ENREF_84)*).* While many NEI submitters reported the emissions factors they used to generate their emissions estimates, EPA was not able to use these reported factors because the units were not provided. Thus, these values are not included in Table 6‑1. However, in a limited number of cases, NEI submitters provided the input quantities (e.g., tons solvent used) that they used to calculate their emissions. Each row of Table 6‑1 where [EPA 2020a](#_ENREF_84)is cited as the source represents an NEI submission where the input quantity was reported. In these cases, reported emissions (Table 6‑1; Column B) were divided by the input quantity (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 emissions factor calculations because it would not be possible to use these inputs to convert emissions to PCE input.
* *WebFIRE (*[*EPA 2020j*](#_ENREF_93)*).* EPA also includes identified emissions factors for each use category from WebFIRE, an EPA database of emissions factors for criteria and hazardous air pollutants. Each row of Table 6‑1 where [EPA 2020j](#_ENREF_93) is cited represents a unique emission factor in the WebFIRE database. Emission factors may differ based on assumptions for equipment and controls used. Note that because the emission factors are provided by WebFIRE and not calculated by this analysis, the input quantity and total emissions columns A and B in Table 6‑1 are not relevant for this source and are represented by a dashed line.
* *Additional sources with published emissions factors.* EPA also identified emissions factors published in additional sources. As with the emission factors identified in WebFIRE, each row of Table 6‑1 where an additional source is cited represents a unique emission factor, and because these emission factors are not calculated by this analysis, the input quantity and total emissions columns A and B in Table 6‑1 are not relevant for these sources and are represented by a dashed line.

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: PCE Emission Factors Estimated from NEI and Identified from Additional Sources | | | | |
| --- | --- | --- | --- | --- |
| Calculation Input Quantity1 | Total emissions (lb) | Emission Factor | Emission Factor2  (lb emitted/lb solvent) | Source |
| A | B | C = B ÷ A |
| Batch, Liquid, and Spray Cold Cleaning | | | | |
| 624 gal make-up solvent | 8 | 0 lb/gal | 0.001 | [EPA 2020a](#_ENREF_84) |
| 0.8 ton solvent | 1,020 | 1,275 lb/ton | 0.638 | [EPA 2020a](#_ENREF_84) |
| - | - | 1,560 lb/ton solvent consumed | 0.780 | EPA emission factor for cold solvent cleaning/stripping; uncontrolled ([EPA 2020j](#_ENREF_93)) |
| - | - | 1 lb/lb solvent consumed | 0.680 | EPA emission factor for cold solvent cleaning/stripping; misc. control devices (Controlled by water cover and 15 sec. drain time) ([EPA 2020j](#_ENREF_93)) |
| - | - | 1,520 lb/ton solvent consumed | 0.760 | EPA emission factor for cold solvent cleaning/stripping; controlled by freeboard refrigeration device (FBR) ([EPA 2020j](#_ENREF_93)) |
| - | - | 1 kg/kg fresh solvent used | 0.780 | EPA emission factor for cold cleaning; uncontrolled; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.760 | EPA emission factor for cold cleaning; controlled by 0.7 freeboard ratio and drainage, rack with 15-second drain time; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.680 | EPA emission factor for cold cleaning; controlled by water cover and 15-second drain time; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.780 | EPA emission factor for cold cleaning; uncontrolled; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.760 | EPA emission factor for cold cleaning; controlled by 0.7 freeboard ratio and drainage, rack with 15-second drain time; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.680 | EPA emission factor for cold cleaning; controlled by water cover and 15-second drain time; Schedule B ([EPA 1989](#_ENREF_68)) |
| **Average Liquid and Spray Batch Cold Cleaning** | | | **0.663** |  |
| Photographic Film Use | | | | |
| - | - | 1 lb/lb | 0.750 | Emission factor for film cleaning; controlled by carbon adsorber ([Rogozen 2000](#_ENREF_44)) |
| - | - | 0 lb/lb | 0.280 | Emission factor for contact printing; controlled by carbon adsorber ([Rogozen 2000](#_ENREF_44)) |
| - | - | 1 lb/lb | 0.850 | Emission factor for optical printing; controlled by carbon adsorber ([Rogozen 2000](#_ENREF_44)) |
| **Average Photographic Film Use** | | | **0.627** |  |
| Vapor Degreasing | | | | |
| 102 gal PCE | 1,271 | 12 lb/gal | 0.923 | [EPA 2020a](#_ENREF_84) |
| 0.659 ton solvent | 66 | 100 lb/ton | 0.050 | [EPA 2020a](#_ENREF_84) |
| 24.56 ton make-up solvent | 49,120 | 2,000 lb/ton | 1.000 | [EPA 2020a](#_ENREF_84) |
| 0.0395 ton make-up solvent | 40 | 1,014 lb/ton | 0.507 | [EPA 2020a](#_ENREF_84) |
| 21 ton make-up solvent | 42,000 | 2,000 lb/ton | 1.000 | [EPA 2020a](#_ENREF_84) |
| 0.226 ton make-up solvent | 452 | 2,000 lb/ton | 1.000 | [EPA 2020a](#_ENREF_84) |
| - | - | 1,860 lb/tons make-up solvent used | 0.930 | EPA emission factor for OTVD; uncontrolled ([EPA 1989](#_ENREF_68)) |
| - | - | 1 lb/lb make-up solvent used | 0.650 | EPA emission factor for OTVD; misc. control devices (Controlled by hoist, enclosed design w/sump cooling) ([EPA 1989](#_ENREF_68)) |
| - | - | 1 lb/lb make-up solvent used | 0.790 | EPA emission factor for OTVD; misc. control devices (Controlled by hoist at 11fpm and freeboard refrigeration device) ([EPA 1989](#_ENREF_68)) |
| - | - | 1 lb/lb make-up solvent used | 0.833 | EPA emission factor for OTVD; misc. control devices (Controlled by hoist, auto cover) ([EPA 1989](#_ENREF_68)) |
| - | - | 1,920 lb/tons make-up solvent used | 0.960 | EPA emission factor for CVD; uncontrolled ([EPA 1989](#_ENREF_68)) |
| - | - | 1 lb/lb make-up solvent used | 0.830 | EPA emission factor for CVD; misc. control devices (Controlled by hot vapor recycle or superheated vapor and sump cooling or freeboard refrigeration) ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.930 | OTVC; uncontrolled; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.870 | OTVC; controlled by hoist at 11 fpm, freeboard refrigeration device (below freezing), 1.0 FBR; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.730 | OTVC; controlled by hoist at 11 fpm, enclosed design, sump co–ling - Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.890 | OTVC; controlled by hoist at 11 fpm, automated cover; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.840 | OTVC; controlled by hoist at 3 fpm, freeboard refrigeration device (below freezing), 1.0 FBR; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.570 | OTVC; controlled by hoist at 3 fpm, enclosed design, sump cooling; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.870 | OTVC; controlled by hoist at 3 fpm, automated cover; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.960 | CVD; uncontrolled; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.920 | CVD; controlled by freeboard refrigeration device; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.920 | CVD; controlled by carbon adsorption; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.890 | CVD; controlled by carbon adsorption, sump cooling; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.890 | CVD; controlled by freeboard refrigeration device, sump cooling; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.880 | CVD; controlled by hot vapor recycle or superheated vapor, sump cooling; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.880 | CVD; controlled by freeboard refrigeration, hot vapor recycle or superheated vapor; Schedule A ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.835 | OTVC; controlled by hoist at 11 fpm, freeboard refrigeration device (below freezing), 1.0 FBR; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.765 | OTVC; controlled by hoist at 11 fpm, enclosed design, sump cooling; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.855 | OTVC; controlled by hoist at 11 fpm, automated cover; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.730 | OTVC; controlled by hoist at 3 fpm, freeboard refrigeration device (below freezing), 1.0 FBR; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.570 | OTVC; controlled by hoist at 3 fpm, enclosed design, sump cooling; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.730 | OTVC; controlled by hoist at 3 fpm, automated cover; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.900 | CVD; controlled by freeboard refrigeration device; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.900 | CVD; controlled by carbon adsorption; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.900 | CVD; controlled by carbon adsorption, sump cooling; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.900 | CVD; controlled by freeboard refrigeration device, sump cooling; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.780 | CVD; controlled by hot vapor recycle or superheated vapor, sump cooling; Schedule B ([EPA 1989](#_ENREF_68)) |
| - | - | 1 kg/kg fresh solvent used | 0.780 | CVD; controlled by freeboard refrigeration, hot vapor recycle or superheated vapor; Schedule B ([EPA 1989](#_ENREF_68)) |
| **Average Vapor Degreasing** | | | **0.820** |  |
| 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 PCE, EPA assumes that the input solvent is solely comprised of PCE 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: 2,000 lb/ton; 2.20462 kg/lb; 13.5 lb/gal. | | | | |

The next step is to categorize each 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 following assumptions:

* Unspecified point source cleaning/degreasing uses are allocated to batch, liquid, and spray cold cleaning and vapor degreasing uses, proportional to the identified point source emissions for those uses.
* Point source uses in the following categories are allocated to liquid and spray batch cold cleaning and vapor degreasing uses, proportional to the identified point source emissions for those uses:
  + Metal fabrication
  + Metal production
  + Plastic molding
  + Plastics production
  + Pulp/paper industry
* Point sources that could not be categorized under a specific use are allocated to all categorized uses, proportional to their identified point source emissions.
  + Note that while certain uses reported in NEI are excluded from this section (i.e., because EPA estimated their volumes using a different approach), they are included for the purposes of reallocation calculations.

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

#### Summary and Discussion

Table 6‑2 presents the PCE 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 PCE Consumed | | | |
| Use Category | Total Emissions (lbs)1 | Average Emissions Factor2 (lb emissions/lb PCE) | PCE Consumption (lbs) |
| A | B | A ÷ B |
| Liquid and Spray Batch Cold Cleaning | 5,644 | 0.66 | **8,506** |
| Photographic Film Use | 1,193 | 0.63 | **1,657** |
| Vapor Degreasing | 417,996 | 0.82 | **509,785** |
| 1 Source: [EPA 2020a](#_ENREF_84)  2 Source: Table 6‑1 | | | |

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. In some cases, it is unclear whether the identified emissions factors are representative of PCE use within a given use category.

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

Given NEI reporting requirements, point source PCE emissions are likely under-reported. PCE is not required to be reported to NEI, although some states voluntarily do report. For the industries where EPA expects PCE to be reported but it is not, NEI applies a scaling factor to reported emissions to best estimate a complete inventory of PCE emissions ([EPA 2020b](#_ENREF_85)). However, NEI only applies this scaling to chemical manufacturing, degreasing, and waste disposal point sources, such that emissions estimates for the remaining point source sectors are comprised solely of voluntary reports ([EPA 2020f](#_ENREF_89)).

### Point and Nonpoint Sources

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

* Adhesives and sealants
* Aerosol spray cleaning/degreasing
* Anti-spatter welding aerosol
* Inks and ink removal
* Lubricants and greases
* Mold cleaning, release, and protectants
* Paint and coatings
* Spot removers
* Wipe and liquid cleaning and polishing

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 PCE. As with the point sources, nonpoint emissions of PCE 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 Expected 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](#_ENREF_85)). Of the relevant use categories, EPA lists PCE as an expected nonpoint pollutant only for degreasing, inks and ink removal, and disposal uses ([EPA 2020g](#_ENREF_90)). Thus, all other nonpoint emissions of PCE reported in NEI (e.g., paint and coatings, adhesives and sealants) only reflect voluntary submissions by states that provided documentation.

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

#### Methodology

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

1. *Estimate total solvent usage*. [The Freedonia Group (2016)](#_ENREF_50)) provides consumption estimates across all solvents for eight broad types of uses.
2. *Allocate total solvent usage to relevant use categories*. Use California Air Resources Board (CARB) data to disaggregate the total solvent volume from the broad categories in step 1 into the total solvent volume for the specific use categories considered in this analysis.
3. *Apply PCE speciation factors to approximate the market share of PCE in each use category.* Use the total solvent volume for specific use categories estimated in step 2 and PCE speciation factors from EPA’s SPECIATE database to estimate the volume of PCE used in specific use categories. PCE speciation factors are assumed to differ for states that have regulations limiting PCE use/emissions and states that do not limit PCE use/emissions.

**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](#_ENREF_50)),[[11]](#footnote-13) which are reproduced in Table 6‑3. These estimates encompass both point and nonpoint sources.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 6‑3: Solvent Usage in the United States | | | |
| 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 |
| Source:[The Freedonia Group 2016](#_ENREF_50) | | | |

**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 the 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](#_ENREF_12)). 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](#_ENREF_11)). 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 PCE, 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 PCE in the next step.

| Table 6‑4: Crosswalk between Use Categories with Both Point and Nonpoint Sources and Estimation Source Categories | | |
| --- | --- | --- |
| Freedonia | Use Category | CARB |
| Adhesives & Sealants Solvent Demand | Adhesives and Sealants | Arts and Crafts Adhesive |
| Carpet and Tile Adhesive |
| Construction, Panel, or Floor Covering Adhesive |
| Contact Adhesive - General Purpose |
| Contact Adhesive - Special Purpose |
| General Purpose Adhesive |
| Household Glues and Paste |
| Specialty Automotive Adhesive |
| Thread Locking Compound |
| Woodworking Glue |
| Other adhesives |
| Floor Seam Sealer |
| Insulating and Sealing Spray Foam |
| Pipe Thread Sealant/Pipe Joint Compound |
| Sealant or Caulking Compound -- Chemically Curing |
| Sealant or Caulking Compound -- Nonchemically Curing |
| Spackling Compound |
| Tile and Grout Sealer |
| Wood Filler |
| Other sealants and caulks |
| Tire Sealants and Inflator |
| Cleaning Products Solvent Demand: Household | Aerosol Spray Cleaning/Degreasing | General Purpose Degreaser (aerosol) |
| Metal Polish/Cleanser (aerosol) |
| Electrical Cleaner |
| Electronic Cleaner |
| Energized Electrical Cleaner |
| Multi-purpose Solvent (aerosol) |
| Anti-Spatter Welding Aerosol | Specialty Adhesive Remover1 |
| Spot Removers | Carpet and Upholstery Cleaner (aerosol) |
| Carpet and Upholstery Cleaner (nonaerosol - dilutable) |
| Carpet and Upholstery Cleaner (nonaerosol - ready-to-use) |
| Spot Remover (aerosol) |
| Spot Remover (nonaerosol) (Laundry Products) |
| Spot Remover (nonaerosol) (Non-Laundry Products) |
| Wipe and Liquid Cleaning and Polishing | General Purpose Degreaser (nonaerosol) |
| Gum or Candle Wax Remover |
| Metal Polish/Cleanser (nonaerosol) |
| Single Purpose Cleaner |
| Single Purpose Degreaser |
| Other cleaners and degreasers |
| Clean Up Solvent |
| Multi-purpose Solvent (nonaerosol) |
| Spray Gun Cleaner and Solvent |
| Tire or Wheel Cleaner (nonaerosol) |
| Engine Degreaser (aerosol) |
| Engine Degreaser (nonaerosol) |
| Cleaning Products Solvent Demand: Industrial & Institutional | Aerosol Spray Cleaning/Degreasing | *Not reported in CARB survey* |
| Anti-Spatter Welding Aerosol | *Not reported in CARB survey* |
| Spot Removers | *Not reported in CARB survey* |
| Wipe and Liquid Cleaning and Polishing | *Not reported in CARB survey* |
| Dry Cleaning | Spot Removers | *Not reported in CARB survey* |
| Paints & Coatings Solvent Demand: Architectural | Paint and Coatings | *Not reported in CARB survey* |
| Paints & Coatings Solvent Demand: Other | Lubricants and Greases | Anti-Seize Lubricant (aerosol) |
| Anti-Seize Lubricant (nonaerosol) |
| Cutting or Tapping Oil (aerosol) |
| Cutting or Tapping Oil (nonaerosol) |
| Firearm Lubricant |
| Gear, Chain, or Wire Lubricant (aerosol) |
| Gear, Chain, or Wire Lubricant (nonaerosol) |
| Lubricants to manufacture or construct goods (labeled not for retail sale) |
| Multi-purpose Dry Lubricant |
| Multi-purpose Lubricant (including solid and semisolid products) |
| Penetrant |
| Silicone-based Multi-purpose Lubricant |
| Single Purpose Lubricant |
| Other lubricants and penetrants |
| Mold Cleaning, Release and Protectants | Molding and Casting Materials (Including all related products) |
| Paint and Coatings | Artist Solvent and Thinner |
| Lacquer Thinner |
| Paint Thinner (nonaerosol) |
| Surface Preparation Solvent and Cleaner (Motor Vehicle Surfaces) |
| Thinner/Reducer/Retardant (Furniture Coating Systems) |
| Thinner/Reducer/Retardant (Motor Vehicle Coating Systems) |
| Other solvent and thinning products |
| Undercoating (aerosol only) |
| Printing Ink Solvent Demand | Inks and Ink Removal | Inks, Toners, Ribbons, and Cartridges for office equipment |
| 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) |
| 1 Anti-spatter welding aerosols are not represented as a separate category in the CARB data. For the purposes of this analysis, EPA mapped the anti-spatter welding aerosols use category to the “Specialty Adhesive Remover” CARB product category and expects the market shares for these two product categories to be comparable, as both are specialty products. | | |

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.

| Table 6‑5: Total Use Category Annual Solvent Demand | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Freedonia Solvent Category | 2020 Total Solvent Demand1 (million lbs) | 2015 CARB Survey Total Solvent Sales (tons per day) | 2015 CARB Survey Use Category Solvent Sales (tons per day) | Market Share of Solvent Category2 (% wt) | Total Use Category Solvent Consump­tion (million lbs) |
| A | B | C | D = C/B | E = A x D |
| Adhesives and Sealants | Adhesives & Sealants Solvent Demand | 643 | 156 | 156 | 1.000 | 643 |
| Aerosol Spray Cleaning/Degreasing | Cleaning Products Solvent Demand: Household | 662 | 940 | 4 | 0.004 | 3 |
| Anti-Spatter Welding Aerosol | 940 | 0.02 | 0.000025 | 0.016 |
| Spot Removers | 940 | 46 | 0.049 | 32 |
| Wipe and Liquid Cleaning and Polishing | 940 | 64 | 0.068 | 45 |
| Aerosol Spray Cleaning/Degreasing | Cleaning Products Solvent Demand: Industrial & Institutional3 | 398 | - | - | 0.004 | 2 |
| Anti-Spatter Welding Aerosol | - | - | 0.000025 | 0.01 |
| Spot Removers | - | - | 0.049 | 20 |
| Wipe and Liquid Cleaning and Polishing | - | - | 0.068 | 27 |
| Spot Removers4 | Dry Cleaning | 16 | - | - | 0.0004 | 0.006 |
| Paint and Coatings5 | Paints & Coatings Solvent Demand: Architectural | 840 | - | - | 1.000 | 840 |
| Lubricants and Greases | Paints & Coatings Solvent Demand: Other | 1,325 | 57 | 24 | 0.416 | 551 |
| Mold Cleaning, Release and Protectants6 | 57 | 0.0004 | 0.000006 | 0.008 |
| Paint and Coatings | 57 | 11 | 0.199 | 264 |
| Inks and Ink Removal | Printing Ink Solvent Demand | 1,138 | 14 | 14 | 1.000 | 1,138 |
| Aerosol Spray Cleaning/Degreasing | Transportation Solvent Demand: Motor Vehicles | 64 | 49 | 15 | 0.305 | 19 |
| 1Source: [The Freedonia Group 2016](#_ENREF_50)  2 Source: [CARB 2019b](#_ENREF_12)  3 The Freedonia Cleaning Products Solvent Demand: Industrial & Institutional category is not represented in the CARB data. EPA therefore assumed that the market shares for these use categories are the same as the market shares calculated for the use categories within the Freedonia Cleaning Products Solvent Demand: Household category.  4 Dry cleaning products are not represented in the CARB data. EPA therefore estimated the spot remover market share by dividing the estimated volume of PCE spotting agents used annually in California in 2007 (150 gallons) by the estimated total volume of PCE used annually in California in 2003 (378,000 gallons). Sources: [Wolf and Morris 2007](#_ENREF_103), [CARB 2006](#_ENREF_9)  5 The Freedonia Paints & Coatings Solvent Demand: Architectural category is not represented in the CARB data. EPA therefore assumed that the market share for this use category is 1 (i.e., that all products within the Freedonia Paints & Coatings Solvent Demand: Architectural category are paints and coatings).  6 Data for “Molding and Casting Materials (Including all related products)” were omitted from the CARB results due to confidentiality. EPA therefore set the numerator for the market share calculation equal to the total for “All Arts and Crafts Supplies” minus the two subcategories that do have data (“Artist Solvent and Thinner” and “Other arts and crafts supplies”). This may be an overestimate as it includes "Ceramic Finishing Product" in addition to “Molding and Casting Materials (Including all related products).” | | | | | | |

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

This analysis follows NEI’s approach by applying a speciation factor to the Freedonia solvent usage estimates to estimate PCE usage. The speciation factors are the estimates of the percentage of total VOCs that PCE constitutes. The underlying implication of this analysis is that the PCE speciation factors are also a proxy for PCE’s market share of total solvent usage.[[12]](#footnote-14) This analysis uses speciation factors from EPA’s SPECIATE database, which is a repository of speciation factors of air pollutant sources ([EPA 2020i](#_ENREF_92)). The database contains approximately 130 speciation profiles for PCE, which are mapped to the use categories (Table 6‑6). The last column of Table 6‑6 includes the CARB and NEI descriptive names for the product or use that the speciation factor represents (The CARB descriptive names include “CARB” in the profile code and the NEI names are associated with 4-digit profile codes).

The PCE profiles in the SPECIATE database are dated 1989-2018 and may cover a range of values for the same use category. In particular, there is a group of about 20 profiles corresponding to CARB’s consumer product categories from 2018 and a group of equivalent profiles from 2004. The 2018 estimates are generally much lower than the 2004 factors, which is the result of the regulations CARB implemented in the intervening years that prohibit use of PCE in a range of consumer product categories ([CARB 2019c](#_ENREF_13)). Where possible, EPA therefore uses CARB’s 2018 factors for states that regulate PCE in a given use and CARB’s 2004 factors for states that do not have PCE regulations.

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

| Table 6‑6: PCE Speciation Factors | | | |
| --- | --- | --- | --- |
| Use Category | PCE Speciation Factor  (Weight %) | | PCE Speciation Factor Profile Names (Profile Code) |
| States with a PCE Limit | States without a PCE Limit |
| Adhesives and Sealants | 0.01 | 1.46 | Consumer and Commercial Products – Adhesives and Sealants Composite CARB 2010 Survey Update1 |
| Aerosol Spray Cleaning/Degreasing (Brake Cleaner) | 0.43 | 33.53 | CONS PRD- AUTOMOTIVE BRAKE CLEANER (2010 UPDATE)  Consumer Products: Automotive Brake Cleaners |
| Aerosol Spray Cleaning/Degreasing (Carburetor or Fuel-Injection Air Intake Cleaner) | 0.00 | 0.04 | Consumer Products: Carburetor Or Fuel-Injection Air Intake Cleaners2 |
| Aerosol Spray Cleaning/Degreasing (Other Automotive Cleaner) | 0.06 | 2.98 | CONS PRD- ENGINE DEGREASER (2010 UPDATE)  Consumer Products: Engine Degreasers - Aerosols |
| Aerosol Spray Cleaning/Degreasing (Household) | 0.0037 | 0.37 | Consumer Products: General Purpose Degreasers - Aerosols2 |
| Aerosol Spray Cleaning/Degreasing (Industrial & Institutional) | 0.0037 | 0.37 | Consumer Products: General Purpose Degreasers - Aerosols2,3 |
| Anti-Spatter Welding Aerosol (Household) | 0.04 | 3.89 | CONS PRD- SPECIAL PURPOSE LUBRICANT (2010 UPDATE)1 |
| Anti-Spatter Welding Aerosol (Industrial & Institutional) | 0.04 | 3.89 | CONS PRD- SPECIAL PURPOSE LUBRICANT (2010 UPDATE)1,3 |
| Inks and Ink Removal | N/A4 | 0.53 | Consumer Products: Combined Small Categories |
| Lubricants and Greases | 0.04 | 3.89 | CONS PRD- SPECIAL PURPOSE LUBRICANT (2010 UPDATE)1 |
| Mold Cleaning, Release and Protectants | N/A4 | 0.32 | Consumer Products Composite: Solvents And Coating Related Products |
| Paint and Coatings (Other) | N/A4 | 0.32 | Consumer Products Composite: Solvents And Coating Related Products |
| Paint and Coatings (Architectural) | N/A4 | 0.15 | 2004 Architectural Coatings - solvent based - 2005 survey |
| Spot Removers (Dry Cleaning) | 0.67 | 3.82 | CONS PRD- SPOT REMOVER - AEROSOL (2010 UPDATE)  Consumer Products: Spot Removers - Aerosols |
| Spot Removers (Household) | 0.67 | 3.82 | CONS PRD- SPOT REMOVER - AEROSOL (2010 UPDATE)  Consumer Products: Spot Removers - Aerosols |
| Spot Removers (Industrial & Institutional) | 0.67 | 3.82 | CONS PRD- SPOT REMOVER - AEROSOL (2010 UPDATE)  Consumer Products: Spot Removers - Aerosols3 |
| Wipe and Liquid Cleaning and Polishing (Household) | 0.68 | 1.29 | CONS PRD- METAL POLISH OR CLEANSER (2010 UPDATE)  Consumer Products: Metal Polishes/Cleansers |
| Wipe and Liquid Cleaning and Polishing (Industrial & Institutional) | 0.68 | 1.29 | CONS PRD- METAL POLISH OR CLEANSER (2010 UPDATE)  Consumer Products: Metal Polishes/Cleansers3 |
| Source: [EPA 2020i](#_ENREF_92)  1 The speciation factor in the 2010 CARB update was greater than that in the 2004 submission. EPA therefore assigned the 2010 speciation factor to the states without a PCE limit and assumed that the speciation factor for states with a PCE limit is 1% of the factor for the states without a PCE limit.  2 No speciation factor was identified in the 2010 CARB update. EPA therefore assumed that the speciation factor for states with a PCE limit would be 1% of the factor for states without a PCE limit.  3 A speciation factor for industrial and institutional products in this use category was not available in SPECIATE. EPA therefore assumed that the speciation factor for industrial & institutional products is the same as the speciation factor for consumer products.  4 No states have a PCE limit for products in this use category. | | | |

Table 6‑7 summarizes the states that limit PCE use. The analysis included states from ISSA ([2018](#_ENREF_24)) that regulate PCE for certain uses, as well as other states that EPA identified as regulating PCE for certain uses based on those states’ regulations. Note that while some states may have VOC limits for certain product categories, PCE is an exempt VOC under EPA’s definition and under all states’ definitions. Therefore, Table 6‑7 only includes states that passed separate regulations that specifically limit PCE.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 6‑7: States with Regulations Limiting PCE Emissions in Consumer Products | | | | | | | | | |
| State | Product Category | | | | | | | | |
| Adhesives and Sealants | Aerosol Spray Cleaning/ Degreasing | Anti-Spatter Welding Aerosol | Inks and Ink Removal | Lubricants and Greases | Mold Release and Protectants | Paint and Coatings | Spot Removers | Wipe Cleaning and Polishing |
| California | ü | ü | ü |  | ü |  |  | ü | ü |
| Connecticut | ü | ü |  |  |  |  |  |  | ü |
| Delaware | ü | ü |  |  |  |  |  |  | ü |
| District of Columbia | ü | ü |  |  |  |  |  |  | ü |
| Illinois | ü | ü |  |  |  |  |  |  | ü |
| Indiana | ü | ü |  |  |  |  |  |  | ü |
| Maine | ü | ü |  |  |  |  |  |  | ü |
| Maryland | ü | ü |  |  |  |  |  |  | ü |
| Massachusetts | ü | ü |  |  |  |  |  |  | ü |
| Michigan | ü | ü |  |  |  |  |  |  | ü |
| New Hampshire | ü |  |  |  |  |  |  |  | ü |
| New Jersey | ü | ü |  |  |  |  |  |  | ü |
| New York | ü | ü |  |  |  |  |  |  | ü |
| Rhode Island | ü | ü |  |  |  |  |  |  | ü |
| Utah | ü |  |  |  |  |  |  |  |  |
| Virginia | ü |  |  |  |  |  |  |  |  |
| Sources: [ISSA 2018](#_ENREF_24), [D.C. Mun. Regs. tit. 20, §§ 725-728 (2011)](#_ENREF_17), [Utah Admin. Code R307-357-4 (2020)](#_ENREF_102) | | | | | | | | | |

#### Summary and Discussion

Table 6‑8 summarizes the PCE 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 PCE limits. These population weights are derived from the 2018 American Community Survey ([U.S. Census Bureau 2019](#_ENREF_64)).

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 5 years. Their predictions therefore may not reflect the actual solvent market in 2020.

The 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 United States
* 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 PCE’s share of the solvent market, but this may be inaccurate to the extent that product categories are largely composed of non-solvent alternatives (i.e., PCE may be a small share of total volatile emissions, but a larger share of solvent emissions/use).

| Table 6‑8: Annual Volume of PCE Consumed for Use Categories with Both Point and Nonpoint Sources | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Total Use Category Solvent Demand (million lbs) | State PCE Limit | | No State PCE Limit | | Annual Volume of PCE Consumed (lbs) |
| PCE Speciation Factor (Weight %) | State Population Weight | PCE 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 |
| Adhesives and Sealants | 643 | 0.01459 | 0.40 | 1.46 | 0.60 | **5,662,769** |
| Anti-Spatter Welding Aerosol (Household) | 0.016 | 0.03890 | 0.12 | 3.89 | 0.88 | **562** |
| Anti-Spatter Welding Aerosol (Industrial & Institutional) | 0.01 | 0.03890 | 0.12 | 3.89 | 0.88 | **338** |
| Inks and Ink Removal | 1,138 | - | 0.00 | 0.53 | 1.00 | **6,031,400** |
| Lubricants and Greases | 551 | 0.03890 | 0.12 | 3.89 | 0.88 | **18,881,997** |
| Mold Cleaning, Release and Protectants | 0.008 | - | 0.00 | 0.32 | 1.00 | **26** |
| Paint and Coatings (Other) | 264 | - | 0.00 | 0.32 | 1.00 | **843,985** |
| Paint and Coatings (Architectural) | 840 | - | 0.00 | 0.15 | 1.00 | **1,276,800** |
| Spot Removers (Dry Cleaning) | 0.006 | 0.67000 | 0.12 | 3.82 | 0.88 | **218** |
| Spot Removers (Household) | 32 | 0.67000 | 0.12 | 3.82 | 0.88 | **1,117,116** |
| Spot Removers (Industrial & Institutional) | 20 | 0.67000 | 0.12 | 3.82 | 0.88 | **671,620** |
| Wipe and Liquid Cleaning and Polishing (Household) | 45 | 0.67800 | 0.36 | 1.29 | 0.64 | **481,344** |
| Wipe and Liquid Cleaning and Polishing (Industrial & Institutional) | 27 | 0.67800 | 0.36 | 1.29 | 0.64 | **289,388** |

### Manufacturing

EPA used CDR data to estimate the manufacturing volume for PCE. As reported in the PCE Risk Evaluation, the total production volume of PCE in 2015 was 324,240,744 pounds ([EPA 2020h](#_ENREF_91)).

### Disposal and Recycling

EPA used TRI data to estimate the disposal and recycling volumes for PCE. In Reporting Year 2019, total disposal or other releases of PCE (Form R Sections 8.1a-8.1d) was 873,991 pounds. The total volume of PCE recycled (both on- and off-site) was 47,532,239 pounds ([EPA 2020c](#_ENREF_86)).

### Dry Cleaning Machines

The volume of PCE used in dry cleaning is estimated by combining an estimate for the number of dry cleaning machines with an estimated average annual PCE production volume per machine.

#### Estimated Number of Dry Cleaning Machines

EPA estimated the number of dry cleaning machines in two ways. This was necessary because the COVID-19 pandemic destabilized the dry cleaning industry, causing a large percentage of dry cleaners to close. The first method uses information from industry experts and state and government data to estimate a range of how many PCE dry cleaning machines are operating in the United States. The second method uses 2021 and 2022 data on the number of PCE machines provided to EPA by various states and extrapolates that data to the rest of the country on the basis of population. The estimates from the second method are the primary estimates used in this economic analysis. However, the high and low estimates from the first method are used to generate a range of estimates in a sensitivity analysis.

##### Method 1 for estimating number of PCE dry cleaning machines

For the first method, EPA relied on two estimates from industry experts. The first is from IBIS World, which estimated that there were 32,380 dry cleaning establishments in February 2020, before the COVID-19 pandemic. The second estimate is from Paul Choe, the Chairman of the Federation of Korean Drycleaners Association, who provided the estimate in a 2021 interview with EPA. In that interview, Mr. Choe estimated that there were 20,000-25,000 dry cleaners in July 2021, which represented a 10-15 percent reduction during the COVID-19 pandemic. This suggests that there were between 22,000 and 32,000 dry cleaning establishments (rounding by the thousand) before the pandemic.

Industry experts, including the National Cleaners Association (NCA) and the Dry Cleaning and Laundry Institute (DLI), estimated that 30-40 percent of dry cleaning establishments would close during the COVID-19 pandemic. Confirming this estimate, Illinois’ public list of dry cleaning establishments in the state shows that as of August 2022, Illinois has 30 percent fewer dry cleaners than at the end of 2019. EPA therefore estimates that 30-40 percent of all dry cleaners have closed since the beginning of the COVID-19 pandemic.

Industry experts (DLI and NCA) estimated that about 60 percent of all dry cleaning machines used PCE as solvent. However, very few PCE dry cleaning machines have been sold in recent years, so older machines are very likely to be PCE machines. These machines are therefore most likely to be retired, so EPA estimates that currently 50-60 percent of dry cleaning machines use PCE as solvent.

A significant number of dry cleaning establishments are “drop shops,” which do not have a dry cleaning machine on site. However, neither EPA nor industry groups know what percentage of dry cleaning establishments are drop shops. Texas compiled information on drop shops for its dry cleaning remediation program in 2020, where they found that 54 percent of Texas dry cleaning establishments were drop shops. In a 2010 survey, King County found that 37 percent of its shops were drop shops. In 2012, the Economic Census divided commercial laundry and dry cleaning establishments into plants and drop shops (it did not do so in 2017). In the 2012 Economic Census, 17 percent of dry cleaning establishments were drop shops. This is almost certainly an underestimate because (1) many dry cleaning establishments are not in the Economic Census because they do not have any payroll and (2) smaller establishments are probably more likely to be drop shops. Very little capital is needed for a drop shop since there is no plant to purchase or maintain. Thus, EPA estimates that between 17-55 percent of all dry cleaning establishments are drop shops.

EPA estimated the number of PCE dry cleaning machines by taking the products of the following low and high estimates described above:

* Number of dry cleaning establishments before the pandemic (22,000 - 32,000)
* Percentage of pre-pandemic establishments that remain open (60 percent - 70 percent)
* Percentage of dry cleaning establishments with machines on site (45 percent - 83 percent)
* Percentage of machines using PCE (50 percent - 60 percent)

The result is an estimated 3,000 to 11,000 PCE dry cleaning machines in use today (rounding to the nearest thousand).

##### Method 2 for estimating number of PCE dry cleaning machines

EPA’s second method for estimating the number of PCE dry cleaning machines used data that the states provided to the public and to EPA. Data were provided to EPA mostly during 2021, although a few states have provided EPA with 2022 numbers. PCE machines will be banned in California at the end of a long 15-year phaseout (2023), so there are very few PCE machines currently remaining in California.

EPA has recent (2021 or 2022) data on numbers of PCE machines representing about one-third of the non-California population of the United States. There are about 1,975 PCE machines with available data, extrapolating to about 6,000 nationwide (rounding to the nearest thousand). EPA believes that 6,000 PCE dry cleaning machines nationally is the best estimate, and therefore this estimate is used as the primary estimate for the economic analysis. However, the high and low estimates are used to generate a range of estimates in a sensitivity analysis.

| Table 6‑9: State Level Data on PCE Dry Cleaning Machines | |
| --- | --- |
| State | Estimated Number of PCE Machines |
| Colorado | 70 |
| Iowa | 49 |
| Michigan | 333 |
| Missouri | 230 |
| North Carolina | 197 |
| Rhode Island | 39 |
| Texas | 505 |
| Washington | 30 |
| New York | 472 |
| Oregon | 50 |
| **Total** | **1,975** |

#### Volume of PCE Consumption in Dry Cleaning

EPA’s best estimate of the amount of PCE used per machine comes from New York State inspection data from 2018-2019. In New York State, every PCE dry cleaning machine has to be inspected yearly, and every operator has to declare how much PCE they use. In New York State, each machine uses an average of 64.5 gallons of PCE per year (slightly more than one 55-gallon drum). This is less than a 2003 CARB survey (CARB 2006b), which reports that about 81 gallons were consumed per machine per year. However, dry cleaning machines have evolved over time to be more efficient (Ceballos et al. 2021), and 64.5 gallons per year of PCE per machine seems reasonable.

Multiplying 64.5 gallons per machine (at 13.6 lbs/gal) by 3,000-11,000 machines suggests that between 2.6 million and 9.6 million pounds of PCE are used for dry cleaning yearly. Using the primary analysis estimate of 6,000 machines, 5.3 million pounds of PCE are used for dry cleaning annually.

### Laboratory Chemicals

EPA did not identify any information on the volume of PCE used in laboratory settings.

### Reactant/Intermediate

Due to the difficulty of identifying PCE emissions factors for reactant/intermediate uses, EPA estimated the volume for this use category using information from the PCE Risk Evaluation rather than the NEI data. Based on multiple sources, the Risk Evaluation estimates that 70 percent of PCE production volume is used for reactant uses and, separately, that 59 percent of PCE production volume is used for intermediates. EPA used the average of these two estimates (i.e., 64.5 percent of PCE production volume) to estimate the volume of PCE used for reactant/intermediate uses. This assumption results in an estimated 209,135,280 pounds of PCE used for reactant/intermediate uses (out of the reported 324,240,744 pounds of PCE produced in the 2015 CDR reporting year) ([EPA 2020h](#_ENREF_91)).

### Processing Aid in Chemical Manufacturing

Due to the difficulty of identifying PCE emissions factors for processing aid uses and identifying processing aid uses within the NEI data, EPA estimated the volume for this use category using data from CDR rather than the NEI data. In the 2015 CDR reporting year, Olin Corporation reported that 4 percent of their PCE production volume was used as a processing aid in petrochemical manufacturing and that 4 percent was used as a processing aid in pesticide, fertilizer, and other agricultural chemical manufacturing ([EPA 2017a](#_ENREF_77)). EPA assumed that the use volumes of the PCE produced by Olin Corporation are representative of all PCE use, and as such, assumed that this use category accounts for 8 percent of PCE production volume. This assumption results in an estimated 25,939,260 pounds of PCE used as a processing aid in chemical manufacturing (out of the reported 324,240,744 pounds of PCE produced in the 2015 CDR reporting year) ([EPA 2020h](#_ENREF_91)).

### Aerosol Spray Cleaning/Degreasing

CRC Industries, Inc., a supplier of aerosol spray cleaning/degreasing products, provided EPA with estimates of annual PCE consumption volume and the number of affected facilities for aerosol spray cleaning/degreasing use in a follow up to a public commented they submitted. CRC Industries, Inc. estimates the total amount of PCE in aerosol spray cleaning/degreasing use is 26.3 million pounds. This analysis uses this estimate as the baseline value for aerosol spray cleaning/degreasing use (estimated number of affected facilities is discussed in section 6.2.15).

### Summary of Consumption Volumes by Use Category

Table 6‑10 summarizes the estimated consumption volumes for each use category, as well as the percentage of the approximately 324 million pounds of PCE production from the 2016 CDR attributed to each use. EPA was not able to estimate a volume for the DOD Uses category.

| Table 6‑10: Summary of PCE Consumption Volume Estimates, by Use Category | | | |
| --- | --- | --- | --- |
| Use Category | Total Volume (lbs) | Percent of 2016 CDR Volume1 | Source |
| Adhesives and Sealants | 5,662,769 | 1.7% | Table 6‑8 |
| Aerosol Spray Cleaning/Degreasing | 26,300,000 | 8.1% | Section 6.1.9 |
| Anti-Spatter Welding Aerosol | 900 | 0.0003% | Table 6‑8 |
| Batch, Liquid, and Spray Cold Cleaning | 8,506 | 0.003% | Table 6‑2 |
| DOD Uses | not estimated | not estimated |  |
| Dry Cleaning Machines | 5,300,000 | 1.6% | Section 6.1.5 |
| Inks and Ink Removal | 6,031,400 | 1.9% | Table 6‑8 |
| Laboratory Chemicals | not estimated | not estimated | Section 6.1.6 |
| Lubricants and Greases | 18,881,997 | 5.8% | Table 6‑8 |
| Mold Release and Protectants | 26 | 0.000008% | Table 6‑8 |
| Paint and Coatings | 2,120,785 | 0.7% | Table 6‑8 |
| Photographic Film Use | 1,657 | 0.0005% | Table 6‑2 |
| Reactant/Intermediate | 209,135,280 | 64.5% | Section 6.1.7 |
| Processing Aid in Chemical Manufacturing | 25,939,260 | 8.0% | Section 6.1.8 |
| Spot Removers | 1,788,955 | 0.6% | Table 6‑8 |
| Textile Processing | 21,749 | 0.007% | Table 6‑2 |
| Vapor Degreasing | 509,785 | 0.2% | Table 6‑2 |
| Wipe Cleaning and Polishing | 770,731 | 0.2% | Table 6‑8 |
| **Total** | 302,761,241 | **93%** |  |
|  | | | |
| Disposal2 | 873,991 |  | Section 6.1.3 |
| Manufacturing | 324,240,744 |  | Section 6.1.3 |
| Recycling | 47,532,239 |  | Section 6.1.3 |
| 1 The Risk Evaluation reports 324,240,744 lbs of PCE produced in the 2015 CDR reporting year ([EPA 2020h](#_ENREF_91))  2 The Disposal, Manufacturing, and Recycling use categories are not included in the total production volume and are not calculated as a percentage of 2016 CDR production volume in order to avoid double-counting PCE volume across multiple stages of the life cycle. | | | |

EPA notes that the total PCE consumption volume estimated in Table 6‑10 (302,761,241 lbs) is slightly lower than the total PCE production volume reported in the 2016 CDR (324,240,744 lbs). This may be due to several reasons. First, this analysis does not include PCE exports. Second, the approach used to estimate PCE consumption volume is subject to various limitations and involves a degree of uncertainty, as discussed in the preceding sections. The difference in PCE consumption volume estimated by this analysis and that reported by CDR may reflect the errors and uncertainties related to this approach. EPA believes the difference between the estimates of this analysis and CDR is acceptable given these factors.

## Estimated Number of Facilities and Individuals with Occupational Exposure

Table 6‑11 presents a summary of the estimated number of facilities and individuals with occupational exposure. The underlying assumptions and data sources used to develop these estimates are presented for each use category in sections 6.2.1 through 6.2.24. Available sources for developing these estimates were limited and should therefore be considered uncertain. To the extent to which numbers of affected facilities, numbers of workers per facility, or ONUs per facility are underestimated or overestimated, costs and benefits for facilities subject to a WCPP could be expected to be underestimated or overestimated. For PCE-containing products that are prohibited, costs are largely a function of the number of existing products, and therefore are less sensitive overestimates or underestimates for the number of affected facilities, workers, and ONUs. For these uses, benefits that are estimated for workers and ONUs increase or decrease proportionally with the number of affected workers and ONUs.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 6‑11: Summary of Estimated Number of Facilities and Individuals with Occupational Exposure, by Use Category | | | |
| Use Category | Number of Facilities | Number of Workers | Number of ONUs |
| Manufacturing | 13 | 1,720 | 815 |
| Import/Repackage | 16 | 59 | 21 |
| Reactant/Intermediate | 8 | 330 | 150 |
| Processing Aid in Petrochemical Manufacturing | 64 | 806 | 346 |
| Production of maskant for chemical milling | 1 | 14 | 61 |
| Use as Maskant for Chemical Milling | 71 | 497 | 2,130 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | 85 | 595 | 170 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | 14 | 98 | 28 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | 2 | 14 | 4 |
| Vapor Degreasing: Web Vapor Degreasing (WVD) | 0 | 0 | 0 |
| Recycling and Disposal | 94 | 1,598 | 658 |
| Incorporation into other formulation, mixture, or reaction products | 43 | 903 | 344 |
| Laboratory Chemicals | 26 | 26 | 236 |
| Processing Aid, except petrochemical | 2 | 25 | 11 |
| DOD Uses | 0 | 0 | 0 |
| Adhesives and Sealants | 853 | 25,596 | 9,385 |
| Paint and Coatings | 30 | 1,230 | 720 |
| Aerosol Spray Cleaning/Degreasing | 148,296 | 201,370 | 10,615 |
| Liquid and Spray Batch Cold Cleaning | 13 | 546 | 325 |
| Photographic Film Use | 60 | 32 | 70 |
| Lubricants and Greases | 1,018 | 3,054 | 407 |
| Wipe and Liquid Cleaning and Polishing | 823 | 2,470 | 329 |
| Inks and Ink Removal | 28 | 26 | 44 |
| Anti-Spatter Welding Aerosol | 100 | 300 | 40 |
| Mold Cleaning, Release and Protectants | 100 | 300 | 40 |
| Dry Cleaning Machines | 6,000 | 18,000 | 4,500 |
| **Total** | **157,760** | **259,609** | **31,449** |
| Notes: See Sections 6.2.1 through 6.2.24 for a description of assumptions and sources used to develop the estimates. | | | |

### Manufacturing

Based on the 2020 CDR, eight sites are expected to manufacture PCE, with approximately 717 workers and 341 occupational non-users (ONUs) potentially exposed ([EPA 2022a](#_ENREF_95)). EPA determined the average number of individuals with occupational exposure using the average of the ranges reported in CDR for the eight sites where data were available. The ratio of workers to ONUs was estimated based on EPA’s ([2020h](#_ENREF_91)) risk evaluation.

### Import/Repackage

Based on the 2020 CDR ([EPA 2022a](#_ENREF_95)), seven sites are expected to import and/or repackage PCE, with approximately 26 workers and 9 ONUs potentially exposed. EPA estimated the average number of individuals with occupational exposure using the average of the ranges reported in CDR for the two sites where data were available. The ratio of workers to ONUs was estimated based on EPA’s ([2020h](#_ENREF_91)) risk evaluation.

### Reactant/Intermediate

Based on the 2020 CDR ([EPA 2022a](#_ENREF_95)), 30 sites are estimated to process PCE as a reactant, with approximately 1,239 workers and 561 ONUs potentially exposed. Four of the CDR reporters indicated less than 10 sites process PCE as a reactant and two others withheld the number of sites that process PCE as a reactant as TSCA confidential business information. EPA used five sites, the midpoint of the “less than 10” range, as the number of sites processing PCE as a reactant for these six CDR reporters, estimating that a total of 30 sites process PCE as a reactant. EPA estimated the average number of individuals with occupational exposure using the average of the ranges reported in CDR for the two sites where data were available. The ratio of workers to ONUs was estimated based on EPA’s ([2020h](#_ENREF_91)) risk evaluation.

### Processing Aid in Petrochemical Manufacturing

Based TRI data ([EPA 2022b](#_ENREF_96)), 64 sites are estimated to use PCE as a processing aid in petrochemical manufacturing, with approximately 806 workers and 346 ONUs potentially exposed. EPA estimated the average number of individuals with occupational exposure using the average of the range reported in CDR for the one site where data were available (18 individuals). The ratio of workers to ONUs was estimated based on EPA’s ([2020h](#_ENREF_91)) risk evaluation.

### Production of Maskant for Chemical Milling

There was one facility identified in the 2020 CDR data that produces maskant for chemical milling using PCE ([EPA 2022a](#_ENREF_95)). EPA used the midpoint of their reported range for the number of individuals with occupational exposure. The ratio of workers to ONUs was estimated based on EPA’s ([2020h](#_ENREF_91)) risk evaluation.

### Use as a Maskant for Chemical Milling

Based on EPA’s ([2020h](#_ENREF_91)) risk evaluation, 71 sites are expected to use PCE in chemical maskants, with 7 workers and 30 ONUs potentially exposed at each site. EPA estimated the number of sites using PCE as a maskant for chemical milling using information obtained during meetings between EPA and industry stakeholders. EPA estimated the number of workers and ONUs using data submitted from public comments.

### Vapor Degreasing

The Institute for Research and Technical Assistance (IRTA) ([2016b](#_ENREF_23)) 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 (IRTA [2016b](#_ENREF_23)), and assuming the mix of TCE, DCM, and PCE OTVDs is 80 percent, 1 percent, and 19 percent, respectively, EPA estimates approximately 85 OTVDs use PCE (= 2,500 x 15/85 x 19%). Using the ratio of OTVDs to enclosed vapor degreasers (EVDs) and conveyorized vapor degreasers (CVDs) as estimated in IRTA ([2016a](#_ENREF_22)), EPA estimates that approximately 2 CVDs use PCE. Based on conversations with industry, EPA believes that 14 EVDs use PCE. It is assumed that no web vapor degreasers use PCE.

### Recycling and Disposal

Based on the Final Risk Evaluation for PCE (EPA [2020h](#_ENREF_91)), 94 sites are expected to handle PCE during disposal and recycling, with 17 workers and 7 ONUs potentially exposed at each site. Multiplying the number of workers and ONUs per site by the 94 firms results in an estimated 1,598 workers and 658 ONUs potentially exposed.

### Incorporation into other formulation, mixture or reaction product

Based on the list EPA compiled of manufacturers of products containing PCE, 43 firms are estimated to process PCE for incorporation into formulation, mixture, or reaction products. In addition, EPA assumes there are two facilities that formulate vapor degreasing fluids and dry cleaning machine solvent that contains PCE. EPA’s ([2020h](#_ENREF_91)) risk evaluation estimated that approximately 21 workers and 8 ONUs are potentially exposed per site. Multiplying the number of workers and ONUs per site by the 43 firms results in an estimated 903 workers and 344 ONUs potentially exposed.

### Laboratory Chemicals

The use of PCEfor this use is expected to be minimal. Therefore, EPA assumed the market penetration of PCE for laboratory chemicals is 0.5 percent. Based on the assumption that the NAICS 541380 Testing Laboratories code covers all activities in this use, EPA estimates approximately 5,283 total firms in the industry using 2019 Statistics of U.S. Businesses (SUSB) data ([U.S. Census Bureau 2022](#_ENREF_66)). Multiplying this total by 0.5 percent results in 26 firms using PCE for laboratory uses. The risk evaluation estimates that 1 worker and 9 ONUs per site are potentially exposed to PCE, resulting in a total of 26 potentially exposed workers and 236 potentially exposed ONUs.

### Processing Aid, Except Petrochemical

There was one reporter in the 2020 CDR data reporting the use of PCE as a processing aid outside of petrochemical manufacturing at less than 10 sites ([EPA 2022a](#_ENREF_95)). EPA used the midpoint of their reported range, five, for the number of sites using PCE for this use. The number of individuals with occupational exposure are assumed to be the same as for the sites using PCE as a processing aid in petrochemical manufacturing. The ratio of workers to ONUs was estimated based on EPA’s ([2020h](#_ENREF_91)) risk evaluation. The resulting estimates are 5 sites, 63 workers, and 27 ONUs for the use of PCE as a processing aid outside of petrochemical manufacturing.

### DOD Uses

No firms were estimated for DOD uses, as it is expected that the majority of activities for this condition of use (COU) are conducted by the federal government. Commenters now report that these uses have been discontinued and so EPA has estimated no current DOD uses for these specialized uses. There is likely some use of PCE in nonspecialized uses, like aerosol degreasing, that are accounted for in other use categories.

### Adhesives and Sealants

EPA identified 10 sites reporting PCE emissions to the 2017 NEI ([EPA 2020a](#_ENREF_84)) that appeared to be using PCE in adhesives and sealants. The NAICS for these 10 sites are assumed to be the affected sectors, and the number of affected facilities was estimated as 13 percent of the establishments in the affected NAICS, where 13 percent is the estimated market share for PCE adhesives (see Table 5‑6).[[13]](#footnote-15) EPA estimated the number of workers and ONUs per site based on EPA’s ([2020h](#_ENREF_91)) risk evaluation. The resulting estimates are 853 sites, 25,596 workers, and 9,385 ONUs for the industrial use of PCE in adhesives and sealants.

### Paint and Coatings

EPA identified 30 sites reporting PCE emissions to the 2017 NEI ([EPA 2020a](#_ENREF_84)) that appeared to be using PCE in paints and coatings (excluding as a chemical maskant). EPA used the estimated number of workers and ONUs per site from EPA’s ([2020h](#_ENREF_91)) risk evaluation. The resulting estimates are 30 sites, 1,230 workers, and 720 ONUs for the industrial use of PCE in paint and coatings.

### Aerosol Spray Cleaning/Degreasing

The number of facilities using PCE for aerosol spray cleaning/degreasing is derived from the consumption volume estimates presented above in section 6.1.9. These estimates are combined with estimates from the California Air Resources Board (CARB) Initial Statement of Reasons for the Proposed Airborne Toxic Control Measure for Emissions of Chlorinated Toxic Air Contaminants from Automotive Maintenance and Repair Activities ([CARB 2000](#_ENREF_8)). This report included information from two studies conducted by CARB. The first is the CARB 1997 Consumer and Commercial Products Survey, and the second is a 1997 on-site survey of automotive repair facilities.

CARB’s analysis uses data from these surveys primarily to develop estimates for the total amount of PCE emissions from “consumer products” (which would include commercial use of aerosol degreasers, such as in an auto repair facility).

EPA employs the following method for using the information presented in CARB’s analysis to estimate the number of facilities that use aerosol degreasers containing PCE:

* Using the consumption volume estimates for the aerosol cleaning/degreasing uses discussed in section 6.1.9, an estimated 26,300,000 pounds of PCE are consumed annually for aerosol cleaning/degreasing. Assuming 14.4 ounces of PCE per can ([CARB 2000](#_ENREF_8)), this is equivalent to 29,222,222 aerosol cans.
* CARB ([2000](#_ENREF_8)) estimates that 90 percent of brake cleaners are commercially used and 10 percent are used by consumers. It follows that 26,300,000 aerosol cans with PCE are used commercially. EPA assumes that 85% of overall use is commercial brake cleaners and 5% is energized electrical equipment, thus, 24,838,889 aerosol cans with PCE are used commercially for brake cleaning and 1,461,111 aerosol cans with PCE are used commercially for energized electrical cleaning.
* CARB ([2000](#_ENREF_8)) estimated that the average facility performed 936 brake jobs per year, so EPA estimates that about 26,537 (=24,838,889/936) facilities use PCE aerosol degreasers.
* EPA assumes that the average facility using energized electrical cleaning aerosols uses them monthly, so EPA estimates that about 121,759 (=1,461,111/12) facilities use PCE aerosol degreasers.

Note that this method for estimating the number of facilities relies on the assumption that the consumption volume per facility is the same for brake cleaning and other aerosol degreasing applications. EPA’s ([2020h](#_ENREF_91)) risk evaluation further estimates 3 workers and 0.4 ONUs per site potentially exposed to PCE, resulting in a total of 79,611 potentially exposed workers and 10,615 potentially exposed ONUs for aerosol brake cleaners. For the energized electrical cleaning use, EPA assumes 1 worker per facility, resulting in a total of 121,759 potentially exposed workers.

### Liquid and Spray Batch Cold Cleaning

Based on the 2017 NEI ([EPA 2020a](#_ENREF_84)), 13 firms are estimated to use PCE in liquid and spray batch cold cleaning (this excludes small-scale cold cleaning). The risk evaluation estimates that 42 workers and 25 ONUs per site are potentially exposed to PCE, resulting in a total of 546 potentially exposed workers and 325 potentially exposed ONUs. Note that this excludes small-scale cold cleaning, such as in a 5-gallon bucket, which is included under the wipe and liquid cleaning and polishing use category.

### Photographic Film Use

EPA assumes a 2 percent market penetration of PCE in the postproduction services and other motion picture and video industries, based on a 2000 study performed for the South Coast Air Quality Management District ([Rogozen 2000](#_ENREF_44)). The study determined that 53 facilities were eligible for the study out of a sample of 73 facilities (73 percent), where eligibility was determined by facilities performing wet-gate printing and motion-picture cleaning. Based on the eligible facilities, 58 percent of film cleaning machines used PCE. EPA determined that NAICS 51219 Postproduction Services and Other Motion Picture and Video Industries best encompassed the motion-picture cleaning industry. However, this NAICS also includes other post-production services such as subtitling, credits, closed-captioning, computer-generated imagery, animation, and special effects. EPA assumes that 5 percent of NAICS 51219 performs film cleaning services. Therefore, the 2 percent market penetration was derived by multiplying this 5 percent by the 73 percent of firms performing wet-gate printing and the 58 percent of cleaning machines using PCE. Multiplying the 2,987 total firms in NAICS 51219 by 2 percent results in an estimated 60 firms using PCE for photographic film use.

To estimate the total number of workers and ONUs potentially using PCE, EPA multiplied the number of firms using PCE (60) by the estimated number of employees per firm (11) and the percentage of workers (5 percent) and ONUs (11 percent) per firm based on 2020 occupational exposure scenario (OES) data. EPA assumed that potentially exposed workers consisted of employees in Production Occupations, and potentially exposed ONUs consisted of employees in Media and Communication Equipment Workers occupations. EPA used OES data for NAICS 512130 Motion Picture and Video Exhibition for this calculation because NAICS 51219 was not in the OES data. This results in an estimated total of 32 workers and 70 ONUs potentially exposed to PCE.

### Lubricants and Greases

The Final Risk Evaluation for PCE assumes that the market penetration for PCE lubricants and greases is 29.6 percent, the same as that for aerosol degreasers (EPA [2020h](#_ENREF_91)). The 2017 NEI included facilities that appeared to be using PCE in using lubricants and greases in two NAICS ([EPA 2020a](#_ENREF_84)). Using 2019 SUSB data ([U.S. Census Bureau 2022](#_ENREF_66)), EPA estimates approximately 3,3,439 total firms in the industry. Multiplying this total by 29.6 percent results in 1,018 firms using PCE in lubricants and greases. The risk evaluation further estimates 3 workers and 0.4 ONUs per site potentially exposed to PCE, resulting in a total of 3,054 potentially exposed workers and 407 potentially exposed ONUs.

### Wipe and Liquid Cleaning and Polishing

Information on market penetration for PCE in wipe cleaning and polishing could not be identified. Therefore, EPA used the PCE consumption volume estimates for this use relative to the PCE consumption volume for aerosol cleaning/degreasing to estimate the number of facilities, workers, and ONUs using PCE for wipe and liquid cleaning and polishing. According to the estimates presented above in Table 6‑8, the consumption volume for this use is about 26 percent of the aerosol cleaning/degreasing consumption volume, and therefore EPA estimates that there are 823 facilities, 2,470 workers and 329 ONUs using PCE for wipe and liquid cleaning and polishing.

### Spot Removers

The estimated number of sites with PCE dry cleaning machines is described above in section 6.1.5. EPA assumes the same number of sites use spot removers containing PCE. This is likely an overestimate because PCE spot removers are generally not compatible with other types of machines and some sites using PCE machines may not use PCE spotting chemicals. Each site is assumed to have one worker and one ONU. The resulting estimates are 14,289 sites, workers, and ONUs for the use of PCE in spot removers.

### Inks and Ink Removal

The use of PCEfor this COU is expected to be minimal. Therefore, EPA assumed the market penetration of PCE for inks and ink removal is 0.5 percent. Based on the assumption that NAICS 323113 Commercial Screen Printing covers all activities in this COU, EPA estimates approximately 5,521 total firms in the industry using 2019 SUSB data ([U.S. Census Bureau 2022](#_ENREF_66)). Multiplying this total by 0.5 percent results in 28 firms using PCE in inks and ink removal. To estimate the total number of workers and ONUs potentially using PCE, EPA multiplied the total number of employees in NAICS 323113 from the 2019 SUSB data by the market penetration of PCE, the percentage of potentially exposed workers, and the ratio of workers to ONUs. It is assumed that the ratio of workers to ONUs is the same as the ratio for the inks and ink removal COU in the Final Risk Evaluation for Trichloroethylene. The percentage of potentially exposed employees (22 percent) is estimated from OSHA enforcement data for NAICS 3231 (see description in Section 6.2.12). Multiplying the total number of employees (64,671) by the market penetration of PCE (0.5 percent), the percentage of potentially exposed workers (22 percent) and the ratio of workers to ONUs (37 percent workers and 63 percent ONUs) results in a total of 26 potentially exposed workers and 44 potentially exposed ONUs.

### Anti-Spatter Welding Aerosol

Data on the numbers of firms using anti-spatter welding aerosols were unavailable. Based on the estimated annual consumption volume for PCE in anti-spatter welding aerosols described in Section 6.1.2 (900 pounds annually), EPA expects that only a small number of facilities use anti-spatter welding aerosols containing PCE and assumes that there are 100 such facilities in this economic analysis. The risk evaluation estimates 3 workers and 0.4 ONUs per site potentially exposed to PCE, resulting in a total of 100 sites, 300 workers, and 40 ONUs.

### Mold Cleaning, Release, and Protectants

Data on the numbers of firms using PCE mold releases and protectants were unavailable. Based on the estimated annual consumption volume for PCE for this use in described in Section 6.1.2 (26 pounds annually), EPA expects that only a small number of facilities use PCE-containing mold releases and protectants and assumes that there are 100 such facilities in this economic analysis. Note that the relatively small volume estimates summarized in Section 6.1.10 and the relatively large PCE market share estimates presented in Section 5.16 appear inconsistent. Both estimates are uncertain, but it is possible that 100 facilities is an underestimate based on the market share estimates.

The number of workers and ONUs per site is estimated based on EPA’s ([2020h](#_ENREF_91)) risk evaluation. The resulting estimates are 100 sites, 300 workers, and 40 ONUs for the use of PCE in mold cleaning, release, and protectants.

### Dry Cleaning Machines

The estimated number of sites with PCE dry cleaning machines is described above in Section 6.1.5. The number of workers and ONUs per site is estimated based on EPA’s ([2020h](#_ENREF_91)) risk evaluation. The resulting estimates are 6,000 sites, 18,000 workers, and 4,500 ONUs for the use of PCE in dry cleaning machines.

# 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 estimated costs for rule familiarization and downstream notification. Section 7.6 estimated costs for the reformulation of products containing PCE. Section 7.7 presents estimated costs for switching to alternatives to PCE in dry cleaning. Section 7.8 presents estimated costs for switching to alternatives to PCE in vapor degreasing. Section 7.9 presents estimated costs for compliance with the dermal protection component of a WCPP. Section 7.10 presents estimated costs for compliance with the respiratory protection components of a WCPP. Section 7.12 summarizes the total costs for WCPP compliance. Section 7.13 presents the estimated costs for prescriptive controls for the energized electrical cleaning use. Section 7.14 presents a discussion of unquantified costs and other uncertainties underlying the cost estimates. Section 7.15 presents the total annualized costs under the options.

## Description of Options

EPA is finalizing under TSCA section 6(a) to: (i) Prohibit most industrial and commercial uses and the manufacture (including import), processing, and distribution in commerce, of PCE for those uses; (ii) Prohibit the manufacture (including import), processing, and distribution in commerce of PCE for all consumer use; (iii) Prohibit the manufacture (including import), processing, distribution in commerce, and commercial use of PCE in dry cleaning and spot cleaning through a 10-year phaseout; (iv) Require strict workplace controls, including a PCE Workplace Chemical Protection Program (WCPP), which would include requirements to meet an inhalation exposure concentration limit and prevent direct dermal contact with PCE, for many occupational conditions of use not prohibited; (v) Require prescriptive workplace controls for laboratory use and energized electrical cleaner; (vi) Establish recordkeeping and downstream notification requirements; and (vii) Provide a 10-year time limited exemption under TSCA section 6(g) for certain emergency uses of PCE in furtherance of National Aeronautics and Space Administration’s (NASA) mission, for specific conditions of use which are critical or essential and for which no technically and economically feasible safer alternative is available.

The primary alternative regulatory action (Option 2) considered by EPA combines prohibitions and requirements for a WCPP to address the unreasonable risk from PCE driven by the various conditions of use. While in some ways it is similar to Option 1, Option 2 differs by providing for a WCPP, including requirements to meet an ECEL and DDCC for some COUs that would be prohibited under the final regulatory action, or other prescriptive workplace controls for COUs that would have WCPP under the final regulatory action. Option 2 also considers prescriptive workplace controls where existing engineering controls, administrative controls, and PPE may already address the unreasonable risk. The alternative regulatory action additionally includes longer compliance timeframes for prohibitions and a WCPP.

All regulatory options prohibit all use of PCE unless it is specifically allowed by a particular option.

Table 7‑1 summarizes the options by use category.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 7‑1: Summary of Options Analyzed by use Category | | | |
| Use Category | | Option 1  (Final Rule) | Option 2  (Primary Alternative) |
| Manufacturing | | **WCPP** | **WCPP** |
| Import/Repackage | |
| Reactant/Intermediate | |
| Processing Aid in Petrochemical Manufacturing | |
| Production of Maskant for Chemical Milling | | **Prohibit**, with section 6(g) exemption for chemical milling of aircraft skins and prohibition in 10 years |
| Use as Maskant for Chemical Milling | |
| Vapor Degreasing | Open Top Vapor Degreasing (OTVD) | **Prohibit**, with section 6(g) exemption for aerospace uses and prohibition in 10 years |
| Enclosed Vapor Degreasing (EVD) |
| Conveyorized Vapor Degreasing (CVD) | **Prohibit** | **Prohibit** |
| Web Vapor Degreasing (WVD) |
| Recycling and Disposal | | **WCPP** | **WCPP** |
| Incorporation into adhesive and sealant products | | **WCPP** | **Prohibit** |
| Incorporation into Other Formulation, Mixture, and Reaction Products1 | | **WCPP** | **Prohibit** (with section 6(g) exemption for cleaning and degreasing products for aerospace use and prohibition in 10 years) |
| Laboratory Chemicals | | **PC** | **WCPP** |
| Processing Aid, Except Petrochemical | | **WCPP** | **Prohibit** |
| Adhesives and Sealants | | **WCPP** (for uses not prohibited) |
| Paint and Coatings | | **Prohibit** |
| Aerosol Spray Cleaning/Degreasing | | **PC** (for uses not prohibited) |
| Liquid and Spray Batch Cold Cleaning | | **Prohibit** |
| Photographic Film Use | |
| Lubricants and Greases | |
| Wipe and Liquid Cleaning and Polishing | |
| Spot Removers2 | |
| Inks and Ink Removal | |
| Anti-Spatter Welding Aerosol | |
| Mold Cleaning, Release and Protectants | |
| Dry Cleaning Machines | | 10-Year Phaseout | 15-Year Phaseout |
| Specialty DOD Uses (oil analysis and water pipe repair) | | **Prohibit** | **Prohibit** |
| Possibly Inactive COUs/Overlapping Tasks3 | |
| 1Costs and benefits for processors that formulate products containing PCE are generally accounted for under the end use category for the product(s) they would need to reformulate under the options.  2Options 1 and 2 have 10- and 15-year phaseouts for dry cleaning machines and spot removers by establishments with PCE dry cleaning machines, respectively.  3Includes textile processing, wood furniture manufacturing, foundry applications, welding.  Note: Use of PCE by Federal agencies and contractors acting for or on behalf of Federal agencies are subject to a different compliance timeframe not captured in this analysis.  Table abbreviations: Workplace Chemical Protection Program (WCPP); Prescriptive controls with Monitoring, and Respiratory and Dermal PPE requirements (Prescriptive Controls, or PC). | | | |

## Timeline for the Analysis

In selecting the number of years to consider in the cost-benefit analysis of the policy, 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 ([2014](#_ENREF_73)) *Guidelines for Preparing Economic Analyses* suggests the following when selecting the time horizon.

“While there is little theoretical guidance on the time horizon of economic analyses, a guiding principle is that the time span should be sufficient to capture major welfare effects from policy alternatives. … 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 following:

* 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
* The extent to which benefits and costs are separated by generations.”

The recommendation in EPA’s ([2014](#_ENREF_73)) 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 percent discount rate. However, the probability that the rule becomes obsolete increases over time. For example, newer chemicals or other technological advances could make PCE 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 PCE-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. That is, if another year is added to the time horizon, the changes in the annualized costs and benefits are less than 2 percent for all of the options using both the 3 percent and 7 percent discount rates. Thus, selecting a longer time horizon is unlikely to have a significant effect on the relative rankings of the options under consideration.

For products that are prohibited, EPA believes that a 20-year timeline is appropriate because EPA wants to limit the analysis to a time period where we have a known comparison of PCE-containing to PCE-free products. The current baseline is a world in which PCE-containing products are produced. However, EPA believes that the baseline uncertainty in twenty years is too great to extend costs benefits longer than that. Furthermore, dry cleaning machines tend to last about twenty years, as well as other capital equipment using PCE. Also note that net benefits are not sensitive to an extension of the analysis timeframe. After the initial costs are incurred, the analysis assumes constant recurring costs and benefits in the additional years.

The present discounted value for the annualized value of the 20-year stream of costs is estimated using discount rates of 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:

|  |  |
| --- | --- |
|  | (1) |

The present discounted value costs are annualized as follows:

|  |  |
| --- | --- |
|  | (2) |

## Summary of Number of Affected Entities

Table 7‑2 presents the estimated numbers of sites and workers. Descriptions of how these estimates were derived are presented in section 6.2.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 7‑2: Number of Sites, Workers, and ONUs Affected by PCE Risk Management | | | |
| Use Category | Number of Facilities | Number of Workers | Number of ONUs |
| Manufacturing | 13 | 1,720 | 815 |
| Import/Repackage | 16 | 59 | 21 |
| Reactant/Intermediate | 8 | 330 | 150 |
| Processing Aid in Petrochemical Manufacturing | 64 | 806 | 346 |
| Production of Maskant for Chemical Milling | 1 | 14 | 61 |
| Use as Maskant for Chemical Milling | 71 | 497 | 2,130 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | 85 | 595 | 170 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | 14 | 98 | 28 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | 2 | 14 | 4 |
| Recycling and Disposal | 94 | 1,598 | 658 |
| Incorporation into Adhesive and Sealant Products | 12 | 252 | 96 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Aerosol) | 18 | 378 | 144 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Other) | 13 | 273 | 104 |
| Laboratory Chemicals | 26 | 26 | 236 |
| Processing Aid, Except Petrochemical | 2 | 25 | 11 |
| Adhesives and Sealants | 853 | 25,596 | 9,385 |
| Paint and Coatings | 30 | 1,230 | 720 |
| Aerosol Spray Cleaning/Degreasing | 148,296 | 201,370 | 10,615 |
| Liquid and Spray Batch Cold Cleaning | 13 | 546 | 325 |
| Photographic Film Use | 60 | 32 | 70 |
| Lubricants and Greases | 1,018 | 3,054 | 407 |
| Wipe and Liquid Cleaning and Polishing | 823 | 2,470 | 329 |
| Inks and Ink Removal | 28 | 26 | 44 |
| Anti-Spatter Welding Aerosol | 100 | 300 | 40 |
| Mold Cleaning, Release and Protectants | 100 | 300 | 40 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | 6,000 | 18,000 | 4,500 |
| **Total** | **157,760** | **259,609** | **31,449** |
| Notes: See sections 6.2.1 through 6.2.24 for a description of assumptions and sources used to develop the estimates. | | | |

## 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 2022](#_ENREF_57); [BLS 2023b](#_ENREF_59)). 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 percent 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 2020e](#_ENREF_88)), 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 7‑3 presents the total hourly loaded wages used in this analysis.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 7‑3: Industry Wage Rates (2022$) | | | | | | | | |
| Labor Category | Data Series | Date | Wage ($/hour) | Fringe Benefit | Total Compen-sation | Overhead as % of Total Compen-sation1 | 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 | 22-Dec | $54.29 | $24.66 | $78.95 | 20% | $15.79 | $94.74 |
| Manufacturing/‌Production Worker | BLS ECEC, Private Manufacturing Industries, “Production occupations”2 | 22-Dec | $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 | 22-Dec | $54.12 | $21.82 | $75.94 | 20% | $15.19 | $91.13 |
| Transportation and Public Utilities/‌Maintenance and Repair Worker | BLSECEC, Trade, Transportation, and Utilities Industries*,* “Installation, maintenance, and repair”2 | 22-Dec | $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” | 22-Dec | $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” | 22-Dec | $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 | 22-May | $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 | 22-May | $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 | 22-May | $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 industry | 22-May | $78.52 | $39.71 | $118.23 | 20% | $23.65 | $141.88 |
| 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 2020e](#_ENREF_88)).  2 Source: *Employer Costs for Employee Compensation Historical Supplementary Tables, National Compensation Survey: December 2022* ([BLS 2023c](#_ENREF_60)).  3 Source: *Occupational Employment Statistics* *(Occupational Employment and Wage Statistics*) for May 2022 ([BLS 2023d](#_ENREF_61)).  4 Fringe benefits are not reported in the BLS Occupational Employment and Wage Statistics (OEWS; [BLS 2023d](#_ENREF_61)). It is therefore is assumed that fringes as a percentage of wages are 50.58 percent, based on the percentage for Private Manufacturing Industries, “Professional and related” in the BLS ECEC ([BLS 2023c](#_ENREF_60)). | | | | | | | | |

## Rule Familiarization and Downstream Notification Costs

Firms that are not subject to WCPP or prescriptive control requirements are assumed to incur an initial managerial labor burden of one hour and firms that are subject to WCPP or prescriptive control 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 or prescriptive control requirements are a result of the complexity of the compliance when compared to firms subject to prohibition requirements.

The wage rates used for the Recycling and Disposal use category are the transportation and public utilities sector wages ($91.13). The wage rate for the Liquid Cleaners and Degreasers, Aerosol Spray Cleaning/Degreasing, Photographic Film Use, Wipe and Liquid Cleaning and Polishing, and Dry Cleaning use categories are the service sector wages ($95.71). The manufacturing sector wage was used for other use categories ($94.74). Table 7‑4 presents the total initial rule familiarization costs by use category.

Table 7‑4: Total Rule Familiarization Costs (2022$)

|  |  |  |  |
| --- | --- | --- | --- |
| Use Category | Number of Sites | Initial Costs (Prohibition) | Initial Costs (WCPP or other worker protection requirements) |
| Manufacturing | 13 | $1,232 | $2,781 |
| Import/Repackage | 16 | $1,516 | $3,423 |
| Reactant/Intermediate | 8 | $758 | $1,712 |
| Processing Aid in Petrochemical Manufacturing | 64 | $6,063 | $13,693 |
| Production of maskant for chemical milling | 1 | $95 | $214 |
| Use as Maskant for Chemical Milling | 71 | $6,727 | $15,191 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | 85 | $8,053 | $18,187 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | 14 | $1,326 | $2,995 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | 2 | $189 | $428 |
| Recycling and Disposal | 94 | $8,566 | $20,112 |
| Incorporation into Adhesive and Sealant Products | 12 | $1,137 | $2,568 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Aerosol) | 18 | $1,705 | $3,851 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Other) | 13 | $1,232 | $2,781 |
| Laboratory Chemicals | 26 | $2,463 | $5,563 |
| Processing Aid, except petrochemical | 2 | $189 | $428 |
| Adhesives and Sealants | 853 | $80,813 | $182,508 |
| Paint and Coatings | 30 | $2,842 | $6,419 |
| Aerosol Spray Cleaning/Degreasing | 148,296 | $14,193,410 | $31,729,412 |
| Liquid and Spray Batch Cold Cleaning | 13 | $1,232 | $2,781 |
| Photographic Film Use | 60 | $5,743 | $12,838 |
| Lubricants and Greases | 1,018 | $96,445 | $217,811 |
| Wipe and Liquid Cleaning and Polishing | 823 | $78,769 | $176,089 |
| Inks and Ink Removal | 28 | $2,653 | $5,991 |
| Anti-Spatter Welding Aerosol | 100 | $9,474 | $21,396 |
| Mold Cleaning, Release and Protectants | 100 | $9,474 | $21,396 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | 6,000 | $574,260 | $1,283,760 |

For conditions of use that are not otherwise prohibited under this regulation, EPA is requiring that manufacturers (including importers), processors, and distributors, excluding retailers, of PCE and PCE-containing products provide downstream notification of the prohibitions in Safety Data Sheets (SDSs). It is assumed that each of the 13 manufacturers and 16 import/repackage facilities spend 2 hours amending their SDSs to include this notification. The initial costs for downstream notification are $189.48 per firm and $5,495 in total for the 29 affected manufacturers and importers.

## Reformulation Costs

This section describes the estimated costs for processors who currently formulate products containing PCE 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 either to 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 reformulated products 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 this instance (even though these costs may be ultimately incurred by users). Another example of when downstream users might have increased costs resulting from reformulation is when the reformulated product is not a perfect drop-in substitute for their use and they need to make changes in how they use the product.

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 reformulation strategies: substitution and product discontinuation.

* **Substitution.** Substitution with a different 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 procurement, 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](#_ENREF_45)).
* **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 the regulation will not result in any product discontinuation. Instead, products will be reformulated through substitution.

### 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)](#_ENREF_45) and CARB ([2013](#_ENREF_10)).

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.
   1. 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.
   2. Efficacy testing. Ensures the product performance meets any label claims and established consumer expectations.
   3. 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, procuring new technology/equipment, and/or constructing 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 7‑5 is adapted from a similar table in [RTI (2002)](#_ENREF_45) and presents suggestions for the types of cost components incurred under each reformulation strategy.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 7‑5: Example Cost Components, by Reformulation Approach | | | | |
| Cost Component | Dilution | Substitution | | Production Process Change |
| Non-Critical Component1 | Critical Component2 |
| Recurring Raw Material Cost |  | P | P |  |
| Research and Product Development |  | P | P | P |
| Product Performance Testing | | | | |
| ·      Stability Testing | P | P | P | P |
| ·      Efficacy Testing | P | P | P | P |
| ·      Safety Testing |  |  | P | P |
| Production and Manufacturing Changes | | | | |
| ·      Process Change |  |  |  | P |
| ·      Start-up and Verification |  | P | P | P |
| ·      Full-Scale Plant Trial |  |  | P | P |
| ·      Pilot Plant Testing |  | P |  |  |
| Packaging |  |  | P | P |
| Labeling |  | P | P | P |
| Marketing | | | | |
| ·      Market Group Testing |  |  |  |  |
| ·      Technical Literature |  |  | P |  |
| 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 are described in the sections below.

#### Cheminfo Services (2006)

[Cheminfo Services (2006)](#_ENREF_15) 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)](#_ENREF_15) sent 120 companies a questionnaire asking about costs associated with reformulation. Responses from 55 companies and information on 39 products were ultimately received. 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 substitution reformulation.

There are several limitations to this study. First, [Cheminfo Services (2006)](#_ENREF_15) 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 percent 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 regulated PCE-containing products. 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](#_ENREF_74)) and the Economic Analysis of the TSCA Section 6 Action on Methylene Chloride, Paint and Coating Remover (EPA [2019](#_ENREF_83)).

#### California Air Resources Board (2013)

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. Details of the methodology to estimate nonrecurring costs are included in 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 ([CARB 2013](#_ENREF_10)). 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).

#### RTI International (2002)

RTI International developed a food and cosmetics reformulation cost module for the FDA ([RTI 2002](#_ENREF_45)). 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 7‑6 and Table 7‑7 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.

### Summary of Available Reformulation Unit Cost Estimates

Table 7‑6 and Table 7‑7 present a cross-walked summary of cost estimates from [Cheminfo Services (2006)](#_ENREF_15), CARB ([2013](#_ENREF_10)), and [RTI (2002)](#_ENREF_45) for minor and major modifications, respectively. The cost component estimates for minor modifications in Table 7‑6 approximately correspond to dilution and substitution of non-critical component reformulation approaches, and therefore are less applicable for reformulating PCE products compared to the cost component estimates for major modifications in Table 7‑7. The Table 7‑7 estimates 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)](#_ENREF_45)) range estimate is presented for each cost component.

The [RTI (2002)](#_ENREF_45) estimates are generally the largest cost estimates, followed by [Cheminfo Services (2006)](#_ENREF_15) and CARB ([2013](#_ENREF_10)). 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)](#_ENREF_45) may have more sophisticated formulations than the aerosol products evaluated by CARB ([2013](#_ENREF_10)). 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)](#_ENREF_45), it is assumed that estimates are presented in 2001$.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Table 7‑6: Crosswalk of Per-Formula Component Cost Estimates (2022$) - Minor Modification1 | | | | | | | |
| Cost Component | Cheminfo2 | | CARB3 | | RTI4 | | |
| 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 | - | - | - | $2,062 | - | - | - |
| -Start-up and Verification | $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)](#_ENREF_15), respectively. 3 Corresponds to the low-cost estimates from CARB ([2013](#_ENREF_10)) (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)](#_ENREF_45). | | | | | | | |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Table 7‑7: Crosswalk of Per-Formula Component Cost Estimates (2022$) - Major Modification1 | | | | | | | |
| Cost Component | Cheminfo2 | | CARB3 | | RTI4 | | |
| 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** | **$18,356** | **$64,968** | **$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)](#_ENREF_15), respectively. 3 Correspond to the high-cost estimates from CARB ([2013](#_ENREF_10)) (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)](#_ENREF_45). | | | | | | | |

### 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](#_ENREF_10)) 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)](#_ENREF_15) estimates also pertain to similar types of products, there is no way to separate the costs for simpler dilution reformulations from those that are more complex. EPA believes that the RTI ([2002](#_ENREF_45)) 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](#_ENREF_45)) estimates’ cost components to estimate reformulation costs for those products that are expected to require complex reformulations.

Table 7‑8 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](#_ENREF_45)) estimates. Research and development, production and manufacturing, and package/labeling costs come from [RTI (2002)](#_ENREF_45), and the other cost components are based on CARB’s highest reformulation cost estimate.

|  |  |  |
| --- | --- | --- |
| Table 7‑8: Reformulation Costs Used in this Analysis (2022$) | | |
| Cost Component | Standard Substitution Reformulation  Cost | Complex Substitution Reformulation  Cost |
| **Research and Product Development** | $27,225 | $49,882 |
| •      Stability Testing | $9,487 | $9,487 |
| •      Efficacy Testing | $7,837 | $7,837 |
| •      Safety Testing | $14,025 | $14,025 |
| **Production and Manufacturing** | | |
| •      Process Change | $2,062 | $3,905 |
| •      Start-up and Verification | $7,363 |
| •      Plant Testing | $5,566 |
| **Packaging/Labeling** | $1,856 | $10,262 |
| **Marketing** | | |
| •      Market Group Testing | $2,062 | $2,062 |
| •      Technical Literature | $412 | $412 |
| **TOTAL** | **$64,966** | **$110,801** |

Table 7‑9 indicates which of the reformulation costs correspond to each of the use categories considered in the analysis. As indicated, affected vapor degreasers and dry cleaners are assumed to switch to different cleaning methods that use existing cleaning agents or a vapor degreasing method using an existing vapor degreasing fluid. For all other use categories, the analysis assumes that the standard substitution reformulation costs are incurred.

Table 7‑9: Reformulation Costs by Use Category

|  |  |  |  |
| --- | --- | --- | --- |
| Use Category | No Reformulation | Standard Substitution Reformulation  Cost | Notes |
| ($0) | ($64,966) |
| Vapor degreasing fluid | ✓ |  | EPA assumes that PCE vapor degreasers will be switched to vapor degreasing fluids that already exist, or that users will 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](#_ENREF_10)) and [RTI (2002)](#_ENREF_45). | | | |

### Summary of Estimated Total Reformulations Costs by Use Category

Table 7‑10 presents the estimated costs for the reformulation of products that would be necessary if PCE were prohibited for all use categories. Note that EPA assumes a prohibition of PCE 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. Similarly for dry cleaning, affected dry cleaners are assumed to switch to fabricare cleaning chemicals and methods that already exist. Under Options 1 and 2, adhesives with PCE concentrations above 1% are assumed to be reformulated. Note that while this would not be required under Option 1 for all uses, it would be one of the requirements under Option 2. However, since adhesives with PCE concentrations above 1% are not believed to be critical uses, reformulation is assumed to be a more practical compliance strategy compared to WCPP compliance under Option 1.

|  |  |  |
| --- | --- | --- |
| Table 7‑10: Total Reformulation Costs | | |
| Use Category | Products Reformulated | **Total Reformulation Costs (Initial Costs, $64,966 per product))** |
| Adhesives and Sealants | 43 | $2,793,538 |
| Paint and Coatings | 1 | $64,966 |
| Aerosol Spray Cleaning/Degreasing | 26 | $1,689,116 |
| Lubricants and Greases | 26 | $1,689,116 |
| Wipe and Liquid Cleaning and Polishing | 7 | $454,762 |
| Inks and Ink Removal | 1 | $64,966 |
| Anti-Spatter Welding Aerosol | 2 | $129,932 |
| Mold Cleaning, Release and Protectants | 6 | $389,796 |
| Spot Removers | 3 | $194,898 |
| **All Conditions of Use** | **115** | **$7,471,090** |

## Costs for Switching to Alternatives to PCE in Dry Cleaning

The use of PCE dry cleaning machines is currently on the decline. In discussions between the National Cleaners Association (NCA) and the Dry Cleaning and Laundry Institute (DLI), NCA indicated that the number of PCE dry cleaning machines purchased annually is in the single digits. NCA indicated that existing PCE dry cleaning machines last about 20 years. New York state PCE dry cleaning facility inspection data ([New York State Department of Environmental Conservation 2019](#_ENREF_32)) obtained by EPA seemed to indicate that machines frequently lasted slightly longer than 20 years, as about 30% of the machines inspected in 2019 were more than 20 years old. However, very few machines (1.2%) were more than 25 years old. Given this, EPA assumed that dry cleaning machines manufactured after 2004 are retired 15 to 25 years after the manufactured date, with an equal number of machines being retired in each of those 11 years after the manufactured date. Dry cleaning machines manufactured before 2005 are assumed to be retired before PCE dry cleaning machines are prohibited.

With many of the existing PCE dry cleaning machines being near the end of their life and very few new PCE machines being purchased, very few PCE dry cleaning machines are expected to be in operation even without the new regulation at the end of the analytical timeframe for this economic analysis. As such, EPA’s general approach to estimate the costs of the regulatory options for PCE dry cleaning machines is to estimate the incremental cost of switching to non-PCE dry cleaning sooner than would happen otherwise without the EPA intervention. This approach is summarized in Figure 7‑1.

|  |
| --- |
| Figure 7‑1: Outline of Approach for Estimating the Costs for Switching to Alternatives to PCE in Dry Cleaning |
|  |

### Estimate Distribution for Baseline Retirement of PCE Dry Cleaning Machines

EPA estimated the distribution for the baseline retirement of PCE dry cleaning machines using NY state inspection data. These data included the date manufactured and the date installed for each PCE machine inspected by NY state in 2018 or 2019. EPA used the date manufactured if it was available and the date installed if the date manufactured was missing. Table 7‑11 summarizes the distribution for the estimated baseline retirement years of PCE dry cleaning machines.

|  |  |  |
| --- | --- | --- |
| Table 7‑11: NY State PCE Dry Cleaning Machines by Year Manufactured and Assumed Retirement Year (25 years after manufacture) | | |
| Year Manufactured | Assumed Baseline Retirement Years | Percent of NY State Dry Cleaning Machines |
| 1988 | 2020 | 0.1% |
| 1990 | 2020 | 0.3% |
| 1991 | 2020 | 0.3% |
| 1992 | 2020 | 0.2% |
| 1993 | 2020 | 0.2% |
| 1994 | 2020 | 3.5% |
| 1995 | 2020 | 6.2% |
| 1996 | 2020 – 2021 | 7.5% |
| 1997 | 2020 – 2022 | 5.9% |
| 1998 | 2020 – 2023 | 11.2% |
| 1999 | 2020 – 2024 | 11.6% |
| 2000 | 2020 – 2025 | 14.4% |
| 2001 | 2020 – 2026 | 5.6% |
| 2002 | 2020 – 2027 | 10.2% |
| 2003 | 2020 – 2028 | 16.4% |
| 2004 | 2020 – 2029 | 1.6% |
| 2005 | 2020 – 2030 | 1.4% |
| 2006 | 2021 – 2031 | 0.8% |
| 2007 | 2022 – 2032 | 0.4% |
| 2009 | 2024 – 2034 | 0.3% |
| 2010 | 2025 – 2035 | 0.2% |
| 2011 | 2026 – 2036 | 0.1% |
| 2012 | 2027 – 2037 | 0.2% |
| 2013 | 2028 – 2038 | 0.1% |
| 2015 | 2030 – 2040 | 0.2% |
| 2016 | 2031 – 2041 | 0.1% |
| 2017 | 2032 – 2042 | 0.2% |
| 2018 | 2033 – 2043 | 0.4% |
| 2019 | 2034 – 2044 | 0.2% |

### Estimate Initial and Recurring Costs for Dry Cleaning Using PCE Alternatives

There are many different alternatives to PCE dry cleaning available (see section 5.17). EPA expects that multi-solvent or hydrocarbon dry cleaning machines are likely to be the most common alternative. Therefore, EPA estimated the costs for switching to hydrocarbon machines and uses these costs as a proxy for all available alternatives to PCE for dry cleaning (see section 5.17 for a description of other dry cleaning alternatives and their estimated costs).

#### Initial Capital Costs for Hydrocarbon Dry Cleaning Systems

Based on information provided by Nora Nealis of the NCA ([Personal Communication with Nora Nealis of the National Cleaners Association (NCA) 2022](#_ENREF_43)), the initial capital costs for installing a new machine include:

1. The cost of the machine (about $1,100 per pound of capacity)
2. Freight ($1,500 to $2,500)
3. Removal of waste from existing machine ($370)
4. Other removal and installation costs ($15,000–$19,000)
5. Permit fees ($12,000–$15,000)

Using the midpoints of these ranges, EPA estimates that installation costs for a new hydrocarbon machine are about $1,100 per pound of capacity for the machine plus $33,000 in other costs associated with removal of the old machine and installation of the new one.

EPA estimated the distribution of dry cleaning machine capacity using the NY state PCE dry cleaning facility inspection data. Thus, EPA assumes that retired PCE machines will be replaced with hydrocarbon machines of the same capacity. Table 7‑12 summarizes the estimated distribution of machines by capacity and the estimated initial capital costs for removing the old machine and replacing it with a hydrocarbon machine.

|  |  |  |
| --- | --- | --- |
| Table 7‑12: NY State PCE Dry Cleaning Machines by Capacity (lbs) and Initial Capital Cost for Replacement with Hydrocarbon Machines (2022$) | | |
| Capacity (lbs) | Percent of NY State Dy Cleaning Machines | Initial Capital Costs  ($1,100 × Capacity + $33,000) |
| 28 | 0.87% | $ 63,800 |
| 29 | 0.11% | $ 64,900 |
| 30 | 1.96% | $ 66,000 |
| 33 | 0.33% | $ 69,300 |
| 35 | 14.47% | $ 71,500 |
| 36 | 0.76% | $ 72,600 |
| 37 | 2.18% | $ 73,700 |
| 37.4 | 0.22% | $ 74,140 |
| 37.5 | 0.11% | $ 74,250 |
| 38 | 0.33% | $ 74,800 |
| 39.6 | 0.11% | $ 76,560 |
| 40 | 26.99% | $ 77,000 |
| 44 | 0.33% | $ 81,400 |
| 45 | 13.06% | $ 82,500 |
| 46 | 0.65% | $ 83,600 |
| 48.4 | 0.11% | $ 86,240 |
| 50 | 13.60% | $ 88,000 |
| 55 | 9.58% | $ 93,500 |
| 57.5 | 0.11% | $ 96,250 |
| 60 | 6.75% | $ 99,000 |
| 65 | 1.41% | $ 104,500 |
| 70 | 0.54% | $ 110,000 |
| 70.4 | 0.11% | $ 110,440 |
| 70.5 | 0.11% | $ 110,550 |
| 75 | 2.50% | $ 115,500 |
| 80 | 2.29% | $ 121,000 |
| 90 | 0.22% | $ 132,000 |
| 120 | 0.22% | $ 165,000 |
| **Average Capacity (46.4)** | **100%** | **$ 84,002** |

#### Incremental Increase in Costs for Hydrocarbon Dry Cleaning Compared to PCE Dry Cleaning

From conversations EPA had with industry experts, PCE and hydrocarbon cleaning use similar processes, and therefore training and labor costs are unlikely to differ substantially. The 2012 TURI report, while dated, indicates that spotting costs are similar for the two methods ([TURI 2012](#_ENREF_51)). [Morris and Wolf (2005)](#_ENREF_30) also found that spotting labor costs would likely be similar and identified solvent, detergent, gas, and electric costs as the recurring costs that would differ between the two cleaning methods.

EPA obtained price information for PCE and hydrocarbon solvents from [www.cleanersoutlet.com](http://www.cleanersoutlet.com), where the price for a 15 gallon drum of PCE was $269.25 ($17.99/gallon) and a 5 gallon drum of DF-2000 hydrocarbon solvent was $93.00 ($18.60/gallon) ([Cleaners Outlet 2022](#_ENREF_16)). EPA analyzed the case study estimates from [Morris and Wolf (2005)](#_ENREF_30) for electricity costs and gas costs by adjusting them to 2022 prices and estimating the relationship between annual electricity and gas costs to annual pounds of garments cleaned using PCE machines using a simple ordinary least squares (OLS) regression (see Figure 7‑2). EPA assumed the cost increase to convert from PCE to hydrocarbon systems is 33.4% for electricity and 9.2% for natural gas based on estimates from [Sinsheimer (2009)](#_ENREF_47).

Figure 7‑2: Electricity and Gas Costs Estimated as a Function of Pounds of Garments Cleaned

EPA then estimated a distribution for pounds of garments cleaned annually using NY state inspections data on the amount of PCE purchased annually for PCE dry cleaning machines.

Dry cleaning machines have evolved over time to use PCE more efficiently. According to Ceballos, et al. ([2021](#_ENREF_14)) the current machines are considered 5th generation. “As the newer generations of machines were introduced,” according to the article, “the amount of PERC used was reduced from 300 to 500 g-PERC/kilogram of fabrics (1st generation) to <10 g-PERC/kilogram cleaned garment” (5th generation).”[[14]](#footnote-16) A rate of 10 grams of PCE per kilogram of garment cleaned is equivalent to 74,354 pounds of garment per 55-gallon drum of PCE (or 1,352 pounds of garments per gallon).

Table 7‑13 presents the estimated pounds of garments cleaned and the estimated annual ongoing costs that differ between PCE and hydrocarbon dry cleaning. Table 7‑14 summarizes the average annual differences in the ongoing costs.

| Table 7‑13: Estimated Distribution of Pounds of Garments Cleaned from Annual PCE Consumption (2022$) | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Annual PCE Usage (Gallons) | Percent of NY State Dy Cleaning Machines | Estimated Pounds of Garments Cleaned Annually | PCE Solvent Cost | PCE Electricity Costs | PCE Gas Costs | Hydrocarbon Solvent Cost | Hydrocarbon Electricity Costs | Hydrocarbon Gas Costs |
|  |  | 1,352 × (a) | $17.99/gallon | 0.0687 × (c) + 1,477 | 0.0657 × (c) + 1,399 | $18.60/gallon | 133.4% × (e) | 109.2% × (f) |
| (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (i) |
| 5 | 0.35% | 6,760 | $90 | $1,994 | $1,973 | $93 | $2,660 | $2,154 |
| 10 | 2.95% | 13,520 | $180 | $2,511 | $2,547 | $186 | $3,350 | $2,781 |
| 13.5 | 0.12% | 18,252 | $243 | $2,873 | $2,949 | $251 | $3,833 | $3,220 |
| 15 | 6.85% | 20,280 | $270 | $3,028 | $3,121 | $279 | $4,040 | $3,408 |
| 20 | 4.96% | 27,040 | $360 | $3,546 | $3,695 | $372 | $4,730 | $4,035 |
| 25 | 4.49% | 33,800 | $450 | $4,063 | $4,269 | $465 | $5,420 | $4,661 |
| 30 | 12.16% | 40,560 | $540 | $4,580 | $4,843 | $558 | $6,110 | $5,288 |
| 35 | 3.78% | 47,320 | $630 | $5,097 | $5,416 | $651 | $6,799 | $5,915 |
| 40 | 4.49% | 54,080 | $720 | $5,614 | $5,990 | $744 | $7,489 | $6,542 |
| 45 | 8.38% | 60,840 | $810 | $6,131 | $6,564 | $837 | $8,179 | $7,168 |
| 50 | 3.31% | 67,600 | $900 | $6,648 | $7,138 | $930 | $8,869 | $7,795 |
| 55 | 2.24% | 74,360 | $989 | $7,166 | $7,712 | $1,023 | $9,559 | $8,422 |
| 60 | 9.56% | 81,120 | $1,079 | $7,683 | $8,286 | $1,116 | $10,249 | $9,048 |
| 62 | 0.12% | 83,824 | $1,115 | $7,890 | $8,516 | $1,153 | $10,525 | $9,299 |
| 65 | 1.77% | 87,880 | $1,169 | $8,200 | $8,860 | $1,209 | $10,939 | $9,675 |
| 70 | 2.72% | 94,640 | $1,259 | $8,717 | $9,434 | $1,302 | $11,628 | $10,302 |
| 75 | 3.31% | 101,400 | $1,349 | $9,234 | $10,008 | $1,395 | $12,318 | $10,929 |
| 80 | 2.48% | 108,160 | $1,439 | $9,751 | $10,582 | $1,488 | $13,008 | $11,555 |
| 85 | 0.83% | 114,920 | $1,529 | $10,268 | $11,156 | $1,581 | $13,698 | $12,182 |
| 90 | 5.19% | 121,680 | $1,619 | $10,786 | $11,730 | $1,674 | $14,388 | $12,809 |
| 95 | 0.83% | 128,440 | $1,709 | $11,303 | $12,304 | $1,767 | $15,078 | $13,435 |
| 100 | 1.53% | 135,200 | $1,799 | $11,820 | $12,877 | $1,860 | $15,768 | $14,062 |
| 105 | 2.60% | 141,960 | $1,889 | $12,337 | $13,451 | $1,953 | $16,457 | $14,689 |
| 110 | 1.42% | 148,720 | $1,979 | $12,854 | $14,025 | $2,046 | $17,147 | $15,316 |
| 115 | 0.71% | 155,480 | $2,069 | $13,371 | $14,599 | $2,139 | $17,837 | $15,942 |
| 120 | 2.72% | 162,240 | $2,159 | $13,888 | $15,173 | $2,232 | $18,527 | $16,569 |
| 125 | 0.24% | 169,000 | $2,249 | $14,406 | $15,747 | $2,325 | $19,217 | $17,196 |
| 130 | 0.35% | 175,760 | $2,339 | $14,923 | $16,321 | $2,418 | $19,907 | $17,823 |
| 135 | 1.30% | 182,520 | $2,429 | $15,440 | $16,895 | $2,511 | $20,597 | $18,449 |
| 140 | 0.59% | 189,280 | $2,519 | $15,957 | $17,469 | $2,604 | $21,287 | $19,076 |
| 145 | 0.12% | 196,040 | $2,609 | $16,474 | $18,043 | $2,697 | $21,976 | $19,703 |
| 150 | 0.71% | 202,800 | $2,699 | $16,991 | $18,617 | $2,790 | $22,666 | $20,329 |
| 155 | 0.24% | 209,560 | $2,788 | $17,508 | $19,191 | $2,883 | $23,356 | $20,956 |
| 160 | 0.35% | 216,320 | $2,878 | $18,025 | $19,765 | $2,976 | $24,046 | $21,583 |
| 165 | 0.35% | 223,080 | $2,968 | $18,543 | $20,338 | $3,069 | $24,736 | $22,210 |
| 175 | 0.24% | 236,600 | $3,148 | $19,577 | $21,486 | $3,255 | $26,116 | $23,463 |
| 180 | 0.59% | 243,360 | $3,238 | $20,094 | $22,060 | $3,348 | $26,805 | $24,090 |
| 185 | 0.12% | 250,120 | $3,328 | $20,611 | $22,634 | $3,441 | $27,495 | $24,717 |
| 190 | 0.59% | 256,880 | $3,418 | $21,128 | $23,208 | $3,534 | $28,185 | $25,343 |
| 195 | 0.59% | 263,640 | $3,508 | $21,645 | $23,782 | $3,627 | $28,875 | $25,970 |
| 200 | 0.24% | 270,400 | $3,598 | $22,163 | $24,356 | $3,720 | $29,565 | $26,597 |
| 205 | 0.12% | 277,160 | $3,688 | $22,680 | $24,930 | $3,813 | $30,255 | $27,223 |
| 210 | 0.35% | 283,920 | $3,778 | $23,197 | $25,504 | $3,906 | $30,945 | $27,850 |
| 220 | 0.12% | 297,440 | $3,958 | $24,231 | $26,652 | $4,092 | $32,324 | $29,104 |
| 230 | 0.24% | 310,960 | $4,138 | $25,265 | $27,800 | $4,278 | $33,704 | $30,357 |
| 240 | 0.35% | 324,480 | $4,318 | $26,300 | $28,947 | $4,464 | $35,084 | $31,611 |
| 245 | 0.12% | 331,240 | $4,408 | $26,817 | $29,521 | $4,557 | $35,774 | $32,237 |
| 250 | 0.12% | 338,000 | $4,498 | $27,334 | $30,095 | $4,650 | $36,464 | $32,864 |
| 255 | 0.24% | 344,760 | $4,587 | $27,851 | $30,669 | $4,743 | $37,153 | $33,491 |
| 260 | 0.12% | 351,520 | $4,677 | $28,368 | $31,243 | $4,836 | $37,843 | $34,117 |
| 270 | 0.35% | 365,040 | $4,857 | $29,403 | $32,391 | $5,022 | $39,223 | $35,371 |
| 295 | 0.12% | 398,840 | $5,307 | $31,988 | $35,261 | $5,487 | $42,672 | $38,504 |
| 320 | 0.12% | 432,640 | $5,757 | $34,574 | $38,130 | $5,952 | $46,122 | $41,638 |
| 330 | 0.12% | 446,160 | $5,937 | $35,608 | $39,278 | $6,138 | $47,501 | $42,892 |
| 360 | 0.24% | 486,720 | $6,476 | $38,711 | $42,722 | $6,696 | $51,641 | $46,652 |
| 375 | 0.12% | 507,000 | $6,746 | $40,263 | $44,443 | $6,975 | $53,710 | $48,532 |
| 390 | 0.12% | 527,280 | $7,016 | $41,814 | $46,165 | $7,254 | $55,780 | $50,412 |
| 395 | 0.12% | 534,040 | $7,106 | $42,331 | $46,739 | $7,347 | $56,470 | $51,039 |
| 470 | 0.12% | 635,440 | $8,455 | $50,088 | $55,348 | $8,742 | $66,818 | $60,440 |
| 528 | 0.12% | 713,856 | $9,499 | $56,087 | $62,005 | $9,821 | $74,820 | $67,710 |
| 540 | 0.12% | 730,080 | $9,715 | $57,328 | $63,383 | $10,044 | $76,476 | $69,214 |
| 820 | 0.12% | 1,108,640 | $14,752 | $86,288 | $95,523 | $15,252 | $115,108 | $104,311 |
| **Weighted Average: 68** | **-** | **91,948** | **$1,223** | **$8,511** | **$9,205** | **$1,265** | **$11,354** | **$10,052** |

|  |  |  |  |
| --- | --- | --- | --- |
| Table 7‑14: Summary of Average Differences in Annual Ongoing Costs Between PCE and Hydrocarbon Dry Cleaning (2022$) | | | |
| Recurring Cost Type | PCE Cost | Hydrocarbon Cost | Incremental Cost for Hydrocarbon Alternative |
| Solvents/Cleaning Agents | $1,223 | $1,265 | $41 |
| Gas | $8,511 | $11,354 | $2,843 |
| Electricity | $9,205 | $10,052 | $847 |
| **Total** | **$18,940** | **$22,671** | **$3,731** |

### Annualized Incremental Costs for Switching from PCE to Hydrocarbon Dry Cleaning

The total incremental costs for switching from PCE to hydrocarbon are presented in Table 7‑15 and Table 7‑16. These costs are calculated by taking the difference in the baseline costs for transitioning to hydrocarbon dry cleaning and the costs for transitioning to hydrocarbon dry cleaning earlier because of the regulation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 7‑15: Summary of Average Differences in Ongoing Costs Between PCE and Hydrocarbon Dry Cleaning (Option 1: 10-Year Phaseout) (2022$) | | | | |
| Assumed Baseline Retirement Year | Percent of NY State PCE Dry Cleaning Machines Being Retired | Annualized Incremental Costs Per Machine | | |
| 2 Percent Discount Rate | 3 Percent Discount Rate | 7 Percent Discount Rate |
| Before 2030 | 97.84% | - | - | - |
| 2030 | 0.35% | - | - | - |
| 2031 | 0.23% | - | - | - |
| 2032 | 0.18% | - | - | - |
| 2033 | 0.18% | - | - | - |
| 2034 | 0.20% | $0 | $0 | $0 |
| 2035 | 0.17% | $270.65 | $289.52 | $404.54 |
| 2036 | 0.15% | $535.99 | $570.60 | $782.62 |
| 2037 | 0.14% | $796.12 | $843.50 | $1,135.97 |
| 2038 | 0.12% | $1,051.16 | $1,108.45 | $1,466.20 |
| 2039 | 0.11% | $1,301.19 | $1,365.68 | $1,774.82 |
| 2040 | 0.11% | $1,546.33 | $1,615.42 | $2,063.25 |
| 2041 | 0.09% | $1,786.65 | $1,857.89 | $2,332.82 |
| 2042 | 0.08% | $2,022.27 | $2,093.29 | $2,584.75 |
| 2043 | 0.06% | $2,253.26 | $2,321.84 | $2,820.20 |
| 2044 | 0.02% | $2,479.73 | $2,543.73 | $3,040.24 |
| **Weighted Average** | - | **$11.68** | **$12.21** | **$15.68** |
| **Total 20-Year Annualized Costs for 6,000 Machines** | - | **$70,081** | **$73,281** | **$94,069** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 7‑16: Summary of Average Differences in Ongoing Costs Between PCE and Hydrocarbon Dry Cleaning (Option 2: 15-Year Phaseout) (2022$) | | | | |
| Assumed Baseline Retirement Year | Percent of NY State PCE Dry Cleaning Machines Being Retired | Annualized Incremental Costs Per Machine | | |
| 2 Percent Discount Rate | 3 Percent Discount Rate | 7 Percent Discount Rate |
| Before 2030 | 97.84% | - | - | - |
| 2030 | 0.35% | - | - | - |
| 2031 | 0.23% | - | - | - |
| 2032 | 0.18% | - | - | - |
| 2033 | 0.18% | - | - | - |
| 2034 | 0.20% | - | - | - |
| 2035 | 0.17% | - | - | - |
| 2036 | 0.15% | - | - | - |
| 2037 | 0.14% | - | - | - |
| 2038 | 0.12% | - | - | - |
| 2039 | 0.11% | $0 | $0 | $0 |
| 2040 | 0.11% | $245.13 | $249.74 | $288.43 |
| 2041 | 0.09% | $485.46 | $492.21 | $558.00 |
| 2042 | 0.08% | $721.07 | $727.61 | $809.93 |
| 2043 | 0.06% | $952.07 | $956.16 | $1,045.38 |
| 2044 | 0.02% | $1,178.53 | $1,178.05 | $1,265.42 |
| **Average** |  | **$2.06** | **$2.08** | **$2.31** |
| **Total 20-Year Annualized Costs for 6,000 Machines** |  | **$12,367** | **$12,477** | **$13,889** |

## Costs for Switching to Alternatives to PCE Vapor Degreasing

EPA consulted with critical cleaning experts Barbara Kanegsberg and Ed Kanegsberg of BFK Solutions about the costs of switching to alternatives to PCE 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 PCE in different sized degreasers used in the different cleaning categories in the first two columns of Table 7‑17 and the different cleaning methods presented the last column in Table 7‑17 .

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 PCE. 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 (eg. 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 7‑17 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 7‑17: Sizes, Cleaning Categories, and Cleaning Methods Considered in the Vapor Degreasing Cost Analysis | | | | |
| --- | --- | --- | --- | --- |
| Size |  | Cleaning Category |  | Cleaning Method |
| Small |  | General |  | Baseline - OTVD 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 7‑18 presents the descriptions of the baseline and alternative cleaning methods considered in this analysis.

| Table 7‑18: Cleaning Methods and Their Definitions | |
| --- | --- |
| Cleaning Method | Definition |
| Baseline - OTVD with PCE | An OTVD uses heated solvent in the liquid and/or vapor phase. For this analysis, the baseline OTVD uses PCE 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 meet the low emissions required by the PCE ECEL. OTVDs using PCE must be “National Emission Standards for Hazardous Air Pollutants (NESHAP) compliant” OTVDs, in that they have double-coils and a high freeboard ratio. An OTVD may include ultrasonic cleaning and/or a spray wand. |
| 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-dichloroethylene (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. Trans-DCE is currently undergoing Risk Evaluation by TSCA. 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 |
| 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, trans-1-chloro-3,3,3-trifluoropropene 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” in OTVDs currently in use for chlorinated or brominated solvents. |
| 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. 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 isopropanol has also been used. The most common very low Flashpoint solvent is acetone. It should be noted that, except for acetone, these other solvents are considered to be VOCs, and have restrictions in areas of poor air quality. |
| 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 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. |
| Co-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 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.  **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-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.  **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 alcohol. 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-solvent and co-solvent processes involve Flashpoint-inerted trans-DCE as the rinsing/displacement agent, additional process development, including testing, would be needed. Low Flashpoint cleaning systems would be needed which would add to equipment costs. |
| High 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 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 48⁰C * boiling point 176⁰C * Methyl Soyate (a mixture of long-chain, typically 16-18 carbons, fatty acid methyl esters) * Flashpoint 130⁰C * boiling point 200⁰C |
| 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, 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 high. Carryover of solvent into the rinse tank can be a problem. |
| Aqueous 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, the water quality can range from tap water to purified water, for example, de-ionized or reverse osmosis.  Aqueous formulations vary in their composition (organic and inorganic additives), the pH, and the concentration at which they are used. 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 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.  The cost analyses generally consider aqueous systems to consist of one or two wash tanks followed by rinse tanks and a dryer. Here are a few non-encompassing examples of aqueous cleaning equipment that are not a sequence of 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 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 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. 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 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. |

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 7‑19 were considered in the analysis.

| Table 7‑19: Categories of Costs Considered in the Vapor Degreasing Cost Analysis |
| --- |
| Cost Categories Considered |
| Process Development for Identifying and Implementing the Alternative Cleaning Process (section 7.8.1) |
| Initial Capital Costs for New Machine (section 7.8.2) |
| Initial Capital Costs aside from New Machine (section 7.8.3) |
| Cleaning Agent Costs (section 7.8.4) |
| Waste Disposal Costs (section 7.8.5) |
| Annual Maintenance Costs (section 7.8.6) |
| Annual Labor Costs (section 7.8.7) |
| Electrical Costs (section 7.8.8) |
| Additional Floorspace (section 7.8.9) |

EPA developed estimates of the baseline mix of cleaning categories by using the 17 sites using PCE for vapor degreasing in the identified in the National Emissions Inventory ([EPA 2020a](#_ENREF_84)). EPA classified each of these facilities as performing high precision cleaning (32% of facilities), safety critical cleaning (48% of facilities), or general cleaning (16%). 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: 48%
* High precision: 32%
* General: 16%
* R&D: 5%

EPA also estimated the baseline mix of small, medium, and large facilities using the PCE emissions reported in National Emissions Inventory from vapor degreasers. Based on the estimates presented below in sections 7.8.4 and 7.8.5, 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 7.8.4, below. Based on these estimates the mix of small, medium, and large facilities is estimated to be 33%, 17%, and 50%, respectively. These baseline estimates are presented in Table 7‑20.

| Table 7‑20: Estimated Baseline Mix for Size and Type | |
| --- | --- |
| Size, Type, or Size/Type Combined | Estimated Baseline Percentage |
| Size | |
| Small | 33% |
| Medium | 17% |
| Large | 50% |
| Type | |
| General Cleaning | 18% |
| High Precision Cleaning | 32% |
| Safety Critical Cleaning | 48% |
| R&D Critical Cleaning | 5% |
| Size/Type Combined | |
| Small/General Cleaning | 5% |
| Medium/General Cleaning | 3% |
| Large/General Cleaning | 8% |
| Small/High Precision Cleaning | 11% |
| Medium/High Precision Cleaning | 5% |
| Large/High Precision Cleaning | 16% |
| Small/Safety Critical Cleaning | 16% |
| Medium/Safety Critical Cleaning | 8% |
| Large/Safety Critical Cleaning | 24% |
| Small/Start-Up/R&D Critical Cleaning | 3% |
| Medium/Start-Up/R&D Critical Cleaning | 2% |

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 PCE vapor degreasing to multiple cleaning methods. These percentages are presented below in section 7.8.10.

### 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 7‑21, 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 7‑21: 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 |

### 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 7‑22 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 7‑22: Initial Capital Costs for New Machine by Size and Cleaning Category | | |
| --- | --- | --- |
| Size/Cleaning Category | Alternative Cleaning Method | Estimated Initial Costs (2022$) |
| Small/General Cleaning | 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 | 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 | 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 |
| Hybrid system (e.g., Inventec, HEMO) | $6,720,000 |
| Small/High Precision Cleaning | 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 | 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 | 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 | 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 | 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 | 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 | 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 | $60,000 |
| Medium/Start-Up/R&D Critical Cleaning | 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 |

### 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 7‑23 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 7‑23: Other Initial Capital Costs by Size and Cleaning Category | | |
| --- | --- | --- |
| Size/Cleaning Category | Alternative Cleaning Method | Estimated Initial Costs (2022$) |
| Small/General Cleaning | 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 | 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 | 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 |
| Hybrid system (e.g., Inventec, HEMO) | $39,200 |
| Small/High Precision Cleaning | 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 | 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 | 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 | 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 | 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 | 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 | 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 |
| Medium/Start-Up/R&D Critical Cleaning | 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 |

### Cleaning Agent Costs

Initial fill cleaning agent matches the volume of the tank, which assumes immersion. 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 includes many variables for estimate including 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. Estimates for annual fill of solvents were estimated using various sources of real-world application and SAFECHEM estimates.

Table 7‑24 presents the estimated initial fill costs for cleaning agent. These initial costs range from $120 to $240,000.

| Table 7‑24: Cleaning Agent Costs: Initial Fill by Size and Cleaning Category, and Alternative Cleaning Method | | |
| --- | --- | --- |
| Size/Cleaning Category | Alternative Cleaning Method | Estimated Initial Costs (2022$) |
| Small/General Cleaning | 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 | 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 | 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 |
| Hybrid system (example: Inventec, HEMO) | $240,000 |
| Small/High Precision Cleaning | 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 | 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 | 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 | 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 | 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 | 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 | 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 |
| Medium/Start-Up/R&D Critical Cleaning | 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 7‑25 presents the cleaning estimated baseline annual replacement cleaning agent costs.

| Table 7‑25: Cleaning Agent Costs: Baseline Annual Replacement (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Size/Type | Cleaning Chamber Tank Size in Inches (Approx) | Cleaning Agent; Annual Replacement (gal) | Cleaning Agent Price ($/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 7‑26 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 7‑26: Cleaning Agent Costs by Size, Cleaning Category, and Alternative Cleaning Method: Annual Replacement (2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Size/Type | Cleaning method | Cleaning Agent; Annual Replacement (gal) | Cleaning Agent Price ($/gal) | Baseline Cost | Post-Conversion Cost | Incremental Cost |
| Small/General Cleaning | 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 | 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 |
| Large/General Cleaning | 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 | 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 | 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 | 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 | 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/Safety Critical Cleaning | 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 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 (e.g., Inventec, HEMO) | 4,800 | $300 | $348,450 | $1,440,000 | $1,091,550 |
| Small/Start-Up/R&D Critical Cleaning | 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 | 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 |
| 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 |

### Waste Disposal Costs

Disposal costs were estimated based on PCE disposal costs and adjusted based on cleaning agent and method. For example, there is an estimated 20 percent upcharge for fluorinated solvents compared to PCE. Additionally, if the cleaning agent is combustible than it would be 80 percent of the PCE cost.

Table 7‑27 presents the baseline waste disposal costs for PCE vapor degreasing.

Table 7‑28 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 7‑27: Baseline Waste Disposal Costs (2022$) | | | |
| --- | --- | --- | --- |
| Size/Type | Cleaning Agent; Annual Replacement (gal) | Cleaning Agent Price ($/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 |

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| Table 7‑28: Annual Waste Disposal Costs, by Size, Cleaning Category and Alternative Cleaning Method (2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Size/Type | Cleaning method | Liquid Waste (gal) | Disposal Cost ($/gal) | Baseline Cost | Post-Conversion Cost | Incremental Cost  Incremental Cost |
| Small/General Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | 17 | $21.80 | $309 | $371 | $61 |
|  |  |  |  |  |  |
| Replace with OTVD using Flashpoint inerted t-DCE | 17 | $21.80 | $309 | $371 | $61 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 17 | $21.80 | $309 | $371 | $61 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 17 | $14.50 | $309 | $247 | ($63) |
| OTVD for Very low Flashpoint (<0C) solvent | 17 | $14.50 | $309 | $247 | ($63) |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 17 | $14.50 | $309 | $247 | ($63) |
| Co-Solvent, Bi-Solvent | 17 | $14.50 | $309 | $247 | ($63) |
| High boiling, non-vacuum, non-rinse | 17 | $14.50 | $309 | $247 | ($63) |
| Semi-Aqueous | 17 | $14.50 | $309 | $247 | ($63) |
| Replace with Aqueous Cleaning | 72 | $4.00 | $309 | $288 | ($21) |
| Hybrid system (e.g., Inventec, HEMO) | 17 | $14.50 | $309 | $247 | ($63) |
| Medium/General Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | 330 | $21.80 | $6,006 | $7,194 | $1,188 |
| Replace with OTVD using Flashpoint inerted t-DCE | 330 | $21.80 | $6,006 | $7,194 | $1,188 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 330 | $21.80 | $6,006 | $7,194 | $1,188 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 330 | $14.50 | $6,006 | $4,785 | ($1,221) |
| OTVD for Very low Flashpoint (<0C) solvent | 330 | $14.50 | $6,006 | $4,785 | ($1,221) |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 330 | $14.50 | $6,006 | $4,785 | ($1,221) |
| Co-Solvent, Bi-Solvent | 330 | $14.50 | $6,006 | $4,785 | ($1,221) |
| High boiling, non-vacuum, non-rinse | 330 | $14.50 | $6,006 | $4,785 | ($1,221) |
| Semi-Aqueous | 330 | $14.50 | $6,006 | $4,785 | ($1,221) |
| Replace with Aqueous Cleaning | 1,500 | $4.00 | $6,006 | $6,000 | ($6) |
| Hybrid system (e.g., Inventec, HEMO) | 330 | $14.50 | $6,006 | $4,785 | ($1,221) |
| Large/General Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | 1,056 | $21.80 | $19,219 | $23,021 | $3,802 |
| Replace with OTVD using Flashpoint inerted t-DCE | 1,056 | $21.80 | $19,219 | $23,021 | $3,802 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 1,056 | $21.80 | $19,219 | $23,021 | $3,802 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 1,056 | $14.50 | $19,219 | $15,312 | ($3,907) |
| OTVD for Very low Flashpoint (<0C) solvent | 1,056 | $14.50 | $19,219 | $15,312 | ($3,907) |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 1,056 | $14.50 | $19,219 | $15,312 | ($3,907) |
| Co-Solvent, Bi-Solvent | 1,056 | $14.50 | $19,219 | $15,312 | ($3,907) |
| High boiling, non-vacuum, non-rinse | 1,056 | $14.50 | $19,219 | $15,312 | ($3,907) |
| Semi-Aqueous | 1,056 | $14.50 | $19,219 | $15,312 | ($3,907) |
| Replace with Aqueous Cleaning | 4,800 | $4.00 | $19,219 | $19,200 | ($19) |
| Hybrid system (e.g., Inventec, HEMO) | 2,112 | $14.50 | $19,219 | $30,624 | $11,405 |
| Small/High Precision Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | 8 | $21.80 | $100 | $174 | $74 |
| Replace with OTVD using Flashpoint inerted t-DCE | 8 | $21.80 | $100 | $174 | $74 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 6 | $21.80 | $100 | $120 | $20 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 8 | $14.50 | $100 | $116 | $16 |
| OTVD for Very low Flashpoint (<0C) solvent | 8 | $14.50 | $100 | $116 | $16 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 3 | $14.50 | $100 | $44 | ($57) |
| Co-Solvent, Bi-Solvent | 8 | $14.50 | $100 | $116 | $16 |
| Semi-Aqueous | 8 | $14.50 | $100 | $116 | $16 |
| Replace with Aqueous Cleaning | 18 | $4.00 | $100 | $72 | ($28) |
| Hybrid system (e.g., Inventec, HEMO) | 17 | $8.20 | $100 | $139 | $39 |
| Medium/High Precision Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | 110 | $21.80 | $2,002 | $2,398 | $396 |
| Replace with OTVD using Flashpoint inerted t-DCE | 110 | $21.80 | $2,002 | $2,398 | $396 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 110 | $21.80 | $2,002 | $2,398 | $396 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| OTVD for Very low Flashpoint (<0C) solvent | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| Co-Solvent, Bi-Solvent | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| Semi-Aqueous | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| Replace with Aqueous Cleaning | 940 | $4.00 | $2,002 | $3,760 | $1,758 |
| Hybrid system (e.g., Inventec, HEMO) | 330 | $14.50 | $2,002 | $4,785 | $2,783 |
| Large/High Precision Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | 352 | $21.80 | $6,406 | $7,674 | $1,267 |
| Replace with OTVD using Flashpoint inerted t-DCE | 352 | $21.80 | $6,406 | $7,674 | $1,267 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 352 | $21.80 | $6,406 | $7,674 | $1,267 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 352 | $14.50 | $6,406 | $5,104 | ($1,302) |
| OTVD for Very low Flashpoint (<0C) solvent | 352 | $14.50 | $6,406 | $5,104 | ($1,302) |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 400 | $14.50 | $6,406 | $5,800 | ($606) |
| Co-Solvent, Bi-Solvent | 352 | $14.50 | $6,406 | $5,104 | ($1,302) |
| Semi-Aqueous | 352 | $14.50 | $6,406 | $5,104 | ($1,302) |
| Replace with Aqueous Cleaning | 5,500 | $4.00 | $6,406 | $22,000 | $15,594 |
| Hybrid system (e.g., Inventec, HEMO) | 2,112 | $8.20 | $6,406 | $17,318 | $10,912 |
| Small/Safety Critical Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | 6 | $21.80 | $100 | $120 | $20 |
| Replace with OTVD using Flashpoint inerted t-DCE | 8 | $21.80 | $100 | $174 | $74 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 6 | $21.80 | $100 | $120 | $20 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 6 | $14.50 | $100 | $80 | ($20) |
| OTVD for Very low Flashpoint (<0C) solvent | 6 | $14.50 | $100 | $80 | ($20) |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 3 | $14.50 | $100 | $44 | ($57) |
| Co-Solvent, Bi-Solvent | 6 | $14.50 | $100 | $80 | ($20) |
| Semi-Aqueous | 6 | $14.50 | $100 | $80 | ($20) |
| Replace with Aqueous Cleaning | 18 | $4.00 | $100 | $72 | ($28) |
| Hybrid system (e.g., Inventec, HEMO) | 17 | $8.20 | $100 | $139 | $39 |
| Medium/Safety Critical Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | 110 | $21.80 | $2,002 | $2,398 | $396 |
| Replace with OTVD using Flashpoint inerted t-DCE | 110 | $21.80 | $2,002 | $2,398 | $396 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 110 | $21.80 | $2,002 | $2,398 | $396 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| OTVD for Very low Flashpoint (<0C) solvent | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| Co-Solvent, Bi-Solvent | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| Semi-Aqueous | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| Replace with Aqueous Cleaning | 940 | $4.00 | $2,002 | $3,760 | $1,758 |
| Hybrid system (e.g., Inventec, HEMO) | 330 | $8.20 | $2,002 | $2,706 | $704 |
| Large/Safety Critical Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | 352 | $21.80 | $6,406 | $7,674 | $1,267 |
| Replace with OTVD using Flashpoint inerted t-DCE | 352 | $21.80 | $6,406 | $7,674 | $1,267 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 352 | $21.80 | $6,406 | $7,674 | $1,267 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 352 | $14.50 | $6,406 | $5,104 | ($1,302) |
| OTVD for Very low Flashpoint (<0C) solvent | 352 | $14.50 | $6,406 | $5,104 | ($1,302) |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 400 | $14.50 | $6,406 | $5,800 | ($606) |
| Co-Solvent, Bi-Solvent | 352 | $14.50 | $6,406 | $5,104 | ($1,302) |
| Semi-Aqueous | 352 | $14.50 | $6,406 | $5,104 | ($1,302) |
| Replace with Aqueous Cleaning | 5,500 | $4.00 | $6,406 | $22,000 | $15,594 |
| Hybrid system (e.g., Inventec, HEMO) | 2,112 | $8.20 | $6,406 | $17,318 | $10,912 |
| Small/Start-Up/R&D Critical Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | 6 | $21.80 | $100 | $120 | $20 |
| Replace with OTVD using Flashpoint inerted t-DCE | 8 | $21.80 | $100 | $174 | $74 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 6 | $21.80 | $100 | $120 | $20 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 6 | $14.50 | $100 | $80 | ($20) |
| OTVD for Very low Flashpoint (<0C) solvent | 6 | $14.50 | $100 | $80 | ($20) |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 3 | $14.50 | $100 | $44 | ($57) |
| Co-Solvent, Bi-Solvent | 6 | $14.50 | $100 | $80 | ($20) |
| Semi-Aqueous | 6 | $14.50 | $100 | $80 | ($20) |
| Replace with Aqueous Cleaning | 18 | $4.00 | $100 | $72 | ($28) |
| Medium/Start-Up/R&D Critical Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | 110 | $21.80 | $2,002 | $2,398 | $396 |
| Replace with OTVD using Flashpoint inerted t-DCE | 110 | $21.80 | $2,002 | $2,398 | $396 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 110 | $21.80 | $2,002 | $2,398 | $396 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| OTVD for Very low Flashpoint (<0C) solvent | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| Co-Solvent, Bi-Solvent | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| Semi-Aqueous | 110 | $14.50 | $2,002 | $1,595 | ($407) |
| Replace with Aqueous Cleaning | 940 | $4.00 | $2,002 | $3,760 | $1,758 |

### Annual Maintenance Costs

Maintenance costs are highly dependent on the type and age of the cleaning system. There is an estimated 10- or 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 7‑29 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 7‑29: Annual Maintenance Costs, by Size, Cleaning Category, and Alternative Cleaning Method (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Size/Type | Cleaning method | Baseline Cost | Post-Conversion Cost | Incremental Cost |
| Small/General Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | $3,750 | $4,313 | $563 |
| Replace with OTVD using Flashpoint inerted t-DCE | $3,750 | $4,313 | $563 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | $3,750 | $6,750 | $3,000 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | $3,750 | $11,000 | $7,250 |
| OTVD for Very low Flashpoint (<0C) solvent | $3,750 | $12,000 | $8,250 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $3,750 | $21,875 | $18,125 |
| Co-Solvent, Bi-Solvent | $3,750 | $28,875 | $25,125 |
| High boiling, non-vacuum, non-rinse | $3,750 | $300 | ($3,450) |
| Semi-Aqueous | $3,750 | $6,875 | $3,125 |
| Replace with Aqueous Cleaning | $3,750 | $15,208 | $11,458 |
| Hybrid system (e.g., Inventec, HEMO) | $3,750 | $26,950 | $23,200 |
| Medium/General Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | $22,500 | $11,250 | ($11,250) |
| Replace with OTVD using Flashpoint inerted t-DCE | $22,500 | $23,750 | $1,250 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | $22,500 | $33,750 | $11,250 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | $22,500 | $31,250 | $8,750 |
| OTVD for Very low Flashpoint (<0C) solvent | $22,500 | $31,250 | $8,750 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $22,500 | $37,500 | $15,000 |
| Co-Solvent, Bi-Solvent | $22,500 | $31,250 | $8,750 |
| High boiling, non-vacuum, non-rinse | $22,500 | $1,000 | ($21,500) |
| Semi-Aqueous | $22,500 | $25,625 | $3,125 |
| Replace with Aqueous Cleaning | $22,500 | $31,875 | $9,375 |
| Hybrid system (e.g., Inventec, HEMO) | $22,500 | $44,450 | $21,950 |
| Large/General Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | $225,000 | $225,563 | $563 |
| Replace with OTVD using Flashpoint inerted t-DCE | $225,000 | $225,563 | $563 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | $225,000 | $337,500 | $112,500 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | $225,000 | $301,000 | $76,000 |
| OTVD for Very low Flashpoint (<0C) solvent | $225,000 | $301,000 | $76,000 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $225,000 | $375,000 | $150,000 |
| Co-Solvent, Bi-Solvent | $225,000 | $19,375 | ($205,625) |
| High boiling, non-vacuum, non-rinse | $225,000 | $2,025 | ($222,975) |
| Semi-Aqueous | $225,000 | $10,625 | ($214,375) |
| Replace with Aqueous Cleaning | $225,000 | $311,250 | $86,250 |
| Hybrid system (e.g., Inventec, HEMO) | $225,000 | $422,450 | $197,450 |
| Small/High Precision Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | $3,750 | $3,750 | $0 |
| Replace with OTVD using Flashpoint inerted t-DCE | $3,750 | $3,750 | $0 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | $3,750 | $5,625 | $1,875 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | $3,750 | $11,000 | $7,250 |
| OTVD for Very low Flashpoint (<0C) solvent | $3,750 | $11,000 | $7,250 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $3,750 | $21,875 | $18,125 |
| Co-Solvent, Bi-Solvent | $3,750 | $15,125 | $11,375 |
| Semi-Aqueous | $3,750 | $6,875 | $3,125 |
| Replace with Aqueous Cleaning | $3,750 | $16,458 | $12,708 |
| Hybrid system (e.g., Inventec, HEMO) | $3,750 | $20,700 | $16,950 |
| Medium/High Precision Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | $22,500 | $23,063 | $563 |
| Replace with OTVD using Flashpoint inerted t-DCE | $22,500 | $23,063 | $563 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | $22,500 | $33,750 | $11,250 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | $22,500 | $32,250 | $9,750 |
| OTVD for Very low Flashpoint (<0C) solvent | $22,500 | $5,375 | ($17,125) |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $22,500 | $32,188 | $9,688 |
| Co-Solvent, Bi-Solvent | $22,500 | $31,375 | $8,875 |
| Semi-Aqueous | $22,500 | $25,625 | $3,125 |
| Replace with Aqueous Cleaning | $22,500 | $31,458 | $8,958 |
| Hybrid system (e.g., Inventec, HEMO) | $22,500 | $44,450 | $21,950 |
| Large/High Precision Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | $225,000 | $225,563 | $563 |
| Replace with OTVD using Flashpoint inerted t-DCE | $225,000 | $225,563 | $563 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | $225,000 | $337,500 | $112,500 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | $225,000 | $301,000 | $76,000 |
| OTVD for Very low Flashpoint (<0C) solvent | $225,000 | $301,000 | $76,000 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $225,000 | $302,188 | $77,188 |
| Co-Solvent, Bi-Solvent | $225,000 | $1,875 | ($223,125) |
| Semi-Aqueous | $225,000 | $10,625 | ($214,375) |
| Replace with Aqueous Cleaning | $225,000 | $300,208 | $75,208 |
| Hybrid system (e.g., Inventec, HEMO) | $225,000 | $422,450 | $197,450 |
| Small/Safety Critical Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | $3,750 | $4,313 | $563 |
| Replace with OTVD using Flashpoint inerted t-DCE | $3,750 | $4,313 | $563 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | $3,750 | $5,625 | $1,875 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | $3,750 | $11,000 | $7,250 |
| OTVD for Very low Flashpoint (<0C) solvent | $3,750 | $11,000 | $7,250 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $3,750 | $19,688 | $15,938 |
| Co-Solvent, Bi-Solvent | $3,750 | $15,125 | $11,375 |
| Semi-Aqueous | $3,750 | $6,875 | $3,125 |
| Replace with Aqueous Cleaning | $3,750 | $3,958 | $208 |
| Hybrid system (e.g., Inventec, HEMO) | $3,750 | $26,950 | $23,200 |
| Medium/Safety Critical Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | $22,500 | $9,563 | ($12,938) |
| Replace with OTVD using Flashpoint inerted t-DCE | $22,500 | $23,063 | $563 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | $22,500 | $33,750 | $11,250 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | $22,500 | $32,250 | $9,750 |
| OTVD for Very low Flashpoint (<0C) solvent | $22,500 | $32,250 | $9,750 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $22,500 | $32,188 | $9,688 |
| Co-Solvent, Bi-Solvent | $22,500 | $31,375 | $8,875 |
| Semi-Aqueous | $22,500 | $25,625 | $3,125 |
| Replace with Aqueous Cleaning | $22,500 | $31,458 | $8,958 |
| Hybrid system (e.g., Inventec, HEMO) | $22,500 | $44,450 | $21,950 |
| Large/Safety Critical Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | $225,000 | $45,563 | ($179,438) |
| Replace with OTVD using Flashpoint inerted t-DCE | $225,000 | $225,563 | $563 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | $225,000 | $337,500 | $112,500 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | $225,000 | $301,000 | $76,000 |
| OTVD for Very low Flashpoint (<0C) solvent | $225,000 | $301,000 | $76,000 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $225,000 | $302,188 | $77,188 |
| Co-Solvent, Bi-Solvent | $225,000 | $301,375 | $76,375 |
| Semi-Aqueous | $225,000 | $100,625 | ($124,375) |
| Replace with Aqueous Cleaning | $225,000 | $300,208 | $75,208 |
| Hybrid system (example: Inventec, HEMO) | $225,000 | $421,200 | $196,200 |
| Small/Start-Up/R&D Critical Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | $3,750 | $4,313 | $563 |
| Replace with OTVD using Flashpoint inerted t-DCE | $3,750 | $4,313 | $563 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | $3,750 | $5,625 | $1,875 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | $3,750 | $11,000 | $7,250 |
| OTVD for Very low Flashpoint (<0C) solvent | $3,750 | $11,000 | $7,250 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $3,750 | $19,688 | $15,938 |
| Co-Solvent, Bi-Solvent | $3,750 | $15,125 | $11,375 |
| Semi-Aqueous | $3,750 | $6,875 | $3,125 |
| Replace with Aqueous Cleaning | $3,750 | $3,958 | $208 |
| Medium/Start-Up/R&D Critical Cleaning | Convert OTVD to use Flashpoint inerted t-DCE | $22,500 | $45,563 | $23,063 |
| Replace with OTVD using Flashpoint inerted t-DCE | $22,500 | $45,563 | $23,063 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | $22,500 | $33,750 | $11,250 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | $22,500 | $32,250 | $9,750 |
| OTVD for Very low Flashpoint (<0C) solvent | $22,500 | $32,250 | $9,750 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $22,500 | $32,188 | $9,688 |
| Co-Solvent, Bi-Solvent | $22,500 | $31,375 | $8,875 |
| Semi-Aqueous | $22,500 | $25,625 | $3,125 |
| Replace with Aqueous Cleaning | $22,500 | $31,458 | $8,958 |

### Annual Labor Costs

Labor costs are dependent on the type of machine, degree of automation and number of runs. Table 7‑30 presents the estimated baseline labor costs for operating a vapor degreasing machine.

| Table 7‑30: Baseline Labor Costs (2022$) by Machine Size and Type | | |
| --- | --- | --- |
| Size/Type | 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 7‑31 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 7‑31: Annual Labor Costs (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Size/Type | Cleaning method | Baseline Cost | Post-Conversion Cost | Incremental Cost |
| Small/General Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $59,876 | $32,598 | ($27,277) |
| Replace with Aqueous Cleaning | $59,876 | $62,995 | $3,119 |
| Medium/General Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $51,986 | $32,598 | ($19,388) |
| Replace with Aqueous Cleaning | $51,986 | $59,019 | $7,033 |
| Large/General Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $48,316 | $32,598 | ($15,718) |
| Replace with Aqueous Cleaning | $48,316 | $59,019 | $10,703 |
| Small/High Precision Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $53,821 | $32,598 | ($21,223) |
| Medium/High Precision Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $45,870 | $32,598 | ($13,272) |
| Replace with Aqueous Cleaning | $45,870 | $49,845 | $3,975 |
| Large/High Precision Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $39,142 | $32,598 | ($6,544) |
| Replace with Aqueous Cleaning | $39,142 | $47,093 | $7,951 |
| Small/Safety Critical Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $53,760 | $32,598 | ($21,161) |
| Replace with Aqueous Cleaning | $53,760 | $59,019 | $5,260 |
| Medium/Safety Critical Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $45,870 | $32,598 | ($13,272) |
| Replace with Aqueous Cleaning | $45,870 | $49,845 | $3,975 |
| Large/Safety Critical Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $39,142 | $32,598 | ($6,544) |
| Replace with Aqueous Cleaning | $39,142 | $47,093 | $7,951 |
| Small/Start-Up/R&D Critical Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $44,035 | $32,598 | ($11,437) |
| Replace with Aqueous Cleaning | $44,035 | $59,019 | $14,984 |
| Medium/Start-Up/R&D Critical Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $44,035 | $32,598 | ($11,437) |
| Replace with Aqueous Cleaning | $44,035 | $49,845 | $5,810 |
| Small/Start-Up/R&D Critical Cleaning | Replace with Aqueous Cleaning | $44,035 | $59,019 | $14,984 |
| Medium/Start-Up/R&D Critical Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $44,035 | $32,598 | ($11,437) |
| Replace with Aqueous Cleaning | $44,035 | $49,845 | $5,810 |

### Annual Electricity Costs

Electrical costs are assuming 2000 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 7‑32 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 $19,000 in additional electricity costs.

| Table 7‑32: Annual Electricity Costs (2022$) by Size | | | | |
| --- | --- | --- | --- | --- |
| Size/Type | Cleaning method | Baseline Cost | Post-Conversion Cost | Incremental Cost |
| Small/General Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $21 | $41 | $21 |
| High boiling, non-vacuum, non-rinse | $21 | $41 | $21 |
| Replace with Aqueous Cleaning | $21 | $483 | $463 |
| Hybrid system (e.g., Inventec, HEMO) | $21 | $162 | $142 |
| Medium/General Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $259 | $518 | $259 |
| Co-Solvent, Bi-Solvent | $259 | $144 | ($115) |
| Semi-Aqueous | $259 | $1,723 | $1,464 |
| Replace with Aqueous Cleaning | $259 | $6,041 | $5,782 |
| Hybrid system (e.g., Inventec, HEMO) | $259 | $2,028 | $1,769 |
| Large/General Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $828 | $1,657 | $828 |
| Replace with Aqueous Cleaning | $828 | $19,331 | $18,503 |
| Hybrid system (e.g., Inventec, HEMO) | $828 | $6,490 | $5,661 |
| Small/High Precision Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $21 | $41 | $21 |
| Replace with Aqueous Cleaning | $21 | $483 | $463 |
| Hybrid system (e.g., Inventec, HEMO) | $21 | $162 | $142 |
| Medium/High Precision Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $259 | $518 | $259 |
| Co-Solvent, Bi-Solvent | $259 | $144 | ($115) |
| Semi-Aqueous | $259 | $1,723 | $1,464 |
| Replace with Aqueous Cleaning | $259 | $6,041 | $5,782 |
| Hybrid system (e.g., Inventec, HEMO) | $259 | $2,028 | $1,769 |
| Large/High Precision Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $828 | $1,657 | $828 |
| Replace with Aqueous Cleaning | $828 | $19,331 | $18,503 |
| Hybrid system (e.g., Inventec, HEMO) | $828 | $6,490 | $5,661 |
| Small/Safety Critical Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $21 | $41 | $21 |
| Replace with Aqueous Cleaning | $21 | $483 | $463 |
| Hybrid system (e.g., Inventec, HEMO) | $21 | $162 | $142 |
| Medium/Safety Critical Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $259 | $518 | $259 |
| Co-Solvent, Bi-Solvent | $259 | $144 | ($115) |
| Semi-Aqueous | $259 | $1,723 | $1,464 |
| Replace with Aqueous Cleaning | $259 | $6,041 | $5,782 |
| Hybrid system (e.g., Inventec, HEMO) | $259 | $2,028 | $1,769 |
| Large/Safety Critical Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $828 | $1,657 | $828 |
| Replace with Aqueous Cleaning | $828 | $19,331 | $18,503 |
| Hybrid system (e.g., Inventec, HEMO) | $828 | $6,490 | $5,661 |
| Small/Start-Up/R&D Critical Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $21 | $41 | $21 |
| Replace with Aqueous Cleaning | $21 | $483 | $463 |
| Medium/Start-Up/R&D Critical Cleaning | EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | $259 | $518 | $259 |
| Co-Solvent, Bi-Solvent | $259 | $144 | ($115) |
| Semi-Aqueous | $259 | $1,723 | $1,464 |
| Replace with Aqueous Cleaning | $259 | $6,041 | $5,782 |

### Additional Floorspace Costs

Floorspace costs are based on a study done in 1999 with BFK Solutions and the Toxics Use Reduction Institute ([Kanegsburg and LeBlanc 1999](#_ENREF_27)). Estimated costs are added if multiple pieces of the cleaning systems are needed (examples include the cleaning system, rinsing tank and dryer)

For the cleaning types and methods estimated to require additional floorspace, Table 7‑33 presents the estimated annual incremental costs. Among those facilities with incremental costs, the costs range from about $100 to $9,000 in additional floorspace.

| Table 7‑33: Annual Additional Floorspace Costs (2022$) | | | |
| --- | --- | --- | --- |
| Size/Type | Cleaning method | Additional Floorspace Required (square feet) | Incremental Cost  ($7.03/sqft) |
| Small/General Cleaning | OTVD for Low boiling point (<100C) Alcohol or other flammable | 20 | $141 |
| OTVD for Very low Flashpoint (<0C) solvent | 20 | $141 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 20 | $141 |
| Co-Solvent, Bi-Solvent | 40 | $281 |
| Replace with Aqueous Cleaning | 65 | $457 |
| Hybrid system (e.g., Inventec, HEMO) | 30 | $211 |
| Medium/General Cleaning | OTVD for Low boiling point (<100C) Alcohol or other flammable | 200 | $1,406 |
| OTVD for Very low Flashpoint (<0C) solvent | 200 | $1,406 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 200 | $1,406 |
| Co-Solvent, Bi-Solvent | 400 | $2,812 |
| Replace with Aqueous Cleaning | 650 | $4,570 |
| Hybrid system (e.g., Inventec, HEMO) | 280 | $1,968 |
| Large/General Cleaning | OTVD for Low boiling point (<100C) Alcohol or other flammable | 400 | $2,812 |
| OTVD for Very low Flashpoint (<0C) solvent | 400 | $2,812 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 400 | $2,812 |
| Co-Solvent, Bi-Solvent | 800 | $5,624 |
| Replace with Aqueous Cleaning | 1,300 | $9,139 |
| Small/High Precision Cleaning | OTVD for Low boiling point (<100C) Alcohol or other flammable | 20 | $141 |
| OTVD for Very low Flashpoint (<0C) solvent | 20 | $141 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 20 | $141 |
| Co-Solvent, Bi-Solvent | 40 | $281 |
| Replace with Aqueous Cleaning | 65 | $457 |
| Hybrid system (e.g., Inventec, HEMO) | 30 | $211 |
| Medium/High Precision Cleaning | OTVD for Low boiling point (<100C) Alcohol or other flammable | 200 | $1,406 |
| OTVD for Very low Flashpoint (<0C) solvent | 200 | $1,406 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 200 | $1,406 |
| Co-Solvent, Bi-Solvent | 400 | $2,812 |
| Replace with Aqueous Cleaning | 650 | $4,570 |
| Hybrid system (e.g., Inventec, HEMO) | 280 | $1,968 |
| Large/High Precision Cleaning | OTVD for Low boiling point (<100C) Alcohol or other flammable | 400 | $2,812 |
| OTVD for Very low Flashpoint (<0C) solvent | 400 | $2,812 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 400 | $2,812 |
| Co-Solvent, Bi-Solvent | 800 | $5,624 |
| Replace with Aqueous Cleaning | 1,300 | $9,139 |
| Small/Safety Critical Cleaning | OTVD for Low boiling point (<100C) Alcohol or other flammable | 20 | $141 |
| OTVD for Very low Flashpoint (<0C) solvent | 20 | $141 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 20 | $141 |
| Co-Solvent, Bi-Solvent | 40 | $281 |
| Replace with Aqueous Cleaning | 65 | $457 |
| Hybrid system (e.g., Inventec, HEMO) | 30 | $211 |
| Medium/Safety Critical Cleaning | OTVD for Low boiling point (<100C) Alcohol or other flammable | 200 | $1,406 |
| OTVD for Very low Flashpoint (<0C) solvent | 200 | $1,406 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 200 | $1,406 |
| Co-Solvent, Bi-Solvent | 400 | $2,812 |
| Replace with Aqueous Cleaning | 650 | $4,570 |
| Hybrid system (e.g., Inventec, HEMO) | 280 | $1,968 |
| Large/Safety Critical Cleaning | OTVD for Low boiling point (<100C) Alcohol or other flammable | 400 | $2,812 |
| OTVD for Very low Flashpoint (<0C) solvent | 400 | $2,812 |
| EVD for High Boiling Point Combustibles (>100C) Hydrocarbons and Alcohols | 400 | $2,812 |
| Co-Solvent, Bi-Solvent | 800 | $5,624 |
| Replace with Aqueous Cleaning | 1,300 | $9,139 |

### Incremental Costs for Vapor Degreasing Facilities Switching to PCE Alternatives

Table 7‑34 through Table 7‑44 present the initial and recurring costs for each size, type, and 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 PCE vapor degreasing to multiple cleaning methods.

| Table 7‑34: Initial and Recurring Costs by Alternative Cleaning Method: Small/General Cleaning (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Cleaning method | Weight1 | | Initial Costs | Annual Recurring Costs |
| with trans-DCE | without trans-DCE |
| Convert OTVD to use Flashpoint inerted t-DCE | 11% | 0% | $191,800 | $8,724 |
| Replace with OTVD using Flashpoint inerted t-DCE | 10% | 0% | $242,800 | $8,724 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 9% | 11% | $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 | 22% | 34% | $522,180 | -$14,094 |
| Co-Solvent, Bi-Solvent | 5% | 9% | $635,911 | $27,587 |
| High boiling, non-vacuum, non-rinse | 16% | 22% | $177,160 | -$6,192 |
| Semi-Aqueous | 16% | 22% | $282,348 | -$1,642 |
| Replace with Aqueous Cleaning | 22% | 28% | $340,597 | $12,956 |
| Hybrid system (e.g., Inventec, HEMO) | 8% | 11% | $606,800 | $21,690 |
| **Weighted Average Across Methods (Including trans-DCE)** |  |  | **$417,613** | **$4,218** |
| **Weighted Average Across Methods (Excluding trans-DCE)** |  |  | **$534,612** | **$3,030** |
| 1Weights 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: Medium/General Cleaning (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Cleaning method | Weight1 | | Initial Costs | Annual Recurring Costs |
| with trans-DCE | without trans-DCE |
| Convert OTVD to use Flashpoint inerted t-DCE | 11% | 0% | $263,500 | $153,438 |
| Replace with OTVD using Flashpoint inerted t-DCE | 10% | 0% | $589,500 | $165,788 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 9% | 11% | $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 | 28% | 39% | $775,750 | -$102,944 |
| Co-Solvent, Bi-Solvent | 6% | 9% | $711,813 | $20,763 |
| High boiling, non-vacuum, non-rinse | 17% | 22% | $195,500 | -$77,141 |
| Semi-Aqueous | 17% | 22% | $589,250 | -$52,868 |
| Replace with Aqueous Cleaning | 22% | 28% | $609,644 | -$52,146 |
| Hybrid system (e.g., Inventec, HEMO) | 8% | 11% | $958,200 | $113,567 |
| **Weighted Average Across Methods (Including trans-DCE)** |  |  | **$753,583** | **-$8,110** |
| **Weighted Average Across Methods (Excluding trans-DCE)** |  |  | **$910,168** | **-$56,432** |
| 1Weights 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: Large/General Cleaning (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Cleaning method | Weight1 | | Initial Costs | Annual Recurring Costs |
| with trans-DCE | without trans-DCE |
| Convert OTVD to use Flashpoint inerted t-DCE | 11% | 0% | $298,000 | $352,814 |
| Replace with OTVD using Flashpoint inerted t-DCE | 10% | 0% | $3,901,000 | $527,039 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 9% | 11% | $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 | 33% | 44% | $6,184,000 | -$211,435 |
| Co-Solvent, Bi-Solvent | 5% | 9% | $609,400 | -$170,158 |
| High boiling, non-vacuum, non-rinse | 16% | 22% | $228,400 | -$435,952 |
| Semi-Aqueous | 20% | 24% | $365,200 | -$431,998 |
| Replace with Aqueous Cleaning | 22% | 28% | $5,085,144 | -$127,874 |
| Hybrid system (e.g., Inventec, HEMO) | 8% | 11% | $7,171,200 | -$73,934 |
| **Weighted Average Across Methods (Including trans-DCE)** |  |  | **$4,819,356** | **-$140,216** |
| **Weighted Average Across Methods (Excluding trans-DCE)** |  |  | **$5,835,730** | **-$305,453** |
| 1Weights 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: Small/High Precision (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Cleaning method | Weight1 | | Initial Costs | Annual Recurring Costs |
| with trans-DCE | Without trans-DCE |
| Convert OTVD to use Flashpoint inerted t-DCE | 23% | 0% | $355,581 | $7,364 |
| Replace with OTVD using Flashpoint inerted t-DCE | 23% | 0% | $397,581 | $7,364 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 14% | 18% | $427,581 | $6,755 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 6% | 10% | $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 | 23% | 40% | $685,961 | -$7,529 |
| Co-Solvent, Bi-Solvent | 6% | 18% | $579,692 | $13,692 |
| Semi-Aqueous | 2% | 6% | $446,129 | -$1,093 |
| Replace with Aqueous Cleaning | 17% | 24% | $551,453 | $11,332 |
| Hybrid system (e.g., Inventec, HEMO) | 11% | 22% | $670,581 | $15,722 |
| **Weighted Average Across Methods (Including trans-DCE)** |  |  | **$633,568** | **$7,317** |
| **Weighted Average Across Methods (Excluding trans-DCE)** |  |  | **$828,938** | **$7,352** |
| 1Weights 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: Medium/High Precision (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Cleaning method | Weight1 | | Initial Costs | Annual Recurring Costs |
| With trans-DCE | Without trans-DCE |  |
| Convert OTVD to use Flashpoint inerted t-DCE | 23% | 0% | $391,281 | $149,459 |
| Replace with OTVD using Flashpoint inerted t-DCE | 23% | 0% | $742,281 | $149,459 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 14% | 18% | $913,281 | $110,646 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 6% | 10% | $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 | 23% | 40% | $854,531 | -$99,676 |
| Co-Solvent, Bi-Solvent | 6% | 18% | $877,594 | $43,546 |
| Semi-Aqueous | 2% | 6% | $753,031 | -$46,968 |
| Replace with Aqueous Cleaning | 17% | 24% | $793,833 | -$66,457 |
| Hybrid system (e.g., Inventec, HEMO) | 11% | 22% | $1,121,981 | $127,471 |
| **Weighted Average Across Methods (Including trans-DCE)** |  |  | **$959,710** | **$60,956** |
| **Weighted Average Across Methods (Excluding trans-DCE)** |  |  | **$1,247,247** | **-$10,158** |
| 1Weights 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: Large/High Precision (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Cleaning method | Weight1 | | Initial Costs | Annual Recurring Costs |
| with trans-DCE | without trans-DCE |
| Convert OTVD to use Flashpoint inerted t-DCE | 23% | 0% | $464,781 | $350,280 |
| Replace with OTVD using Flashpoint inerted t-DCE | 23% | 0% | $4,064,781 | $350,280 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 14% | 18% | $5,855,781 | $462,217 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 6% | 10% | $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 | 23% | 40% | $5,182,781 | -$205,083 |
| Co-Solvent, Bi-Solvent | 6% | 18% | $3,685,181 | -$551,328 |
| Semi-Aqueous | 2% | 6% | $528,981 | -$429,393 |
| Replace with Aqueous Cleaning | 17% | 24% | $5,099,333 | -$175,596 |
| Hybrid system (e.g., Inventec, HEMO) | 11% | 22% | $7,334,981 | $1,305,573 |
| **Weighted Average Across Methods (Including trans-DCE)** |  |  | **$5,282,393** | **$241,109** |
| **Weighted Average Across Methods (Excluding trans-DCE)** |  |  | **$7,323,409** | **$97,282** |
| 1Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods | | | | |

| Table 7‑40: Initial and Recurring Costs by Alternative Cleaning Method: Small/Safety Critical (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Cleaning method | Weight1 | | Initial Costs | Annual Recurring Costs |
| With trans-DCE | Without trans-DCE |
| Convert OTVD to use Flashpoint inerted t-DCE | 23% | 0% | $1,559,788 | $7,872 |
| Replace with OTVD using Flashpoint inerted t-DCE | 23% | 0% | $1,607,788 | $7,927 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 17% | 22% | $1,628,788 | $6,755 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 14% | 19% | $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 | 29% | 41% | $1,852,168 | -$9,655 |
| Co-Solvent, Bi-Solvent | 9% | 19% | $1,780,899 | $13,655 |
| Semi-Aqueous | 2% | 6% | $1,647,336 | -$1,129 |
| Replace with Aqueous Cleaning | 17% | 25% | $1,163,453 | $4,092 |
| Hybrid system (e.g., Inventec, HEMO) | 12% | 22% | $1,971,788 | $21,972 |
| **Weighted Average Across Methods (Including trans-DCE)** |  |  | **$2,457,742** | **$7,192** |
| **Weighted Average Across Methods (Excluding trans-DCE)** |  |  | **$2,640,562** | **$6,816** |
| 1Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods | | | | |

| Table 7‑41: Initial and Recurring Costs by Alternative Cleaning Method: Medium/Safety Critical (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Cleaning method | Weight1 | | Initial Costs | Annual Recurring Costs |
| with trans-DCE | without trans-DCE |
| Convert OTVD to use Flashpoint inerted t-DCE | 23% | 0% | $1,727,488 | -$95,042 |
| Replace with OTVD using Flashpoint inerted t-DCE | 23% | 0% | $1,943,488 | $149,459 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 17% | 22% | $2,114,488 | $110,646 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 14% | 19% | $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 | 29% | 41% | $2,055,738 | -$76,576 |
| Co-Solvent, Bi-Solvent | 9% | 19% | $2,078,801 | -$79,077 |
| Semi-Aqueous | 2% | 6% | $1,954,238 | -$46,968 |
| Replace with Aqueous Cleaning | 17% | 25% | $1,605,833 | -$57,457 |
| Hybrid system (e.g., Inventec, HEMO) | 12% | 22% | $2,323,188 | $39,892 |
| **Weighted Average Across Methods (Including trans-DCE)** |  |  | **$2,924,591** | **-$12,854** |
| **Weighted Average Across Methods (Excluding trans-DCE)** |  |  | **$3,166,747** | **-$40,984** |
| 1Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods | | | | |

| Table 7‑42: Initial and Recurring Costs by Alternative Cleaning Method: Large/Safety Critical (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Cleaning method | Weight1 | | Initial Costs | Annual Recurring Costs |
| with trans-DCE | without trans-DCE |
| Convert OTVD to use Flashpoint inerted t-DCE | 23% | 0% | $2,385,988 | $170,280 |
| Replace with OTVD using Flashpoint inerted t-DCE | 23% | 0% | $5,265,988 | $350,280 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 17% | 22% | $7,056,988 | $462,217 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 14% | 19% | $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 | 29% | 41% | $6,383,988 | -$205,083 |
| Co-Solvent, Bi-Solvent | 9% | 19% | $6,486,388 | -$251,828 |
| Semi-Aqueous | 2% | 6% | $3,170,188 | -$339,393 |
| Replace with Aqueous Cleaning | 17% | 25% | $5,911,333 | -$175,596 |
| Hybrid system (e.g., Inventec, HEMO) | 12% | 22% | $8,516,188 | $1,304,323 |
| **Weighted Average Across Methods (Including trans-DCE)** |  |  | **$8,544,182** | **$201,987** |
| **Weighted Average Across Methods (Excluding trans-DCE)** |  |  | **$10,284,151** | **$161,742** |
| 1Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods | | | | |

| Table 7‑43: Initial and Recurring Costs by Alternative Cleaning Method: Small/R&D Safety Critical (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Cleaning method | Weight1 | | Initial Costs | Annual Recurring Costs |
| with trans-DCE | without trans-DCE |
| Convert OTVD to use Flashpoint inerted t-DCE | 19% | 0% | $434,775 | $7,872 |
| Replace with OTVD using Flashpoint inerted t-DCE | 19% | 0% | $485,775 | $7,927 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 28% | 41% | $506,775 | $6,755 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 13% | 23% | $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 | 19% | 38% | $730,155 | -$71 |
| Co-Solvent, Bi-Solvent | 11% | 20% | $658,886 | $13,374 |
| Semi-Aqueous | 8% | 13% | $525,323 | -$1,129 |
| Replace with Aqueous Cleaning | 17% | 26% | $478,428 | $13,359 |
| **Weighted Average Across Methods (Including trans-DCE)** |  |  | **$740,242** | **$9,157** |
| **Weighted Average Across Methods (Excluding trans-DCE)** |  |  | **$953,103** | **$9,696** |
| 1Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods | | | | |

| Table 7‑44: : Initial and Recurring Costs by Alternative Cleaning Method: Medium/R&D Safety Critical (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Cleaning method | Weight1 | | Initial Costs | Annual Recurring Costs |
| with trans-DCE | without trans-DCE |
| Convert OTVD to use Flashpoint inerted t-DCE | 19% | 0% | $470,475 | $38,339 |
| Replace with OTVD using Flashpoint inerted t-DCE | 19% | 0% | $1,181,475 | $269,339 |
| Replace with Solstice system (trans-1-chloro-3,3,3-trifluoropropene) | 28% | 41% | $992,475 | $13,266 |
| OTVD for Low boiling point (<100C) Alcohol or other flammable | 13% | 23% | $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 | 19% | 38% | $933,725 | $21,232 |
| Co-Solvent, Bi-Solvent | 11% | 20% | $956,788 | $15,491 |
| Semi-Aqueous | 8% | 13% | $832,225 | $50,412 |
| Replace with Aqueous Cleaning | 17% | 26% | $920,808 | $37,189 |
| **Weighted Average Across Methods (Including trans-DCE)** |  |  | **$1,237,969** | **$84,594** |
| **Weighted Average Across Methods (Excluding trans-DCE)** |  |  | **$1,525,641** | **$42,595** |
| 1Weights sum to more than 100 percent in order to account for switching to multiple cleaning methods | | | | |

Table 7‑45 and Table 7‑46 present a summary of the incremental costs for facilities using PCE for vapor degreasing that switch to an alternative cleaning method. The primary estimates used in the analysis are presented in Table 7‑46 (assuming trans-DCE cleaning methods are not a viable option).

| Table 7‑45: 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 | 5.33% | $417,613 | $4,218 |
| Medium/General Cleaning | 2.67% | $753,583 | ($8,110) |
| Large/General Cleaning | 8.00% | $4,819,356 | ($140,216) |
| Small/High Precision Cleaning | 10.67% | $633,568 | $7,317 |
| Medium/High Precision Cleaning | 5.33% | $959,710 | $60,956 |
| Large/High Precision Cleaning | 16.00% | $5,282,393 | $241,109 |
| Small/Safety Critical Cleaning | 16.00% | $2,457,742 | $7,192 |
| Medium/Safety Critical Cleaning | 8.00% | $2,924,591 | ($12,854) |
| Large/Safety Critical Cleaning | 24.00% | $8,544,182 | $201,987 |
| Small/Start-Up/R&D Critical Cleaning | 3.33% | $740,242 | $9,157 |
| Medium/Start-Up/R&D Critical Cleaning | 1.67% | $1,237,969 | $84,594 |
| **All Types Combined** | **-** | **$4,115,000** | **$82,000** |

| Table 7‑46: 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 | 5.33% | $534,612 | $3,030 |
| Medium/General Cleaning | 2.67% | $910,168 | ($56,432) |
| Large/General Cleaning | 8.00% | $5,835,730 | ($305,453) |
| Small/High Precision Cleaning | 10.67% | $828,938 | $7,352 |
| Medium/High Precision Cleaning | 5.33% | $1,247,247 | ($10,158) |
| Large/High Precision Cleaning | 16.00% | $7,323,409 | $97,282 |
| Small/Safety Critical Cleaning | 16.00% | $2,640,562 | $6,816 |
| Medium/Safety Critical Cleaning | 8.00% | $3,166,747 | ($40,984) |
| Large/Safety Critical Cleaning | 24.00% | $10,284,151 | $161,742 |
| Small/Start-Up/R&D Critical Cleaning | 3.33% | $953,103 | $9,696 |
| Medium/Start-Up/R&D Critical Cleaning | 1.67% | $1,525,641 | $42,595 |
| **All Types Combined** | **-** | **$5,048,000** | **$28,000** |

## Costs of the Dermal Protection Component of the WCPP

The estimated costs for dermal protection include the costs for gloves, presented in section 7.9.1, and the costs associated with developing and implementing a dermal protection control plan, presented in section 7.9.2. Dermal protection costs would be incurred under the conditions of use subject to WCPP requirements.

### 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.

#### 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](#_ENREF_34); [Grainger 2019](#_ENREF_20)):

**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 PCE, so EPA assumes PVA gloves will be the most common choice for compliance with dermal protection requirements. Table 7‑47 presents the unit cost per pair for the gloves used in the cost analysis.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 7‑47: 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)](#_ENREF_6) | | | | |

After use, gloves will need to be disposed of as hazardous material waste. EPA assumes a cost of $2.01 per pound for HazMat disposal and a weight of 0.3 pounds per pair of gloves, resulting in a $0.60 unit cost per pair of gloves.

#### 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 7‑48 presents the annual cost per-worker for gloves.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Table 7‑48: Annual Per-Worker Cost for Dermal PPE (2022$) | | | | | |
| Glove Type | Unit Cost Per Pair of Gloves | | Useful Life (years)\* | Pairs per Year per Worker | Annual Costs |
| Glove Cost | Disposal Cost |
| Supported/Lined PVA | $3.74 | $0.60 | 0.02 | 50 | $217 |
| \*1 pair per week/50 work weeks per year  Source: [Autumn Supply (2022)](#_ENREF_6) | | | | | |

### Dermal Exposure Control Plan Costs

EPA estimates costs for each element of the dermal exposure control plan. The plan and associated recordkeeping costs are documented below. These are then combined with PPE costs to estimate the total costs of dermal protection.

Dermal exposure control plan costs include costs for:

* **Developing the dermal exposure control plan –** Develop aplan documenting pollution prevention, source reduction, engineering controls, and administrative controls or work practices, considered to eliminate direct dermal contact in the workplace.
  + EPA assumes an average of 40 hours per facility to develop the plan and document efforts to reduce exposures to the lowest level achievable.
* **Documenting regular inspections** 
  + EPA assumes 1 hour per inspection and four inspections per year per facility.
* **Documenting personal protective equipment program** – Create and maintain records documenting the type of gloves worn by each person reasonably likely to be dermally exposed to PCE, as well as name, workplace address, work shift, job classification, and work area.
  + EPA assumes 10 minutes per employee record.
* **Document plan implementation** – Document the implementation of the PPE program; and training on donning, doffing, and proper care/‌disposal of PPE.

EPA assumes 15 minutes per employee record.

* **Documenting the occurrence and duration of any dermal exposures** – EPA assumes 10 minutes per record per exposure, and 5 percent of employees with dermal exposures per year (e.g., if a glove became torn and a dermal exposure occurred).

Table 7‑49 presents initial and recurring unit costs per facility and per employee, as applicable for these requirements. Labor costs are estimated using the certified industrial hygienist wage rate (see Table 7‑3)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Table 7‑49: Develop Exposure Control Plan (per facility, 2022$) | | | | | |
| Activity | Labor Burden | Units | Frequency | Initial Costs | **Recurring Costs** |
| Develop Exposure Control Plan | 40 | hours per facility | one time | $2,852.80 | - |
| Conduct Regular Inspections | 4 | hours per facility | annually | - | $285.28 |
| PPE Program Plan Documentation | 10 | minutes per worker | annually | - | $11.89 |
| Records Documenting Plan Implementation | 15 | minutes per worker | annually | - | $17.83 |
| Records of Dermal Exposure | 0.5 | minutes per worker | annually | - | $0.59 |

Table 7‑50 summarizes the initial and annual dermal protection control plan costs.

| Table 7‑50: Total Dermal Protection Control Plan Costs, by Use Category (2022$) | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Use Category | Number of Affected Facilities | Per Facility Costs (initial) | Per Facility Costs (annual) | Number of Affected Workers | Per Worker Costs(annual) | Total Costs | |
| Initial | Annual |
| Manufacturing | 13 | $2,853 | $285.28 | 1,720 | $248 | $37,086 | $429,442 |
| Import/Repackage | 16 | $2,853 | $285.28 | 59 | $248 | $45,645 | $19,168 |
| Reactant/Intermediate | 8 | $2,853 | $285.28 | 330 | $248 | $22,822 | $83,964 |
| Processing Aid in Petrochemical Manufacturing | 64 | $2,853 | $285.28 | 806 | $248 | $182,579 | $217,759 |
| Production of Maskant for Chemical Milling | 1 | $2,853 | $285.28 | 14 | $248 | $2,853 | $3,751 |
| Use as Maskant for Chemical Milling | 71 | $2,853 | $285.28 | 497 | $248 | $202,549 | $143,272 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | 85 | $2,853 | $285.28 | 595 | $248 | $242,488 | $171,523 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | 14 | $2,853 | $285.28 | 98 | $248 | $39,939 | $28,251 |
| Recycling and Disposal | 94 | $2,853 | $285.28 | 1,598 | $248 | $268,163 | $422,352 |
| Incorporation into Adhesive and Sealant Products | 12 | $2,853 | $285.28 | 252 | $248 | $34,234 | $65,798 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Aerosol) | 18 | $2,853 | $285.28 | 378 | $248 | $51,350 | $98,697 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Other) | 13 | $2,853 | $285.28 | 273 | $248 | $37,086 | $71,281 |
| Laboratory Chemicals | 26 | $2,853 | $285.28 | 26 | $248 | $74,173 | $13,853 |
| Processing Aid, Except Petrochemical | 2 | $2,853 | $285.28 | 25 | $248 | $5,706 | $6,759 |
| Adhesives and Sealants | 853 | $2,853 | $285.28 | 25,596 | $248 | $2,433,438 | $6,578,849 |
| Aerosol Spray Cleaning/Degreasing | 148,296 | $2,853 | $285.28 | 201,370 | $248 | $423,058,829 | $92,148,851 |

## WCPP Costs Assuming Additional Engineering and Administrative Controls for Vapor Degreasing

### Engineering Control Costs

EPA developed cost estimates related to construction and operation of a negative pressure room designed to reduce worker exposures to PCE. The system also includes ventilation using carbon adsorption treatment.

Other controls assumed to be in place include not allowing operators to be in the room with degreasing systems except under maintenance conditions; and design of a negative pressure room including walls impervious to solvents. EH&E developed a cost estimate assuming no operator entry into the negative pressure space. In addition, the need for impervious walls was deemed likely to be minimal as the high air flow through the room would far outweigh diffusion to walls. The analysis assumes that the plants where these systems will be installed have adequate electrical, steam, and chilled water capacity to accommodate additional requirements of whatever carbon capture systems are installed.

#### Negative Pressure Room

To estimate the pricing for a negatively-pressured enclosure, EPA used pricing available on prefabricated enclosures, priced from a [supplier](https://www.nationalpartitions.com/store/machine-enclosures/modular-room-20x40-4) with appropriate likely options included. These options included windows, power and data wiring, apertures, set-up labor, shipping, etc. The base model chosen was marketed as designed for use in powder coating applications. The price for a 20 ft by 20 ft by 10 ft prefab enclosure is approximately $60,000. Assuming a 50% internal overhead rate to cover indirect costs and a contingency, as well as a fire suppression system at $40,000, the total cost to the plant to build would be approximately $150,000.

The assumptions for the negative pressure enclosure are listed in Table 1, below.

|  |  |  |  |
| --- | --- | --- | --- |
| Cost breakdown for negative pressure enclosure | | | |
| Item | Price Per Item | Each | Cost |
| Machine Enclosure 20 by 20 by 10' for powder coating | $ 23,000 | 1 | $23,000 |
| Window 4' X 4'-High, Half Light | $120 | 20 | $2,400 |
| Framed Wall Cutout | $200 | 10 | $2,000 |
| Data/Communication Basic Prep | $60 | 10 | $600 |
| Modular Wiring Option | $2,500 | 1 | $2,500 |
| Equipment cost | $30,500 | | |
| Site Assembly (less travel) |  | 0.4 | $12,200. |
| Travel Expenses for assembly | $1,000 | 3 | $3,000 |
| Shipping $/mi | $4 | 3000 | $12,000 |
| Prefab Cost | $57,700 | | |
| Sales Tax (TN Only) |  | 9.25% |  |
| Purge vent system/CO2 Suppression |  |  | $30,000 |
| Window Closing operators |  |  | $10,000 |
|  |  |  |  |
| Total cost |  |  | $97,700 |
| Internal Overhead |  | 50% | $48,850 |
|  |  |  |  |
| **Total Cost to install** |  |  | **$146,550** |
| Costs obtained from enclosure supplier, <https://www.nationalpartitions.com/store/machine-enclosures/modular-room-20x40-4> | | | |

#### Carbon Adsorber Systems

Costs for two carbon adsorber systems were also estimated. For a fixed-bed carbon adsorption system with steam regeneration, EPA’s spreadsheet based on the EPA Air Pollution Control Cost Manual “epa\_carbon\_absorber\_calc\_sheet\_7thedition\_nov2020” was used, here-in referred to as the EPA Carbon Filtration Model.[[15]](#footnote-17) For cost estimates of carbon canister adsorber with carbon replacement, a manufacturer quote from [Carbtrol Corporation](https://carbtrol.com/) (Stratford, CT) was obtained, and costs estimated based on those data inputs.

The default values of the EPA Carbon Filtration Model were used except for those assumptions for which better information was available. Since isotherm parameters “k” and “m” necessary to calculate carbon capacity were not available for either PERC or 1-BP, a procedure outlined in Chapter 1 of Carbon Adsorbers by Sorrels et. al. (Calgon 5th order polynomial) was used to calculate which of the compounds for which k and m factors were published in Table A would best represent PERC and 1-BP. Based on comparison with carbon capacity from carbon capture scenarios from Carbtrol, the default toluene carbon adsorption was close to the Carbtrol prediction for both PERC and 1-BP, so the default values for toluene were used to predict capital cost for both carbon regeneration and carbon replacement, and to predict operating costs for carbon regeneration. For scenarios in which carbon was replaced, the annual costs were based on carbon capacity data provided by Carbtrol.

#### Fixed Bed Carbon Filtration Model

Assumptions for the EPA carbon filtration model include the following:

* Modeled using toluene as the default solvent based on similarity in thermodynamic properties.
* VOC Emission Rate (mvoc)= 4.850 lbs/hour for 720 gallons usage per year and 12.96 lbs/hr for 2,300 gals/year
* Intermittent operation
* Stainless steel 304
* Horizontal orientation
* Operating hours per year = 2,000
* Waste gas flow rate = 500 cfm
* VOC removal efficiency = 99.96%
* Superficial Bed Velocity (vb) = 75 ft/min
* Estimated equipment life of adsorber vessels and auxiliary Equipment (n) = 15 years
* Estimated Carbon life (n) = 5 years
* Total Number of carbon beds (Ntotal) = 3 beds
* Number of carbon beds adsorbing VOC when system is operating (NA) = 2 beds
* Total time for adsorption (ƟA) = 12 hours
* Total time for desorption (ƟD) = 5 hours
* Estimated Carbon Replacement Rate (CRR) = 379 lbs/hour

If carbon filtration is used and expected to be discharged into the larger plant at levels below the ECEL of 0.05 ppm then the filtration efficiency needs to be greater than 99.9964% efficient. If the discharge is into a plant area of 50,000 ft2 with 20 ft high bay height ventilated at the rate of 0.1 CFM/ft2 then the filter needs to have a filter efficiency greater than 99.9928%. This may not be possible in practice (channeling through the filter, etc.) or may require review of a model for carbon performance that can sufficiently predict breakthrough down to these low levels. Since the exhaust volume is low, it is recommended that 500 CFM be exhausted from the plant even if it is filtered through carbon.

Models for using carbon indicate that carbon is better at capturing at high concentrations. Minimizing flow will maximize concentration and hence the depth and the amount of carbon required for effective filtration.

Estimated costs are shown below in Table 2, below. Total costs range from approximately $100,000 to more than $510,000 per year, including cost savings for recovered solvent.

#### **Carbon Canister Adsorber with Carbon Replacement**

Cost estimates for canister systems were also calculated based on a quote from a vendor, Carbtrol. A detailed description of canister units can be found in section 1.2.2 of [EPA’s VOC control guidance](https://www.epa.gov/sites/default/files/2018-10/documents/final_carbonadsorberschapter_7thedition.pdf). Cost estimates are shown in Table 3, below. Inputs to the data table were provided in an estimate provided by the vendor. This is included in an appendix.

Total annualized costs not including cost of solvent range from approximately $30,000 for a 36 gals/yr usage to approximately $900,000 for 2,300 gals/yr usage.

#### Summary of Engineering Control Costs for Vapor Degreasers

Table 7‑51 presents a summary of the estimated engineering control costs for vapor degreasers

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Table 7‑51: Summary of Engineering Control Costs for Vapor Degreasers | | | | | | |
| Cost Type | Small: EPA Cannister Adsorption Model with Steam Regeneration, PCE 2,300 gallons per year | | Medium: EPA Cannister Carbon Adsorption Model with Steam Regeneration, PCE 720 gallons per year | | Large: EPA Cannister Carbon Adsorption Model with Steam Regeneration, PCE 36 gallons per year | |
| Initial Costs | Recurring Costs | Initial Costs | Recurring Costs | Initial Costs | Recurring Costs |
| Negative Pressure Room | $146,550 | - | $146,550 | - | $146,550 | - |
| Adsorption | $58,253 | $20,241 | $114,455 | $209,350 | $254,905 | $596,337 |
| Automation | $375,000 | - | $375,000 | - | $375,000 | - |
| **Total Engineering Controls** | **$579,803** | **$20,241** | **$636,005** | **$209,350** | **$776,455** | **$596,337** |

### Summary of WCPP Costs for Vapor Degreasers Assuming Engineering Controls

Table 7‑52 presents the summary of the WCPP costs assuming that engineering controls are used to achieve exposure levels below the ECEL.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Table 7‑52: Summary of WCPP Costs with Engineering Controls for Vapor Degreasers | | | | | | |
| Cost Type | Small | | Medium | | Large | |
| Initial Costs | Recurring Costs | Initial Costs | Recurring Costs | Initial Costs | Recurring Costs |
| Total Engineering Controls | $579,803 | $20,241 | $636,005 | $209,350 | $776,455 | $596,337 |
| WCPP Costs (assuming exposures below ECEL) | $2,454 | $596 | $2,454 | $596 | $2,454 | $596 |
| **Total WCPP Costs** | **$582,257** | **$20,837** | **$638,459** | **$209,946** | **$778,909** | **$596,933** |

Table 7‑53 presents the estimated costs for vapor degreasers under a WCPP. Note that vapor degreasers are assumed to switch to alternatives instead of using engineering controls to comply with the WCPP when the annualized costs for switching to alternatives are lower.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 7‑53: Summary of WCPP Option Costs for Vapor Degreasers | | | | |
| Size/Type | Compliance Strategy | Size/Type Percentage Weight | Initial Costs | Recurring Costs |
| Small/General Cleaning | Switch to Alternatives | 5.33% | $549,055 | $420 |
| Medium/General Cleaning | Switch to Alternatives | 2.67% | $920,171 | ($66,937) |
| Large/General Cleaning | Switch to Alternatives | 8.00% | $6,015,022 | ($310,974) |
| Small/High Precision Cleaning | WCPP | 10.67% | $582,257 | $20,837 |
| Medium/High Precision Cleaning | Switch to Alternatives | 5.33% | $1,241,737 | ($31,659) |
| Large/High Precision Cleaning | WCPP | 16.00% | $778,909 | $158,781 |
| Small/Safety Critical Cleaning | WCPP | 16.00% | $582,257 | $20,837 |
| Medium/Safety Critical Cleaning | WCPP | 8.00% | $638,459 | $33,381 |
| Large/Safety Critical Cleaning | WCPP | 24.00% | $778,909 | $158,781 |
| Small/Start-Up/R&D Critical Cleaning | WCPP | 3.33% | $582,257 | $20,837 |
| Medium/Start-Up/R&D Critical Cleaning | WCPP | 1.67% | $638,459 | $33,381 |
| **All Types Combined** |  |  | **$1,149,199** | **$44,661** |

## 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 0.14 ppm as an 8-hour time-weighted average for PCE and an action level of 0.10 ppm as an 8-hour TWA. 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 7‑54.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 7‑54: Monitoring Threshold Requirements | | | |
| Exposure Threshold | Monitoring Requirements | PPE Requirements | Notification and Recordkeeping Requirements |
| ≤0.10 ppm (8-hour TWA) | 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. |
| 0.10–0.14 ppm (8-hour TWA) | Initial exposure monitoring  Periodic exposure monitoring every 6 months | No respiratory protection | Notify employee of exposure monitoring results within 15 days of receipt of results.  Retain compliance records for 5 years. |
| 0.14–1.4 ppm (8-hour TWA) | Initial exposure monitoring  Periodic exposure monitoring every 3 months | Assigned Protection Factor (APF) 10 | Notify employee of exposure monitoring results within 15 days of receipt of results.  Retain compliance records for 5 years. |
| 1.4–3.5 ppm (8-hour TWA) | Initial exposure monitoring  Periodic exposure monitoring every 3 months | APF 25 | Notify employee of exposure monitoring results within 15 days of receipt of results.  Retain compliance records for 5 years. |
| 3.5–7 ppm (8-hour TWA) | Initial exposure monitoring  Periodic exposure monitoring every 3 months | APF 50 | Notify employee of exposure monitoring results within 15 days of receipt of results.  Retain compliance records for 5 years. |
| 7–140 ppm (8-hour TWA) | Initial exposure monitoring  Periodic exposure monitoring every 3 months | APF 1,000 | Notify employee of exposure monitoring results within 15 days of receipt of results.  Retain compliance records for 5 years. |
| 140–1,400 ppm (8-hour TWA) | Initial exposure monitoring  Periodic exposure monitoring every 3 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. The costs of engineering and administrative controls are site-specific and depend on the extent to which controls are already in place, which is unknown. 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 7.14.3, 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, 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 and estimated the distribution assuming the exposures were distributed across facilities according to a log normal distribution.[[16]](#footnote-18) EPA estimated the 8-hour TWA exposure distribution to estimate which threshold monitoring category an entity fell under.

Table 7‑55 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.

| Table 7‑55. 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 ECEL | 10% of entities Between Action Level and ECEL |
| 16 | Between Action Level and ECEL |
| 17 | Between Action Level and ECEL |
| 18 | Between Action Level and ECEL |
| 19 | Between Action Level and ECEL |
| 20 | Between Action Level and ECEL |
| 21 | Between Action Level and ECEL |
| 22 | Between Action Level and ECEL |
| 23 | Between Action Level and ECEL |
| 24 | Between Action Level and ECEL |
| 25 | 1 to <10 times the ECEL | 44% of entities 1 to  <‍10 times the ECEL |
| 26 | 1 to <10 times the ECEL |
| 27 | 1 to <10 times the ECEL |
| 28 | 1 to <10 times the ECEL |
| 29 | 1 to <10 times the ECEL |
| 30 | 1 to <10 times the ECEL |
| 31 | 1 to <10 times the ECEL |
| 32 | 1 to <10 times the ECEL |
| 33 | 1 to <10 times the ECEL |
| 34 | 1 to <10 times the ECEL |
| 35 | 1 to <10 times the ECEL |
| 36 | 1 to <10 times the ECEL |
| 37 | 1 to <10 times the ECEL |
| 38 | 1 to <10 times the ECEL |
| 39 | 1 to <10 times the ECEL |
| 40 | 1 to <10 times the ECEL |
| 41 | 1 to <10 times the ECEL |
| 42 | 1 to <10 times the ECEL |
| 43 | 1 to <10 times the ECEL |
| 44 | 1 to <10 times the ECEL |
| 45 | 1 to <10 times the ECEL |
| 46 | 1 to <10 times the ECEL |
| 47 | 1 to <10 times the ECEL |
| 48 | 1 to <10 times the ECEL |
| 49 | 1 to <10 times the ECEL |
| 50 | 1 to <10 times the ECEL |
| 51 | 1 to <10 times the ECEL |
| 52 | 1 to <10 times the ECEL |
| 53 | 1 to <10 times the ECEL |
| 54 | 1 to <10 times the ECEL |
| 55 | 1 to <10 times the ECEL |
| 56 | 1 to <10 times the ECEL |
| 57 | 1 to <10 times the ECEL |
| 58 | 1 to <10 times the ECEL |
| 59 | 1 to <10 times the ECEL |
| 60 | 1 to <10 times the ECEL |
| 61 | 1 to <10 times the ECEL |
| 62 | 1 to <10 times the ECEL |
| 63 | 1 to <10 times the ECEL |
| 64 | 1 to <10 times the ECEL |
| 65 | 1 to <10 times the ECEL |
| 66 | 1 to <10 times the ECEL |
| 67 | 1 to <10 times the ECEL |
| 68 | 1 to <10 times the ECEL |
| 69 | 10 to <25 times the ECEL | 14% of Entities 10 to <25 times the ECEL |
| 70 | 10 to <25 times the ECEL |
| 71 | 10 to <25 times the ECEL |
| 72 | 10 to <25 times the ECEL |
| 73 | 10 to <25 times the ECEL |
| 74 | 10 to <25 times the ECEL |
| 75 | 10 to <25 times the ECEL |
| 76 | 10 to <25 times the ECEL |
| 77 | 10 to <25 times the ECEL |
| 78 | 10 to <25 times the ECEL |
| 79 | 10 to <25 times the ECEL |
| 80 | 10 to <25 times the ECEL |
| 81 | 10 to <25 times the ECEL |
| 82 | 10 to <25 times the ECEL |
| 83 | 25 to <50 times the ECEL | 8% of Entities 25 to <50 times the ECEL |
| 84 | 25 to <50 times the ECEL |
| 85 | 25 to <50 times the ECEL |
| 86 | 25 to <50 times the ECEL |
| 87 | 25 to <50 times the ECEL |
| 88 | 25 to <50 times the ECEL |
| 89 | 25 to <50 times the ECEL |
| 90 | 25 to <50 times the ECEL |
| 91 | 50 to <1,000 times the ECEL | 10% of Entities 50 to <1,000 times the ECEL |
| 92 | 50 to <1,000 times the ECEL |
| 93 | 50 to <1,000 times the ECEL |
| 94 | 50 to <1,000 times the ECEL |
| 95 | 50 to <1,000 times the ECEL |
| 96 | 50 to <1,000 times the ECEL |
| 97 | 50 to <1,000 times the ECEL |
| 98 | 50 to <1,000 times the ECEL |
| 99 | 50 to <1,000 times the ECEL |
| 100 | 50 to <1,000 times the ECEL |

In order to estimate costs (and benefits), EPA assumed that the variation in exposure is reflected across the entities rather than the workers. Table 7‑56 and Table 7‑57 present the respective estimated numbers of entities and workers in each ECEL threshold category.

| Table 7‑56: Count of Entities, by Use Category and Exposure Threshold | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Use Category | <Action Level | Between Action Level and ECEL | 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 to <10,000 times the ECEL | Total |
| Manufacturing | 8.6 | 0.5 | 2.7 | 0.5 | 0.3 | 0.4 | - | 13 |
| Import/Repackage | - | 0.3 | 15.4 | 0.3 | - | - | - | 16 |
| Reactant/Intermediate | 5.3 | 0.3 | 1.7 | 0.3 | 0.2 | 0.2 | - | 8 |
| Processing Aid in Petrochemical Manufacturing | 39.0 | 4.5 | 17.3 | 1.9 | 0.6 | 0.6 | - | 64 |
| Production of Maskant for Chemical Milling | 0.0 | 0.0 | 0.9 | 0.0 | - | - | - | 1 |
| Use as Maskant for Chemical Milling | 3.6 | 1.4 | 23.4 | 12.8 | 9.2 | 19.2 | 1.4 | 71 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | 2.6 | 1.7 | 29.8 | 18.7 | 11.9 | 19.6 | 0.9 | 85 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | 9.2 | 2.0 | 2.8 | - | - | - | - | 14 |
| Recycling and Disposal | 89.3 | 0.9 | 3.8 | - | - | - | - | 94 |
| Incorporation into Adhesive and Sealant Products | 0.2 | 0.5 | 11.0 | 0.2 | - | - | - | 12 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Aerosol) | - | - | - | 1.4 | 5.0 | 11.5 | - | 18 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Other) | 0.3 | 0.5 | 12.0 | 0.3 | - | - | - | 13 |
| Laboratory Chemicals | - | - | 26.0 | - | - | - | - | 26 |
| Processing Aid, Except Petrochemical | 1.2 | 0.1 | 0.5 | 0.1 | 0.0 | 0.0 | - | 2 |
| Adhesives and Sealants | 452.1 | 85.3 | 290.0 | 25.6 | - | - | - | 853 |
| Aerosol Spray Cleaning/Degreasing | - | 1,483.0 | 71,182.1 | 47,454.7 | 19,278.5 | 8,897.8 | - | 148,296 |

| Table 7‑57: Count of Employees, by Use Category, Worker Type, and Exposure Threshold | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Use Category | Employee Type | <Action Level | Between Action Level and ECEL | 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 to <10,000 times the ECEL | Total |
| Manufacturing | Worker | 1,135.2 | 68.8 | 361.2 | 68.8 | 34.4 | 51.6 | - | 1,720 |
| Manufacturing | ONU | 782.4 | 32.6 | - | - | - | - | - | 815 |
| Import/Repackage | Worker | - | 1.2 | 56.6 | 1.2 | - | - | - | 59 |
| Reactant/Intermediate | Worker | 217.8 | 13.2 | 69.3 | 13.2 | 6.6 | 9.9 | - | 330 |
| Reactant/Intermediate | ONU | 144.0 | 6.0 | - | - | - | - | - | 150 |
| Processing Aid in Petrochemical Manufacturing | Worker | 491.7 | 56.4 | 217.6 | 24.2 | 8.1 | 8.1 | - | 806 |
| Production of Maskant for Chemical Milling | Worker | 0.3 | 0.6 | 12.9 | 0.3 | - | - | - | 14 |
| Use as Maskant for Chemical Milling | Worker | 24.9 | 9.9 | 164.0 | 89.5 | 64.6 | 134.2 | 9.9 | 497 |
| Use as Maskant for Chemical Milling | ONU | - | - | 1,576.2 | 553.8 | - | - | - | 2,130 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | 17.9 | 11.9 | 208.3 | 130.9 | 83.3 | 136.9 | 6.0 | 595 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | 13.6 | 8.5 | 102.0 | 28.9 | 10.2 | 6.8 | - | 170 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | 64.7 | 13.7 | 19.6 | - | - | - | - | 98 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | 27.2 | 0.8 | - | - | - | - | - | 28 |
| Recycling and Disposal | Worker | 1,518.1 | 16.0 | 63.9 | - | - | - | - | 1,598 |
| Incorporation into Adhesive and Sealant Products | Worker | 5.0 | 10.1 | 231.8 | 5.0 | - | - | - | 252 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Aerosol) | Worker | - | - | - | 30.2 | 105.8 | 241.9 | - | 378 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Other) | Worker | 5.5 | 10.9 | 251.2 | 5.5 | - | - | - | 273 |
| Laboratory Chemicals | Worker | - | - | 26.0 | - | - | - | - | 26 |
| Processing Aid, Except Petrochemical | Worker | 15.3 | 1.8 | 6.8 | 0.8 | 0.3 | 0.3 | - | 25 |
| Adhesives and Sealants | Worker | 13,565.9 | 2,559.6 | 8,702.6 | 767.9 | - | - | - | 25,596 |
| Aerosol Spray Cleaning/Degreasing | Worker | - | 2,013.7 | 96,657.6 | 64,438.4 | 26,178.1 | 12,082.2 | - | 201,370 |
| Aerosol Spray Cleaning/Degreasing | ONU | 4,882.9 | 1,380.0 | 4,352.2 | - | - | - | - | 10,615 |

### Initial Exposure Monitoring and Periodic Exposure Monitoring

The initial exposure monitoring and periodic monitoring costs presented in Table 7‑58 are based on the research and professional judgment of the industrial hygiene firm, Environmental Health & Engineering, Inc. 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.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 7‑58: Summary of Costs Associated with an Exposure Evaluation of PCE at a Simple Worksite (10 Workers Sampled, 2022$) | | | | |
| Category | Sub-category | Unit Cost | Quantity | Total\* |
| Laboratory Analysis | PCE: Media | $52 | 1 unit | $50 |
| PCE: Analysis | $62 | 13 units | $800 |
| Equipment | Personal Pumps | $38 | 11 units | $420 |
| Calibration Meter | $54 | 1 unit | $55 |
| Tubing | $32 | 1 unit | $30 |
| 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** | | | | **$2,850** |
| ODC other direct costs  CIH Certified Industrial Hygienist  \* Rounded to nearest $5. | | | | |

Since some of the per-facility costs presented in Table 7‑58 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 7‑59 presents the re-categorized estimates together with the per-facility costs.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Table 7‑59: Summary of Per Facility and Per Employee Costs Associated with an Exposure Evaluation of PCE (2022$) | | | | | |
| Category | Sub-category | Unit Cost | Quantity for a 10-Employee Site | Per-Facility Costs | Per-Employee Costs  (10 Employees) |
| Laboratory Analysis | PCE: Media | $52 | 1 unit | $50 | - |
| PCE: Analysis | $62 | 13 units | - | $80 |
| Equipment | Personal Pumps | $38 | 11 units | - | $42 |
| Calibration Meter | $54 | 1 unit | - | $6 |
| Tubing | $32 | 1 unit | $30 | - |
| ODCs | Shipping | $108 | 1 unit | - | $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** | | | | **$443** | **$241** |
| Abbreviations: ODC: other direct costs. CIH: Certified Industrial Hygienist. | | | | | |

The per facility costs from Table 7‑59 are presented in Table 7‑60 and the per-worker costs from Table 7‑59 are presented in Table 7‑61. Table 7‑60 and Table 7‑61 both present the initial and recurring annual costs.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 7‑60: Per Facility Monitoring Costs (2022$) | | | | |
| Threshold | Cost Incurred | | | |
| Initial Monitoring Costs | Periodic Monitoring Costs | Initial Costs | Annual Costs |
| <Action Level | $443 | $443 every five years | $443 | $89 |
| Between Action Level and ECEL | - | $886 = 443 × 2 | - | $886 |
| 1 to <10 times the ECEL | - | $1,772 = 443 × 4 | - | $1,772 |
| 10 to <25 times the ECEL | - | $1,772 = 443 × 4 | - | $1,772 |
| 25 to <50 times the ECEL | - | $1,772 = 443 × 4 | - | $1,772 |
| 50 to <1,000 times the ECEL | - | $1,772 = 443 × 4 | - | $1,772 |
| 1,000 to <10,000 times the ECEL | - | $1,772 = 443 × 4 | - | $1,772 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 7‑61: Per Worker Monitoring Costs (2022$) | | | | |
| Threshold | Cost Incurred | | | |
| Initial Monitoring Costs | Periodic Monitoring Costs | Initial Costs | Annual Costs |
| <Action Level | $241 | $241 every five years | $241 | $48 |
| Between Action Level and ECEL | - | $481 = 241 x 2 | - | $481 |
| 1 to <10 times the ECEL | - | $963 = 241 x 4 | - | $963 |
| 10 to <25 times the ECEL | - | $963 = 241 x 4 | - | $963 |
| 25 to <50 times the ECEL | - | $963 = 241 x 4 | - | $963 |
| 50 to <1,000 times the ECEL | - | $963 = 241 x 4 | - | $963 |
| 1,000 to <10,000 times the ECEL | - | $963 = 241 x 4 | - | $963 |

### 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 2016](#_ENREF_37)). That document included a recordkeeping burden for program development and associated recordkeeping, program updates and associated recordkeeping, and exposure monitoring recordkeeping and notifications.

OSHA ([2016](#_ENREF_37)) 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 employees or more) 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 initial and annual costs are presented in Table 7‑62. The per worker initial and annual costs are presented for each threshold in Table 7‑63.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 7‑62: Per Facility Notification and Recordkeeping Costs (2022$) | | | | |
| Threshold | Cost Incurred | | | |
| Setting up WCPP and Associated Recordkeeping1 | Updating WCPP and Associated Recordkeeping2 | Initial Costs | Annual Costs |
| All Thresholds | $378.96 | $37.90 | $379 | $38 |
| 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 7‑63: Per Worker Notification and Recordkeeping Costs (2022$) | | | |
| Threshold | Cost Incurred | | |
| Exposure Monitoring Notifications and Recordkeeping | Initial Costs | Recurring Costs |
| <Action Level | $23.69 = 1 sample periods\*$23.69 (every five years) | $24 | $5 |
| Between Action Level and ECEL | $47.37 = 2 sample periods\*$23.69 | - | $47 |
| 1 to <10 times the ECEL | $94.74 = 4 sample periods\*$23.69 | - | $95 |
| 10 to <25 times the ECEL | $94.74 = 4 sample periods\*$23.69 | - | $95 |
| 25 to <50 times the ECEL | $94.74 = 4 sample periods\*$23.69 | - | $95 |
| 50 to <1,000 times the ECEL | $94.74 = 4 sample periods\*$23.69 | - | $95 |
| 1,000 to <10,000 times the ECEL | $94.74 = 4 sample periods\*$23.69 | - | $95 |

### Respiratory Personal Protective Equipment (PPE)

EPA assumed that all workers or ONUs in facilities at the following monitoring thresholds would wear the minimum required assigned protection factor (APF), unless they are already using PPE that is more protective.[[17]](#footnote-19) 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 1,000 respirator
* 1,000 to <10,000 times the ECEL: APF 10,000 respirator

Total respiratory PPE costs are estimated by multiplying the number of workers and ONUs at each monitoring threshold (see Table 7‑56 and Table 7‑57) by the unit cost for the corresponding PPE required at that threshold. The estimates account for baseline usage of PPE in the industries expected to be affected by the requirements. See [Abt Associates 2022a](#_ENREF_2), Appendix C, for a detailed description of how the PPE costs were estimated.

The total estimated initial and recurring costs by use category are presented in Table 7‑64. The initial and recurring costs, excluding hazardous waste costs, correspond to the estimated PPE costs in Table C-18 and Table C-19 in Appendix C. Hazardous waste disposal costs are estimated from EPA’s P2 Cost Calculator {EPA 2017}, and are $2.01 per pound in 2022$.

| Table 7‑64: Total Initial and recurring PPE Costs per Worker or ONU by Sector (2022$) | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sector (use categories) | APF | Average PPE Cost per Worker | | | | | |
| Incremental PPE Costs, Excluding Hazardous Waste Disposal1 | | Incremental Hazardous Waste Disposal Costs for Filter Cartridges2 | | Incremental PPE Costs, Including Hazardous Waste Disposal | |
| Initial Costs | Recurring Costs | Initial Costs | Recurring Costs | Initial Costs | Recurring Costs |
| Manufacturing (All uses where WCPP is applicable except Recycling and Disposal and Aerosol Cleaning/Degreasing) | 10 | $1,845 | $1,992 | $88 | $88 | $1,933 | $2,080 |
| 25 | $1,763 | $1,344 | $272 | $244 | $2,035 | $1,588 |
| 50 | $1,920 | $1,877 | $100 | $98 | $2,020 | $1,975 |
| 1,000 | $1,625 | $1,177 | $109 | $109 | $1,734 | $1,285 |
| 10,000 | $8,364 | $1,788 | ($36) | ($20) | $8,328 | $1,768 |
| Transportation and Public Utilities (Recycling and Disposal) | 10 | $2,361 | $2,653 | $108 | $108 | $2,470 | $2,762 |
| 25 | $2,260 | $1,870 | $311 | $299 | $2,572 | $2,169 |
| 50 | $2,405 | $2,466 | $111 | $111 | $2,516 | $2,577 |
| 1,000 | $2,051 | $1,626 | $102 | $102 | $2,153 | $1,729 |
| 10,000 | $8,861 | $2,497 | ($12) | ($12) | $8,849 | $2,485 |
| Services (Aerosol Spray Cleaning/Degreasing) | 10 | $2,569 | $2,789 | $117 | $117 | $2,686 | $2,906 |
| 25 | $2,461 | $1,943 | $327 | $322 | $2,788 | $2,264 |
| 50 | $2,595 | $2,551 | $116 | $116 | $2,711 | $2,667 |
| 1,000 | $2,413 | $1,918 | $221 | $221 | $2,634 | $2,139 |
| 10,000 | $9,179 | $2,560 | ($7) | ($0.05) | $9,172 | $2,560 |
| 1Initial costs correspond to the Table C-18 estimates in Appendix C. Recurring Costs correspond to the Table C-19 estimates in Appendix C.  2Hazardous was costs are estimated as $1.11 per set for air purifying respirator cartridges and $6.09 per set for powered air purifying respirator (PAPR) cartridges. Hazardous waste disposal cost is estimated as $2.01 per pound (EPA 2017). Air purifying respirator cartridges weigh about 100 grams each, are used in pairs, and are assumed to be increased in weight by 25 percent when disposed. PAPR cartridges weigh about 370 grams each, are used in groups of three, and are assumed to be increased in weight by 25 percent when disposed. Note that since APF 10,000 PPE includes only supplied air respirators, which would not use filter cartridges that could be hazardous waste, adding the hazardous waste costs increases the baseline cost estimates only, which is why there is an incremental cost savings for APF 10,000 respirators for adding hazardous waste costs. | | | | | | | |

### Total Costs for Respiratory Components of the WCPP

Table 7‑65 and Table 7‑66 present the total initial and annual costs of complying with WCPP monitoring, recordkeeping, and respiratory protection requirements by sector, use category, and monitoring threshold.

| Table 7‑65. Summary of Per Worker Annualized 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)  Transportation and Public Utilities (Recycling and Disposal) | <Action Level | $241 | - | $241 | $48 | $24 | - | $72 |
| Between Action Level and ECEL | - | - | - | $481 | - | - | $481 |
| 1 to <10 times the ECEL | - | $1,933 | $1,933 | $963 | - | $2,080 | $3,043 |
| 10 to <25 times the ECEL | - | $2,035 | $2,035 | $963 | - | $1,588 | $2,550 |
| 25 to <50 times the ECEL | - | $2,020 | $2,020 | $963 | - | $1,975 | $2,938 |
| 50 to <1,000 times the ECEL | - | $1,734 | $1,734 | $963 | - | $1,285 | $2,248 |
| 1,000 to <10,000 times the ECEL | - | $8,328 | $8,328 | $963 | - | $1,768 | $2,731 |
| Transportation and Public Utilities (Recycling and Disposal) | <Action Level | $241 | - | $241 | $48 | $24 | - | $72 |
| Between Action Level and ECEL | - | - | - | $481 | - | - | $481 |
| 1 to <10 times the ECEL | - | $2,470 | $2,470 | $963 | - | $2,762 | $3,725 |
| 10 to <25 times the ECEL | - | $2,572 | $2,572 | $963 | - | $2,169 | $3,132 |
| 25 to <50 times the ECEL | - | $2,516 | $2,516 | $963 | - | $2,577 | $3,539 |
| 50 to <1,000 times the ECEL | - | $2,153 | $2,153 | $963 | - | $1,729 | $2,691 |
| 1,000 to <10,000 times the ECEL | - | $8,849 | $8,849 | $963 | - | $2,485 | $3,448 |
| Services (Aerosol Spray Cleaning/Degreasing) | <Action Level | $241 | - | $241 | $48 | $24 | - | $72 |
| Between Action Level and ECEL | - | - | - | $481 | - | - | $481 |
| 1 to <10 times the ECEL | - | $2,686 | $2,686 | $963 | - | $2,906 | $3,868 |
| 10 to <25 times the ECEL | - | $2,788 | $2,788 | $963 | - | $2,264 | $3,227 |
| 25 to <50 times the ECEL | - | $2,711 | $2,711 | $963 | - | $2,667 | $3,630 |
| 50 to <1,000 times the ECEL | - | $2,634 | $2,634 | $963 | - | $2,139 | $3,101 |
| 1,000 to <10,000 times the ECEL | - | $9,172 | $9,172 | $963 | - | $2,560 | $3,522 |

| Table 7‑66: 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 | $443 | $379 | $822 | $48 | $38 | $86 |
| Between Action Level and ECEL | - | $379 | $379 | $481 | $38 | $519 |
| 1 to <10 times the ECEL | - | $379 | $379 | $963 | $38 | $1,001 |
| 10 to <25 times the ECEL | - | $379 | $379 | $963 | $38 | $1,001 |
| 25 to <50 times the ECEL | - | $379 | $379 | $963 | $38 | $1,001 |
| 50 to <1,000 times the ECEL | - | $379 | $379 | $963 | $38 | $1,001 |
| 1,000 to < 10,000 times the ECEL | - | $379 | $379 | $963 | $38 | $1,001 |

## Total WCPP Costs

Table 7‑67 present the total costs of complying with WCPP requirements by use category and monitoring threshold (estimated by aggregating the costs presented in sections 7.9 and 7.10).

| Table 7‑67: 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** |
| Manufacturing | <Action Level | 8.58 | 1135.2 | $821.96 | $86.03 | $240.65 | $71.82 | $280,241 | $82,263 |
| Between Action Level and ECEL | 0.52 | 68.8 | $378.96 | $519.20 | $0.00 | $481.30 | $197 | $33,384 |
| 1 to <10 times the ECEL | 2.73 | 361.2 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $699,357 | $1,101,774 |
| 10 to <25 times the ECEL | 0.52 | 68.8 | $378.96 | $1,000.50 | $2,034.83 | $2,550.18 | $140,193 | $175,973 |
| 25 to <50 times the ECEL | 0.26 | 34.4 | $378.96 | $1,000.50 | $2,020.42 | $2,937.90 | $69,601 | $101,324 |
| 50 to <1,000 times the ECEL | 0.39 | 51.6 | $378.96 | $1,000.50 | $1,733.57 | $2,248.09 | $89,600 | $116,392 |
| 1,000 to < 10,000 times the ECEL | - | - | - | - | - | - | - | - |
| **All thresholds** | **13** | **1720.0** | **$671.34** | **$377.70** | **$738.64** | **$933.84** | **$1,279,189** | **$1,611,109** |
| Import/Repackage | <Action Level | - | - | - | - | - | - | - | - |
| Between Action Level and ECEL | 0.32 | 1.2 | $378.96 | $519.20 | $0.00 | $481.30 | $121 | $734 |
| 1 to <10 times the ECEL | 15.36 | 56.6 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $115,325 | $187,709 |
| 10 to <25 times the ECEL | 0.32 | 1.2 | $378.96 | $1,000.50 | $2,034.83 | $2,550.18 | $2,522 | $3,329 |
| 25 to <50 times the ECEL | - | - | - | - | - | - | - | - |
| 50 to <1,000 times the ECEL | - | - | - | - | - | - | - | - |
| 1,000 to < 10,000 times the ECEL | - | - |  | - | - | - | - | - |
| **All thresholds** | **16** | **59.0** | **$378.96** | **$990.88** | **$1,896.70** | **$2,981.67** | **$117,969** | **$191,773** |
| Reactant/Intermediate | <Action Level | 5.28 | 217.8 | $821.96 | $86.03 | $240.65 | $71.82 | $56,754 | $16,096 |
| Between Action Level and ECEL | 0.32 | 13.2 | $378.96 | $519.20 | $0.00 | $481.30 | $121 | $6,519 |
| 1 to <10 times the ECEL | 1.68 | 69.3 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $134,617 | $212,544 |
| 10 to <25 times the ECEL | 0.32 | 13.2 | $378.96 | $1,000.50 | $2,034.83 | $2,550.18 | $26,981 | $33,983 |
| 25 to <50 times the ECEL | 0.16 | 6.6 | $378.96 | $1,000.50 | $2,020.42 | $2,937.90 | $13,395 | $19,550 |
| 50 to <1,000 times the ECEL | 0.24 | 9.9 | $378.96 | $1,000.50 | $1,733.57 | $2,248.09 | $17,253 | $22,496 |
| 1,000 to < 10,000 times the ECEL | - | - | - | - | - | - | - | - |
| **All thresholds** | **8** | **330.0** | **$671.34** | **$377.70** | **$738.64** | **$933.84** | **$249,122** | **$311,188** |
| Processing Aid in Petrochemical Manufacturing | <Action Level | 39.04 | 491.7 | $821.96 | $86.03 | $240.65 | $71.82 | $150,408 | $38,667 |
| Between Action Level and ECEL | 4.48 | 56.4 | $378.96 | $519.20 | $0.00 | $481.30 | $1,698 | $29,481 |
| 1 to <10 times the ECEL | 17.28 | 217.6 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $427,282 | $679,453 |
| 10 to <25 times the ECEL | 1.92 | 24.2 | $378.96 | $1,000.50 | $2,034.83 | $2,550.18 | $49,930 | $63,584 |
| 25 to <50 times the ECEL | 0.64 | 8.1 | $378.96 | $1,000.50 | $2,020.42 | $2,937.90 | $16,527 | $24,320 |
| 50 to <1,000 times the ECEL | 0.64 | 8.1 | $378.96 | $1,000.50 | $1,733.57 | $2,248.09 | $14,215 | $18,760 |
| 1,000 to < 10,000 times the ECEL | - | - | - | - | - | - | - | - |
| **All thresholds** | **64** | **806.0** | **$649.19** | **$408.98** | **$767.38** | **$1,027.41** | **$660,060** | **$854,265** |
| Production of maskant for chemical milling | <Action Level | 0.02 | 0.3 | $821.96 | $86.03 | $240.65 | $71.82 | $84 | $22 |
| Between Action Level and ECEL | 0.04 | 0.6 | $378.96 | $519.20 | $0.00 | $481.30 | $15 | $290 |
| 1 to <10 times the ECEL | 0.92 | 12.9 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $25,250 | $40,111 |
| 10 to <25 times the ECEL | 0.02 | 0.3 | $378.96 | $1,000.50 | $2,034.83 | $2,550.18 | $577 | $734 |
| 25 to <50 times the ECEL | - | - | - | - | - | - | - | - |
| 50 to <1,000 times the ECEL | - | - | - | - | - | - | - | - |
| 1,000 to < 10,000 times the ECEL | - | - | - | - | - | - | - | - |
| **All thresholds** | **1** | **14.0** | **$387.82** | **$962.96** | **$1,824.18** | **$2,871.03** | **$25,926** | **$41,157** |
| Use as Maskant for Chemical Milling | <Action Level | 3.55 | 24.9 | $821.96 | $86.03 | $240.65 | $71.82 | $8,898 | $2,090 |
| Between Action Level and ECEL | 1.42 | 9.9 | $378.96 | $519.20 | $0.00 | $481.30 | $538 | $5,521 |
| 1 to <10 times the ECEL | 23.43 | 164.0 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $325,966 | $522,484 |
| 10 to <25 times the ECEL | 12.78 | 89.5 | $378.96 | $1,000.50 | $2,034.83 | $2,550.18 | $186,879 | $240,926 |
| 25 to <50 times the ECEL | 9.23 | 64.6 | $378.96 | $1,000.50 | $2,020.42 | $2,937.90 | $134,037 | $199,053 |
| 50 to <1,000 times the ECEL | 19.17 | 134.2 | $378.96 | $1,000.50 | $1,733.57 | $2,248.09 | $239,892 | $320,851 |
| 1,000 to < 10,000 times the ECEL | 1.42 | 9.9 | $378.96 | $1,000.50 | $8,327.62 | $2,730.85 | $83,315 | $28,565 |
| **All thresholds** | **71** | **497.0** | **$401.11** | **$945.15** | **$1,913.57** | **$2,519.89** | **$979,525** | **$1,319,490** |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | <Action Level | 2.55 | 17.9 | $821.96 | $86.03 | $240.65 | $71.82 | $6,392 | $1,501 |
| Between Action Level and ECEL | 1.7 | 11.9 | $378.96 | $519.20 | $0.00 | $481.30 | $644 | $6,610 |
| 1 to <10 times the ECEL | 29.75 | 208.3 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $413,892 | $663,418 |
| 10 to <25 times the ECEL | 18.7 | 130.9 | $378.96 | $1,000.50 | $2,034.83 | $2,550.18 | $273,445 | $352,528 |
| 25 to <50 times the ECEL | 11.9 | 83.3 | $378.96 | $1,000.50 | $2,020.42 | $2,937.90 | $172,810 | $256,633 |
| 50 to <1,000 times the ECEL | 19.55 | 136.9 | $378.96 | $1,000.50 | $1,733.57 | $2,248.09 | $244,648 | $327,211 |
| 1,000 to < 10,000 times the ECEL | 0.85 | 6.0 | $378.96 | $1,000.50 | $8,327.62 | $2,730.85 | $49,871 | $17,099 |
| **All thresholds** | **85** | **595.0** | **$392.25** | **$963.44** | **$1,896.41** | **$2,593.46** | **$1,161,703** | **$1,625,001** |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | <Action Level | 9.24 | 64.7 | $821.96 | $86.03 | $240.65 | $71.82 | $23,160 | $5,440 |
| Between Action Level and ECEL | 1.96 | 13.7 | $378.96 | $519.20 | $0.00 | $481.30 | $743 | $7,621 |
| 1 to <10 times the ECEL | 2.8 | 19.6 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $38,955 | $62,439 |
| 10 to <25 times the ECEL | - | - | - | - | - | - | - | - |
| 25 to <50 times the ECEL | - | - | - | - | - | - | - | - |
| 50 to <1,000 times the ECEL | - | - | - | - | - | - | - | - |
| 1,000 to < 10,000 times the ECEL | - | - |  | - | - | - | - | - |
| **All thresholds** | **14** | **98.0** | **$671.34** | **$329.57** | **$545.50** | **$723.33** | **$62,858** | **$75,500** |
| Recycling and Disposal | <Action Level | 89.3 | 1518.1 | $821.96 | $86.03 | $240.65 | $71.82 | $438,735 | $116,705 |
| Between Action Level and ECEL | 0.94 | 16.0 | $378.96 | $519.20 | $0.00 | $481.30 | $356 | $8,179 |
| 1 to <10 times the ECEL | 3.76 | 63.9 | $378.96 | $1,000.50 | $2,469.86 | $3,724.54 | $159,298 | $241,834 |
| 10 to <25 times the ECEL | - | - | - | - | - | - | - | - |
| 25 to <50 times the ECEL | - | - | - | - | - | - | - | - |
| 50 to <1,000 times the ECEL | - | - | - | - | - | - | - | - |
| 1,000 to < 10,000 times the ECEL | - | - | - | - | - | - | - | - |
| **All thresholds** | **94** | **1,598.0** | **$799.81** | **$126.94** | $327.41 | $222.02 | $598,389 | $366,719 |
| Incorporation into Adhesive and Sealant Products | <Action Level | 0.24 | 5.0 | $821.96 | $86.03 | $240.65 | $71.82 | $1,410 | $383 |
| Between Action Level and ECEL | 0.48 | 10.1 | $378.96 | $519.20 | $0.00 | $481.30 | $182 | $5,101 |
| 1 to <10 times the ECEL | 11.04 | 231.8 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $452,410 | $716,477 |
| 10 to <25 times the ECEL | 0.24 | 5.0 | $378.96 | $1,000.50 | $2,034.83 | $2,550.18 | $10,346 | $13,093 |
| 25 to <50 times the ECEL | - | - | - | - | - | - | - | - |
| 50 to <1,000 times the ECEL | - | - | - | - | - | - | - | - |
| 1,000 to < 10,000 times the ECEL | - | - | - | - | - | - | - | - |
| **All thresholds** | **11.76** | **252.0** | **$395.73** | **$982.61** | $1,824.18 | $2,871.03 | $464,348 | $735,054 |
| Incorporation into other formulation, mixture, or reaction products (aerosol) | <Action Level | - | - | - | - | - | - | - | - |
| Between Action Level and ECEL | - | - | - | - | - | - | - | - |
| 1 to <10 times the ECEL | - | - | - | - | - | - | - | - |
| 10 to <25 times the ECEL | 1.44 | 30.2 | $378.96 | $1,000.50 | $2,034.83 | $2,550.18 | $62,079 | $78,558 |
| 25 to <50 times the ECEL | 5.04 | 105.8 | $378.96 | $1,000.50 | $2,020.42 | $2,937.90 | $215,751 | $315,990 |
| 50 to <1,000 times the ECEL | 11.52 | 241.9 | $378.96 | $1,000.50 | $1,733.57 | $2,248.09 | $423,751 | $555,384 |
| 1,000 to < 10,000 times the ECEL | - | - | - | - | - | - | - | - |
| **All thresholds** | **18** | **378.0** | **$378.96** | **$1,000.50** | $1,837.99 | $2,465.41 | $701,581 | $949,932 |
| Incorporation into other formulation, mixture, or reaction products (other) | <Action Level | 0.26 | 5.5 | $821.96 | $86.03 | $240.65 | $71.82 | $1,528 | $414 |
| Between Action Level and ECEL | 0.52 | 10.9 | $378.96 | $519.20 | $0.00 | $481.30 | $197 | $5,526 |
| 1 to <10 times the ECEL | 11.96 | 251.2 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $490,110 | $776,184 |
| 10 to <25 times the ECEL | 0.26 | 5.5 | $378.96 | $1,000.50 | $2,034.83 | $2,550.18 | $11,209 | $14,184 |
| 25 to <50 times the ECEL | - | - | - | - | - | - | - | - |
| 50 to <1,000 times the ECEL | - | - | - | - | - | - | - | - |
| 1,000 to < 10,000 times the ECEL | - | - | - | - | - | - | - | - |
| **All thresholds** | **13** | **273.0** | **$387.82** | **$962.96** | $1,824.18 | $2,871.03 | $503,044 | $796,308 |
| Laboratory Chemicals | <Action Level | - | - | - | - | - | - | - | - |
| Between Action Level and ECEL | - | - | - | - | - | - | - | - |
| 1 to <10 times the ECEL | 26 | 26.0 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $60,120 | $105,125 |
| 10 to <25 times the ECEL | - | - | - | - | - | - | - | - |
| 25 to <50 times the ECEL | - | - | - | - | - | - | - | - |
| 50 to <1,000 times the ECEL | - | - | - | - | - | - | - | - |
| 1,000 to < 10,000 times the ECEL | - | - | - | - | - | - | - | - |
| **All thresholds** | 26 | 26.0 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $60,120 | $105,125 |
| Processing Aid, except petrochemical | <Action Level | 1.22 | 15.3 | $821.96 | $86.03 | $240.65 | $71.82 | $4,673 | $1,200 |
| Between Action Level and ECEL | 0.14 | 1.8 | $378.96 | $519.20 | $0.00 | $481.30 | $53 | $915 |
| 1 to <10 times the ECEL | 0.54 | 6.8 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $13,255 | $21,079 |
| 10 to <25 times the ECEL | 0.06 | 0.8 | $378.96 | $1,000.50 | $2,034.83 | $2,550.18 | $1,549 | $1,973 |
| 25 to <50 times the ECEL | 0.02 | 0.3 | $378.96 | $1,000.50 | $2,020.42 | $2,937.90 | $513 | $754 |
| 50 to <1,000 times the ECEL | 0.02 | 0.3 | $378.96 | $1,000.50 | $1,733.57 | $2,248.09 | $441 | $582 |
| 1,000 to < 10,000 times the ECEL | - | - | - | - | - | - | - | - |
| **All thresholds** | **2** | **25.0** | **$649.19** | **$408.98** | $767.38 | $1,027.41 | $20,483 | $26,503 |
| Adhesives and Sealants | <Action Level | 452.09 | 13565.9 | $821.96 | $86.03 | $240.65 | $71.82 | $3,636,256 | $1,013,131 |
| Between Action Level and ECEL | 85.3 | 2559.6 | $378.96 | $519.20 | $0.00 | $481.30 | $32,325 | $1,276,233 |
| 1 to <10 times the ECEL | 290.02 | 8702.6 | $378.96 | $1,000.50 | $1,933.34 | $3,042.75 | $16,935,078 | $26,770,153 |
| 10 to <25 times the ECEL | 25.59 | 767.9 | $378.96 | $1,000.50 | $2,034.83 | $2,550.18 | $1,572,201 | $1,983,837 |
| 25 to <50 times the ECEL | - | - | - | - | - | - | - | - |
| 50 to <1,000 times the ECEL | - | - | - | - | - | - | - | - |
| 1,000 to < 10,000 times the ECEL | - | - | - | - | - | - | - | - |
| **All thresholds** | **853** | **25,596** | **$613.75** | **$467.70** | $845.93 | $1,197.23 | **$22,175,860** | **$31,043,354** |
| Aerosol Spray Cleaning/Degreasing | <Action Level | - | - | - | - | - | - | - | - |
| Between Action Level and ECEL | 1482.96 | 2013.7 | $378.96 | $519.20 | $0.00 | $481.30 | $561,983 | $1,739,155 |
| 1 to <10 times the ECEL | 71182.08 | 96657.6 | $378.96 | $1,000.50 | $2,685.90 | $3,868.44 | $286,588,273 | $445,131,899 |
| 10 to <25 times the ECEL | 47454.72 | 64438.4 | $378.96 | $1,000.50 | $2,787.81 | $3,227.03 | $197,625,389 | $255,423,237 |
| 25 to <50 times the ECEL | 19278.48 | 26178.1 | $378.96 | $1,000.50 | $2,710.50 | $3,629.93 | $78,261,621 | $114,312,924 |
| 50 to <1,000 times the ECEL | 8897.76 | 12082.2 | $378.96 | $1,000.50 | $2,633.72 | $3,101.20 | $35,193,073 | $46,371,606 |
| 1,000 to < 10,000 times the ECEL | - | - | - | - | - | - | - | - |
| **All thresholds** | **148296** | **201,370.0** | **$378.96** | **$995.69** | **$2,691.72** | **$3,552.28** | **$598,230,338** | **$862,978,822** |

## 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, along with self-certification and product labeling requirements under Option 1. While it is possible that users of PCE-products will switch to an alternative instead, for the purpose of estimated costs and benefits EPA assumes that energized electrical cleaners will choose to implement the required prescriptive controls under Option 1.

### APF 50 Respirator and Dermal Control PPE Costs

Table 7‑68 and Table 7‑69 present the total initial and recurring annual costs for complying with the APF 50 respirator and dermal control requirements for energized electrical cleaners, respectively. EPA assumes that 5 percent of EEC users would be using the aerosol EECs in enclosed spaces where respiratory protection would be required. Similarly, EPA assumes that 5 percent of EEC users would not be wearing the required dermal protection in the baseline.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 7‑68: Total Initial and Annual APF 50 Respirator Costs for Energized Electrical Cleaners | | | | |
| Number of Affected Workers | Per Worker Costs | | Total Costs | |
| Initial Costs | Annual Costs | Initial Costs | Annual Costs |
| 6,088 | $2,711 | $2,667 | $16,501,414 | $16,238,536 |

|  |  |  |
| --- | --- | --- |
| Table 7‑69: Total Initial and Annual Dermal Control Costs for Energized Electrical Cleaners | | |
| Number of Affected Workers | Per worker Costs (annual) | Total Annual Costs |
|
| 6,088 | $217 | $1,322,353 |

### Self-Certification Costs

EPA assumes a $143 per facility cost for self-certification, calculated as 2 hours of labor with the fully loaded certified industrial hygienist wage rate as discussed above in section 7.4. Table 7‑70 presents the total self-certification costs for EEC facilities.

|  |  |  |
| --- | --- | --- |
| Table 7‑70: Per Facility and Total Self Certification Costs for Energized Electrical Cleaners | | |
| Number of Affected Facilities | Per Facility Certification | Total Initial Costs |
| 121,759 | $142.64 | $17,367,704 |
| 1 Estimated as 2 hours of labor with the fully loaded Certified Industrial hygienist wage rate ($71.32) | | |

### Energized Electrical Cleaning Product Label Costs

Abt surveyed five blenders of aerosol spray degreasers that contain trichloroethylene on what types of costs they would incur for amending labels to add additional precautions and directions to their products. Aerosol spray degreasing products are used in consumer, commercial, and industrial sectors. Respondents reported potential costs associated with disposal of pre-existing labels and packaging, graphic design, reviewing proofs, creating electronic files used to engrave the printing plates, and changing the printing plates. None of the respondents reported any incremental recurring costs for labeling. One blender estimated minimal labor costs of $100 to $200 per label and $600 for the plate change, for total one-time costs ranging from $700 to $800 per label (2014$). This estimate was used in the Economic Analysis of Regulation of Methylene Chloride, Paint and Coating Remover under TSCA Section 6(a). Table 7‑71 presents the estimated per-product label costs, which are $989 after updating the $800 2014$ estimate to 2022$.

|  |  |  |
| --- | --- | --- |
| Table 7‑71: Total Energized Electrical Cleaning Product Label Costs (2022$) | | |
| Number of Known Affected products | Per Product Costs (Initial) | Total Initial Costs |
| 6 | $989 | $5,934 |

### Total Energized Electrical Cleaning Prescriptive Control Costs

Table 7‑72 presents the total initial and recurring energized electrical cleaning prescriptive control costs.

|  |  |  |
| --- | --- | --- |
| Table 7‑72: Total Initial and Recurring Energized Electrical Cleaning Prescriptive Control Costs | | |
| Prescriptive Control | Total Costs | |
| Initial | Annual |
| APF 50 Respirators | $16,501,414 | $16,238,536 |
| Dermal PPE | - | $1,322,353 |
| Product Labels | $5,934 | - |
| Self-certification | $17,367,704 | - |
| **Total** | **$33,875,051** | **$17,560,890** |

## 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.

### Products Formulated with PCE

The cost estimates for switching to alternatives to products formulated with PCE include reformulation costs for each product that EPA identified. If there are additional products that EPA did not identify that need to be reformulated, these costs could be underestimated. Conversely, many producers of these products already make PCE-free alternative products, since the PCE products are already prohibited in several states. Thus, the reformulation costs may be overstated to the extent to which producers replace PCE products with existing products, instead of reformulating.

As documented in Chapter 5, alternative products with similar cost and efficacy are available for most of the products currently formulated with PCE. For some applications, there may be additional unquantified costs associated with the alternatives. Regarding the costs of the products themselves, in most cases there are both more costly and less costly alternative products, but it is unclear whether average product costs would be higher or lower after a prohibition of PCE in these products.

For most product types, alternatives with similar efficacy are available. However, there may be some applications where PCE is more effective or reduces labor time and wait time, but this analysis was unable to quantify these costs. There may be some safety-critical applications, such as adhesives used in aviation, where alternatives would need to undergo extensive safety reviews and testing before the PCE adhesives could be replaced. A prohibition of PCE for *these uses* could potentially have important negative impacts regardless of the regulatory option selected.

### Energized Electrical Cleaning Aerosols

There is considerable uncertainty about the estimated costs associated with aerosol energized electrical cleaners (EEC). While stakeholders have provided information indicating that the volume of usage is small compared to aerosols overall and to brake cleaner use. EPA considered using assumptions ranging from 1 to 5 percent and decided upon 5 percent after reviewing VOC emissions final data from the 2013 - 2015 Survey of Consumer and Commercial Products: Survey Data Summary and Findings ([CARB 2019a](#_ENREF_11)). The cost estimates are sensitive to this assumption as costs for this use would increase or decrease proportionally to the assumed usage percentage. EPA also assumed that 5 percent of EEC users would be subject to the PPE requirements (i.e., users who use aerosol EECs indoors in confined spaces), which are the largest driver of compliance costs. EPA believes most usage is outdoors but does not have any information or data on the percentage of usage that would be indoors in confined spaces. It is also unknown whether users of PCE aerosol EECs in confined spaces might choose to switch to an alternative containing a flashpoint-inerted trans-DCE. As the flashpoint inertion is accomplished with fluorinated compounds (i.e., PFAS), which are facing regulatory scrutiny, and trans-DCE is undergoing risk evaluation, it is unknown whether this will even be an available option. However, were it to be available and were it to be satisfactory in terms of performance and safety, it would be much less expensive than using respiratory protection.

### WCPP Cost Estimate Uncertainties

As noted in section 7.10, the costs of WCPP compliance vary with how far above the ECEL a facility is according to the monitoring results. EPA estimated a distribution for air monitoring results, described in section 7.10, but since these data were not collected in the same way monitoring data under a 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, the options require 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.

In addition, there 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](#_ENREF_26)). 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.

### Implications of the Unquantified Costs and Uncertain Costs for Comparing the Costs of the Options

The costs of switching to alternatives to PCE are unknown for the following use categories:

* Production and use of maskants for chemical milling
* Processing aid, except in petrochemical industries

No known alternatives have been identified for the use of PCE in maskants for chemical milling, and this includes uses such as aircraft part manufacturing. The economic impacts of prohibiting this use are not known, but it could include substantial economic impacts that are not estimated under Option 2.

Similarly, no known alternatives have been identified for the use of PCE as a processing aid outside of the petrochemical industries. The economic impacts of prohibiting this use are not known but could include economic impacts that are not estimated under Option 2.

### 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 7.11.3 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.

## Total Annualized Costs

Table 7‑73 through Table 7‑75 present the total annualized costs for 2, 3 and 7 percent discount rates, respectively. Note that EPA was unable to estimate costs of prohibition for three conditions of use that have either a WCPP requirement or are prohibited across the two options: production and use of chemical maskant and as a processing aid outside the petrochemical sector. WCPP costs are used as a proxy under the options where these uses are prohibited. Since switching to alternatives is an available compliance strategy under the uses with a WCPP requirement option, it is reasonable to assume that affected entities would simply switch to alternatives if it were less costly to switch compared to the costs of compliance with a WCPP. Thus, it is possible that the WCPP compliance costs are overstated if there are instances where switching to alternatives is less costly. It follows that compliance costs under a prohibition would exceed the costs of compliance with a WCPP.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Table 7‑73:Total 20-Year Annualized Costs by Use Category by Option (2% Discount Rate) | | | | | |
| Use Category | Option 1  (Final Rule) | Option 2  (Alternative Option) | Notes | | |
| Option 1  (Final Rule) | Option 2  (Alternative Option | |
| Manufacturing | $1,995,617 | $1,995,617 | WCPP | WCPP | |
| Import/Repackage | $204,284 | $204,284 | WCPP | WCPP | |
| Reactant/Intermediate | $385,999 | $385,999 | WCPP | WCPP | |
| Processing Aid in Petrochemical Manufacturing | $1,042,387 | $1,042,387 | WCPP | WCPP | |
| Production of Maskant for Chemical Milling | $43,722 | $43,722 | WCPP | Prohibition1 | |
| Use as Maskant for Chemical Milling | $1,428,373 | $1,428,373 | WCPP | Prohibition1 | |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $11,092,618 | $25,553,406 | WCPP | Prohibition2 | |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100,105 | $4,208,796 | WCPP | Prohibition | |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $634,637 | $634,637 | Prohibition | Prohibition | |
| Recycling and Disposal | $769,425 | $769,425 | WCPP | WCPP | |
| Incorporation into Adhesive and Sealant Products | accounted for under end-use categories | | | | |
| Incorporation into other formulation, mixture, or reaction products (aerosol) |
| Incorporation into other formulation, mixture, or reaction products (other) |
| Laboratory Chemicals | $321 | $113,191 | Prescriptive Controls | WCPP | |
| Processing Aid, except petrochemical | $32,341 | $32,341 | WCPP | Prohibition | |
| Adhesives and Sealants | $165,655 | $165,655 | Prohibition3 | Prohibition | |
| Paint and Coatings | $3,908 | $3,908 | Prohibition | Prohibition | |
| Aerosol Spray Cleaning/Degreasing | $892,955 | $892,955 | Prohibition | Prohibition | |
| Aerosol Spray Cleaning/Degreasing -EEC | $20,239,509 | $20,239,509 | Prescriptive Controls | Prohibition | |
| Liquid and Spray Batch Cold Cleaning | $4,125,144 | $4,125,144 | Prohibition | Prohibition | |
| Photographic Film Use | $331 | $331 | Prohibition | Prohibition | |
| Lubricants and Greases | $102,906 | $102,906 | Prohibition | Prohibition | |
| Wipe and Liquid Cleaning and Polishing | $30,749 | $30,749 | Prohibition | Prohibition | |
| Inks and Ink Removal | $3,897 | $3,897 | Prohibition | Prohibition | |
| Anti-Spatter Welding Aerosol | $8,034 | $8,034 | Prohibit | Prohibition | |
| Mold Cleaning, Release and Protectants | $23,011 | $23,011 | Prohibit | Prohibition | |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $106,446 | $45,303 | 10-Year Phase Out | 15-Year Phase Out | |
| **Total** | **$43,432,371** | **$62,053,579** |  |  | |
| 1Since the costs of prohibition are unknown, the WCPP costs are used as a proxy estimate for the prohibition costs. Note that WCPP costs should be lower than the cost of prohibition (because switching to an alternative is a viable compliance strategy under a WCPP requirement, so if it is the more cost-effective compliance strategy then firms are likely to switch to alternatives instead of following the WCPP requirements.  2 Vapor degreasing costs are lower under Option 2 compared to Option 1 because 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  3While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | |
| Table 7‑74:Total 20-Year Annualized Costs by Use Category by Option (3% Discount Rate) | | | | | |
| Use Category | Option 1  (Final Rule) | Option 2  (Alternative Option) | Notes | | |
| Option 1  (Final Rule) | Option 2  (Alternative Option | |
| Manufacturing | $1,991,790 | $1,991,790 | WCPP | WCPP | |
| Import/Repackage | $204,090 | $204,090 | WCPP | WCPP | |
| Reactant/Intermediate | $385,361 | $385,361 | WCPP | WCPP | |
| Processing Aid in Petrochemical Manufacturing | $1,041,331 | $1,041,331 | WCPP | WCPP | |
| Production of Maskant for Chemical Milling | $43,638 | $43,638 | WCPP | Prohibition1 | |
| Use as Maskant for Chemical Milling | $1,427,061 | $1,427,061 | WCPP | Prohibition1 | |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $11,584,564 | $27,206,430 | WCPP | Prohibition2 | |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100,137 | $4,481,059 | WCPP | Prohibition | |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $688,354 | $688,354 | Prohibition | Prohibition | |
| Recycling and Disposal | $770,090 | $770,090 | WCPP | WCPP | |
| Incorporation into Adhesive and Sealant Products | accounted for under end-use categories | | | | |
| Incorporation into other formulation, mixture, or reaction products (aerosol) |
| Incorporation into other formulation, mixture, or reaction products (other) |
| Laboratory Chemicals | $350 | $113,342 | Prescriptive Controls | WCPP | |
| Processing Aid, except petrochemical | $32,309 | $32,309 | WCPP | Prohibition | |
| Adhesives and Sealants | $181,033 | $181,033 | Prohibition3 | Prohibition | |
| Paint and Coatings | $4,271 | $4,271 | Prohibition | Prohibition | |
| Aerosol Spray Cleaning/Degreasing | $975,851 | $975,851 | Prohibition | Prohibition | |
| Aerosol Spray Cleaning/Degreasing -EEC | $20,465,820 | $20,465,820 | Prescriptive Controls | Prohibition | |
| Liquid and Spray Batch Cold Cleaning | $4,474,303 | $4,474,303 | Prohibition | Prohibit | |
| Photographic Film Use | $362 | $362 | Prohibition | Prohibit | |
| Lubricants and Greases | $112,459 | $112,459 | Prohibition | Prohibit | |
| Wipe and Liquid Cleaning and Polishing | $33,603 | $33,603 | Prohibit | Prohibit | |
| Inks and Ink Removal | $4,259 | $4,259 | Prohibit | Prohibit | |
| Anti-Spatter Welding Aerosol | $8,780 | $8,780 | Prohibit | Prohibit | |
| Mold Cleaning, Release and Protectants | $25,147 | $25,147 | Prohibit | Prohibit | |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $109,327 | $43,571 | 10-Year Phase Out | 15-Year Phase Out | |
| **Total** | **$44,664,289** | **$64,714,312** |  |  | |
| 1Since the costs of prohibition are unknown, the WCPP costs are used as a proxy estimate for the prohibition costs. Note that WCPP costs should be lower than the cost of prohibition (because switching to an alternative is a viable compliance strategy under a WCPP requirement, so if it is the more cost-effective compliance strategy then firms are likely to switch to alternatives instead of following the WCPP requirements.  2 Vapor degreasing costs are lower under Option 2 compared to Option 1 because 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  3While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | |
| Table 7‑75:Total 20-Year Annualized Costs by Use Category by Option (7% Discount Rate) | | | | | |
| Use Category | Option 1  (Final Rule) | Option 2  (Alternative Option) | Notes | | |
| Option 1  (Final Rule) | | Option 2  (Alternative Option |
| Manufacturing | $1,975,145 | $1,975,145 | WCPP | | WCPP |
| Import/Repackage | $203,245 | $203,245 | WCPP | | WCPP |
| Reactant/Intermediate | $382,587 | $382,587 | WCPP | | WCPP |
| Processing Aid in Petrochemical Manufacturing | $1,036,737 | $1,036,737 | WCPP | | WCPP |
| Production of Maskant for Chemical Milling | $43,275 | $43,275 | WCPP | | Prohibition1 |
| Use as Maskant for Chemical Milling | $1,421,354 | $1,421,354 | WCPP | | Prohibition1 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $13,724,146 | $34,274,791 | WCPP | | Prohibition2 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100,278 | $5,645,260 | WCPP | | Prohibition |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $921,980 | $921,980 | Prohibition | | Prohibition |
| Recycling and Disposal | $772,985 | $772,985 | WCPP | | WCPP |
| Incorporation into Adhesive and Sealant Products | accounted for under end-use categories | | | | |
| Incorporation into other formulation, mixture, or reaction products (aerosol) |
| Incorporation into other formulation, mixture, or reaction products (other) |
| Laboratory Chemicals | $480 | $114,001 | Prescriptive Controls | | WCPP |
| Processing Aid, except petrochemical | $32,167 | $32,167 | WCPP | | Prohibition |
| Adhesives and Sealants | $247,917 | $247,917 | Prohibition3 | | Prohibition |
| Paint and Coatings | $5,849 | $5,849 | Prohibition | | Prohibition |
| Aerosol Spray Cleaning/Degreasing | $1,336,383 | $1,336,383 | Prohibition | | Prohibition |
| Aerosol Spray Cleaning/Degreasing - EEC | $21,450,092 | $21,450,092 | Prescriptive Controls | | Prohibition |
| Liquid and Spray Batch Cold Cleaning | $5,992,873 | $5,992,873 | Prohibition | | Prohibition |
| Photographic Film Use | $495 | $495 | Prohibition | | Prohibition |
| Lubricants and Greases | $154,007 | $154,007 | Prohibition | | Prohibition |
| Wipe and Liquid Cleaning and Polishing | $46,018 | $46,018 | Prohibition | | Prohibition |
| Inks and Ink Removal | $5,832 | $5,832 | Prohibition | | Prohibition |
| Anti-Spatter Welding Aerosol | $12,024 | $12,024 | Prohibition | | Prohibition |
| Mold Cleaning, Release and Protectants | $34,438 | $34,438 | Prohibition | | Prohibition |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $127,794 | $37,934 | 10-Year Phase Out | | 15-Year Phase Out |
| **Total** | **$50,028,099** | **$76,147,387** |  | |  |
| 1Since the costs of prohibition are unknown, the WCPP costs are used as a proxy estimate for the prohibition costs. Note that WCPP costs should be lower than the cost of prohibition (because switching to an alternative is a viable compliance strategy under a WCPP requirement, so if it is the more cost-effective compliance strategy then firms are likely to switch to alternatives instead of follow the WCPP requirements.  2 Vapor degreasing costs are lower under Option 2 compared to Option 1 because 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  3While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | |

# Benefits Analysis

This chapter presents the monetized benefits estimates under the options and includes a discussion of unquantified non-cancer benefits (Table 8‑1).

Table 8‑1: Overview of Benefits Considered in Benefits Analysis

|  |  |  |
| --- | --- | --- |
| **Health Endpoint** | **Benefits Considered in This Analysis** | **Section** |
| Liver cancer | Monetized benefits of avoided cancer risk. | Sections 8.2–8.7 |
| Kidney cancer |
| Brain gliomas |
| Testicular cancer |
| Neurotoxicity | Qualitative discussion of benefits. Supported by human studies. Potentially large dollar-valued benefits. | Section 8.8 |
| Nephrotoxicity | Qualitative discussion of benefits. Support from animal studies. Magnitude of potential benefits unknown. |
| Reproductive/developmental toxicity |
| Immunotoxicity |
| Hematological effects |

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. Since the benefits in each year of reduced exposure risks are estimated to be the same, annualized benefits are not sensitive to the analysis timeframe.

The options are summarized in Section 8.1. The avoided cancer benefits estimates are described in sections ‎8.2 through 8.7, following the approach outlined in Figure 8‑1.

|  |
| --- |
| Figure 8‑1: Outline of Approach for Estimating Avoided Cancer Benefits |
|  |

Section 8.8 discusses the non-cancer benefits that are not monetized in this economic analysis.

## Summary of Options Considered

Table 8‑2 summarizes the options by use category.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 8‑2: Summary of Options Considered by use Category | | | |
| Use Category | | Option 1  (Final Rule) | Option 2  (Primary Alternative) |
| Manufacturing | | **WCPP** | **WCPP** |
| Import/Repackage | |
| Reactant/Intermediate | |
| Processing Aid in Petrochemical Manufacturing | |
| Production of Maskant for Chemical Milling | | **Prohibit**, with section 6(g) exemption for chemical milling of aircraft skins and prohibition in 10 years |
| Use as Maskant for Chemical Milling | |
| Vapor Degreasing | Open Top Vapor Degreasing (OTVD) | **Prohibit**, with section 6(g) exemption for aerospace uses and prohibition in 10 years |
| Enclosed Vapor Degreasing (EVD) |
| Conveyorized Vapor Degreasing (CVD) | **Prohibit** | **Prohibit** |
| Web Vapor Degreasing (WVD) |
| Recycling and Disposal | | **WCPP** | **WCPP** |
| Incorporation into adhesive and sealant products | | **WCPP** | **Prohibit** |
| Incorporation into Other Formulation, Mixture, and Reaction Products1 | | **WCPP** | **Prohibit** (with section 6(g) exemption for cleaning and degreasing products for aerospace use and prohibition in 10 years) |
| Laboratory Chemicals | | **PC** | **WCPP** |
| Processing Aid, Except Petrochemical | | **WCPP** | **Prohibit** |
| Adhesives and Sealants | | **WCPP** (for uses not prohibited) |
| Paint and Coatings | | **Prohibit** |
| Aerosol Spray Cleaning/Degreasing | | **PC** (for uses not prohibited) |
| Liquid and Spray Batch Cold Cleaning | | **Prohibit** |
| Photographic Film Use | |
| Lubricants and Greases | |
| Wipe and Liquid Cleaning and Polishing | |
| Spot Removers2 | |
| Inks and Ink Removal | |
| Anti-Spatter Welding Aerosol | |
| Mold Cleaning, Release and Protectants | |
| Dry Cleaning Machines | | 10-Year Phaseout | 15-Year Phaseout |
| Specialty DOD Uses (oil analysis and water pipe repair) | | **Prohibit** | **Prohibit** |
| Possibly Inactive COUs/Overlapping Tasks3 | |
| 1Costs and benefits for processors that formulate products containing PCE are generally accounted for under the end use category for the product(s) they would need to reformulate under the options.  2Options 1 and 2 have 10- and 15-year phaseouts for dry cleaning machines and spot removers by establishments with PCE dry cleaning machines, respectively.  3Includes textile processing, wood furniture manufacturing, foundry applications, welding.  Note: Use of PCE by Federal agencies and contractors acting for or on behalf of Federal agencies are subject to a different compliance timeframe not captured in this analysis.  Table abbreviations: Workplace Chemical Protection Program (WCPP); Prescriptive controls with Monitoring, and Respiratory and Dermal PPE requirements (Prescriptive Controls, or PC). | | | |

## 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 PCE Exposure | | | |
| --- | --- | --- | --- |
| Use Category | Occupational Users | Occupational Non-Users (ONUs) | Total Occupational Users and ONUs |
| Manufacturing | 1,720 | 815 | 2,535 |
| Import/Repackage | 59 | 21 | 80 |
| Reactant/Intermediate | 330 | 150 | 480 |
| Processing Aid in Petrochemical Manufacturing | 806 | 346 | 1,152 |
| Production of Maskant for Chemical Milling | 14 | 61 | 75 |
| Use as Maskant for Chemical Milling | 497 | 2,130 | 2,627 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | 595 | 170 | 765 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | 98 | 28 | 126 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | 14 | 4 | 18 |
| Recycling and Disposal | 1,598 | 658 | 2,256 |
| Incorporation into Adhesive and Sealant Products | 252 | 96 | 348 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | 378 | 144 | 522 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | 273 | 104 | 377 |
| Laboratory Chemicals | 26 | 236 | 262 |
| Processing Aid, Except Petrochemical | 25 | 11 | 36 |
| Adhesives and Sealants | 25,596 | 9,385 | 34,981 |
| Paint and Coatings | 1,230 | 720 | 1,950 |
| Aerosol Spray Cleaning/Degreasing | 201,370 | 10,615 | 211,985 |
| Liquid and Spray Batch Cold Cleaning | 546 | 325 | 871 |
| Photographic Film Use | 32 | 70 | 102 |
| Lubricants and Greases | 3,054 | 407 | 3,461 |
| Wipe and Liquid Cleaning and Polishing | 2,470 | 329 | 2,799 |
| Inks and Ink Removal | 26 | 44 | 70 |
| Anti-Spatter Welding Aerosol | 300 | 40 | 340 |
| Mold Cleaning, Release and Protectants | 300 | 40 | 340 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | 18,000 | 4,500 | 22,500 |
| **Total** | **259,609** | **31,449** | **291,058** |

Table 8‑4 presents the estimated numbers of individuals with exposure reductions mapped to the categories for which exposures are estimated. Thus, the occupational users and ONUs in Table 8‑3 without exposures that could be estimated are excluded from Table 8‑4. This analysis only includes benefits estimates for workers and ONUs; benefits for consumers who would avoid exposure under the 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.

| Table 8‑4: Number of Individuals with PCE Exposure, by Exposure Type | | |
| --- | --- | --- |
| Use Category | Exposure Type | Number of Individuals Exposed |
| Manufacturing | Worker | 1,720 |
| Manufacturing | ONU | 815 |
| Import/Repackage | Worker | 59 |
| Reactant/Intermediate | Worker | 330 |
| Reactant/Intermediate | ONU | 150 |
| Processing Aid in Petrochemical Manufacturing | Worker | 806 |
| Production of Maskant for Chemical Milling | Worker | 14 |
| Use as Maskant for Chemical Milling | Worker | 497 |
| Use as Maskant for Chemical Milling | ONU | 2,130 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | 595 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | 170 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | 98 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | 28 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | 14 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | 4 |
| Recycling and Disposal | Worker | 1,598 |
| Incorporation into Adhesive and Sealant Products | Worker | 252 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | 378 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | 273 |
| Laboratory Chemicals | Worker | 26 |
| Processing Aid, Except Petrochemical | Worker | 25 |
| Adhesives and Sealants | Worker | 25,596 |
| Paint and Coatings | Worker | 1,230 |
| Aerosol Spray Cleaning/Degreasing | Worker | 201,370 |
| Aerosol Spray Cleaning/Degreasing | ONU | 10,615 |
| Liquid and Spray Batch Cold Cleaning | Worker | 546 |
| Liquid and Spray Batch Cold Cleaning | ONU | 325 |
| Photographic Film Use | Worker | 32 |
| Lubricants and Greases | Worker | 3,054 |
| Lubricants and Greases | ONU | 407 |
| Wipe and Liquid Cleaning and Polishing | Worker | 2,470 |
| Wipe and Liquid Cleaning and Polishing | ONU | 329 |
| Inks and Ink Removal | Worker | 26 |
| Anti-Spatter Welding Aerosol | Worker | 300 |
| Anti-Spatter Welding Aerosol | ONU | 40 |
| Mold Cleaning, Release and Protectants | Worker | 300 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | Worker | 18,000 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | ONU | 4,500 |
| **Total** | **-** | **279,122** |

## 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 [2020d](#_ENREF_87)). Since the central (median) LADC was calculated assuming 31 years of exposure and the high end LADC was calculated assuming 40 years of exposure in the risk evaluation, these LADC estimates were divided by 31 years (central) or 40 years (high end) to get a 50th percentile and a 95th percentile estimate for the change in the LADC from eliminating one year of exposure A percentile distribution for the change in the LADC was estimated by assuming that exposures are distributed lognormally.[[18]](#footnote-20) Consistent with the cost analysis assumptions described in section 7.10, this distribution of exposure is assumed to reflect exposure differences across facilities. Thus, costs and benefits are calculated for each estimated percentile of exposure. For example, the 25th percentile of exposure for an open-top vapor degreasing worker is 0.157 ppm. This represents the baseline exposure for 1 percent of the open top vapor degreasing workers (before adjusting for baseline PPE).[[19]](#footnote-21) Costs for this 1 percent of open-top vapor degreasing workers (and sites) reflect the compliance costs associated with this level of exposure (between 1 and <10 times the ECEL). Benefits for this 1 percent of the open-top vapor degreasing workers are estimated using the 25th percentile LADC estimate (which reflects eliminating 1 year of exposure with an 8-hour time-weighted average of 0.157 ppm).

The LADC estimates are adjusted by the percentages shown in Table 8‑5 to account for baseline PPE use. The estimated percentage of baseline PPE use by APF[[20]](#footnote-22) shown in Table 8‑5 is described in Appendix C ([Abt Associates 2022a](#_ENREF_2)). 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 percent adjustment for manufacturing is calculated as follows:

[[21]](#footnote-23)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 estimates are used for disposal and recycling. Baseline PPE use for the services sector estimates are used for aerosol spray cleaning/degreasing, photographic film use, wipe and liquid cleaning and polishing, and dry cleaning. All other use categories use the manufacturing sector estimates. | | | | | | | |

Table 8‑6 presents the mean increase in the LADC from 1 year of baseline occupational exposure, with and without the baseline PPE adjustment.

| Table 8‑6: Mean Increase in LADC from One Year of Baseline Occupational Exposure, by Use Category and Exposure Type | | | |
| --- | --- | --- | --- |
| Use Category | Exposure Type | Mean Change in LADC from 1 Year of Occupational Exposure (µg/m3) | |
| Without Accounting for Baseline PPE Use | After Accounting for Baseline PPE Use |
| Manufacturing | Worker | 0.003436 | 0.002508 |
| Manufacturing | ONU | 0.000119 | 0.000087 |
| Import/Repackage | Worker | 0.001598 | 0.001166 |
| Reactant/Intermediate | Worker | 0.003436 | 0.002508 |
| Reactant/Intermediate | ONU | 0.000119 | 0.000087 |
| Processing Aid in Petrochemical Manufacturing | Worker | 0.000905 | 0.000661 |
| Production of Maskant for Chemical Milling | Worker | 0.001361 | 0.000993 |
| Use as Maskant for Chemical Milling | Worker | 0.045201 | 0.032989 |
| Use as Maskant for Chemical Milling | ONU | 0.003378 | 0.002466 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | 0.024277 | 0.017718 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | 0.004187 | 0.003056 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | 0.000283 | 0.000206 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | 0.000197 | 0.000144 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | 0.237751 | 0.173516 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | 0.133579 | 0.097489 |
| Recycling and Disposal | Worker | 0.000080 | 0.000071 |
| Incorporation into Adhesive and Sealant Products | Worker | 0.001361 | 0.000993 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | 0.031581 | 0.023048 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | 0.001361 | 0.000993 |
| Laboratory Chemicals | Worker | 0.003478 | 0.002538 |
| Processing Aid, Except Petrochemical | Worker | 0.000905 | 0.000661 |
| Adhesives and Sealants | Worker | 0.000642 | 0.000468 |
| Paint and Coatings | Worker | 0.003496 | 0.002552 |
| Aerosol Spray Cleaning/Degreasing | Worker | 0.006911 | 0.006571 |
| Aerosol Spray Cleaning/Degreasing | ONU | 0.000547 | 0.000520 |
| Liquid and Spray Batch Cold Cleaning | Worker | 0.007981 | 0.005825 |
| Liquid and Spray Batch Cold Cleaning | ONU | 0.004151 | 0.003029 |
| Photographic Film Use | Worker | 0.044783 | 0.042578 |
| Lubricants and Greases | Worker | 0.006911 | 0.005044 |
| Lubricants and Greases | ONU | 0.000547 | 0.000399 |
| Wipe and Liquid Cleaning and Polishing | Worker | 0.387028 | 0.367974 |
| Wipe and Liquid Cleaning and Polishing | ONU | 0.000209 | 0.000198 |
| Inks and Ink Removal | Worker | 0.010889 | 0.007947 |
| Anti-Spatter Welding Aerosol | Worker | 0.006911 | 0.005044 |
| Anti-Spatter Welding Aerosol | ONU | 0.000547 | 0.000399 |
| Mold Cleaning, Release and Protectants | Worker | 0.000181 | 0.000132 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | Worker | 0.005639 | 0.005361 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | ONU | 0.000112 | 0.000107 |

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 and available APF is worn by workers and ONUs not wearing compliant PPE in the baseline. The following examples illustrate how the values in Table 8‑7 are calculated from the estimates in Table 8‑5:

* The 4.8 percent in the manufacturing sector row and the “1 to <10 times the ECEL” column is calculated as [(72%+11%+0%)/25 + 7%/50 + 8%/1,000 + 2%/10,000]/73%. Thus, the percentage of workers or ONUs using no PPE or PPE with an APF of 10 in the baseline would switch to PPE with an APF of 25.
* The 0.1 percent in the Transportation and Public Utilities sector row and the “<1,000 times the ECEL” column is calculated as [(88%+4%+0%+3%+4%)/1,000 + 2%/10,000]/89%. Thus, the percentage of workers or ONUs using no PPE or PPE with an APF of less than 1,000 in the baseline would switch to PPE with an APF of 1,000.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Table 8‑7: Exposure Under a 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 to <10,000 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: The transportation and public utilities sector estimates are used for disposal and recycling. The services sector estimates are used for aerosol spray cleaning/degreasing, photographic film use, wipe and liquid cleaning and polishing, and dry cleaning. 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 [2020d](#_ENREF_87)). The estimated percentages of workers and ONUs in each ECEL threshold category were estimated from these median and 95th percentile values by assuming a lognormal distribution 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 options, disaggregated by the ECEL threshold levels, from 1 year of *baseline* occupational exposure. Table 8‑10 presents the mean increase in the LAD C from 1 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 ECEL | 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 to <10,000 times the ECEL |
| Manufacturing | Worker | 66% | 4% | 21% | 4% | 2% | 3% | - |
| Manufacturing | ONU | 96% | 4% | - | - | - | - | - |
| Import/Repackage | Worker | - | 2% | 96% | 2% | - | - | - |
| Reactant/Intermediate | Worker | 66% | 4% | 21% | 4% | 2% | 3% | - |
| Reactant/Intermediate | ONU | 96% | 4% | - | - | - | - | - |
| Processing Aid in Petrochemical Manufacturing | Worker | 61% | 7% | 27% | 3% | 1% | 1% | - |
| Production of Maskant for Chemical Milling | Worker | 2% | 4% | 92% | 2% | - | - | - |
| Use as Maskant for Chemical Milling | Worker | 5% | 2% | 33% | 18% | 13% | 27% | 2% |
| Use as Maskant for Chemical Milling | ONU | - | - | 74% | 26% | - | - | - |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | 3% | 2% | 35% | 22% | 14% | 23% | 1% |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | 8% | 5% | 60% | 17% | 6% | 4% | - |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | 66% | 14% | 20% | - | - | - | - |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | 97% | 3% | - | - | - | - | - |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | - | - | - | - | - | 93% | 7% |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | - | - | - | - | - | 99% | 1% |
| Recycling and Disposal | Worker | 95% | 1% | 4% | - | - | - | - |
| Incorporation into Adhesive and Sealant Products | Worker | 2% | 4% | 92% | 2% | - | - | - |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | - | - | - | 8% | 28% | 64% | - |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | 2% | 4% | 92% | 2% | - | - | - |
| Laboratory Chemicals | Worker | - | - | 100% | - | - | - | - |
| Processing Aid, Except Petrochemical | Worker | 61% | 7% | 27% | 3% | 1% | 1% | - |
| Adhesives and Sealants | Worker | 53% | 10% | 34% | 3% | - | - | - |
| Paint and Coatings | Worker | 31% | 7% | 45% | 10% | 4% | 3% | - |
| Aerosol Spray Cleaning/Degreasing | Worker | - | 1% | 48% | 32% | 13% | 6% | - |
| Aerosol Spray Cleaning/Degreasing | ONU | 46% | 13% | 41% | - | - | - | - |

| 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 ECEL | 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 to <10,000 times the ECEL | Average Across All Thresholds1 |
| Median | 95th |
| Manufacturing | Worker | 0.00007 | 0.00569 | 0.00005 | 0.00025 | 0.00095 | 0.00419 | 0.00912 | 0.06392 | - | 0.0025 |
| Manufacturing | ONU | 0.00007 | 0.00020 | 0.00008 | 0.00025 | - | - | - | - | - | 0.0001 |
| Import/Repackage | Worker | 0.00098 | 0.00259 | - | 0.00027 | 0.00113 | 0.00359 | - | - | - | 0.0012 |
| Reactant/Intermediate | Worker | 0.00007 | 0.00569 | 0.00005 | 0.00025 | 0.00095 | 0.00419 | 0.00912 | 0.06392 | - | 0.0025 |
| Reactant/Intermediate | ONU | 0.00007 | 0.00020 | 0.00008 | 0.00025 | - | - | - | - | - | 0.0001 |
| Processing Aid in Petrochemical Manufacturing | Worker | 0.00013 | 0.00252 | 0.00007 | 0.00026 | 0.00089 | 0.00407 | 0.00866 | 0.01524 | - | 0.0007 |
| Production of Maskant for Chemical Milling | Worker | 0.00080 | 0.00234 | 0.00019 | 0.00027 | 0.00099 | 0.00335 | - | - | - | 0.0010 |
| Use as Maskant for Chemical Milling | Worker | 0.00478 | 0.12123 | 0.00012 | 0.00024 | 0.00134 | 0.00482 | 0.01045 | 0.06083 | 0.69431 | 0.0330 |
| Use as Maskant for Chemical Milling | ONU | 0.00223 | 0.00465 | - | - | 0.00194 | 0.00396 | - | - | - | 0.0025 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | 0.00449 | 0.06853 | 0.00015 | 0.00027 | 0.00143 | 0.00495 | 0.01070 | 0.04923 | 0.32964 | 0.0177 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | 0.00129 | 0.01118 | 0.00014 | 0.00026 | 0.00122 | 0.00454 | 0.00976 | 0.02356 | - | 0.0031 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | 0.00015 | 0.00054 | 0.00011 | 0.00025 | 0.00048 | - | - | - | - | 0.0002 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | 0.00014 | 0.00020 | 0.00014 | 0.00023 | - | - | - | - | - | 0.0001 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | 0.15854 | 0.31892 | - | - | - | - | - | 0.16057 | 0.34549 | 0.1735 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | 0.08280 | 0.21196 | - | - | - | - | - | 0.09531 | 0.31289 | 0.0975 |
| Recycling and Disposal | Worker | 0.00001 | 0.00026 | 0.00003 | 0.00032 | 0.00101 | - | - | - | - | 0.0001 |
| Incorporation into Adhesive and Sealant Products | Worker | 0.00080 | 0.00234 | 0.00019 | 0.00027 | 0.00099 | 0.00335 | - | - | - | 0.0010 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | 0.00080 | - | - | - | 0.00099 | 0.00335 | - | - | - | 0.0010 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | 0.01865 | 0.00019 | 0.00027 | 0.00027 | - | 0.00603 | 0.01137 | 0.03029 | - | 0.0230 |
| Laboratory Chemicals | Worker | 0.00254 | - | - | 0.00026 | 0.00254 | - | - | - | - | 0.0025 |
| Processing Aid, Except Petrochemical | Worker | 0.00013 | 0.00007 | 0.00026 | 0.00025 | 0.00089 | 0.00407 | 0.00866 | 0.01524 | - | 0.0007 |
| Adhesives and Sealants | Worker | 0.00019 | 0.00009 | 0.00025 | 0.00025 | 0.00079 | 0.00422 | - | - | - | 0.0005 |
| Paint and Coatings | Worker | 0.00050 | 0.00009 | 0.00025 | 0.00037 | 0.00105 | 0.00465 | 0.01118 | 0.03744 | - | 0.0026 |
| Aerosol Spray Cleaning/Degreasing | Worker | 0.00392 | - | 0.00037 | 0.00033 | 0.00207 | 0.00617 | 0.01351 | 0.03072 | - | 0.0066 |
| Aerosol Spray Cleaning/Degreasing | ONU | 0.00031 | 0.00015 | 0.00033 | 0.00025 | 0.00100 | - | - | - | - | 0.0005 |
| 1This average value is the weighted average across the seven 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 Level1 | Between Action Level and ECEL1 | 1 to <10 times the ECEL2 | 10 to <25 times the ECEL2 | 25 to <50 times the ECEL2 | 50 to <1,000 times the ECEL2 | 1,000 to <10,000 times the ECEL2 | Average Across All Thresholds3 |
| Manufacturing | Worker | 0.00005 | 0.00025 | 0.00011 | 0.00020 | 0.00023 | 0.00009 | - | 0.00008 |
| Manufacturing | ONU | 0.00008 | 0.00025 | - | - | - | - | - | 0.00009 |
| Import/Repackage | Worker | - | 0.00027 | 0.00013 | 0.00017 | - | - | - | 0.00013 |
| Reactant/Intermediate | Worker | 0.00005 | 0.00025 | 0.00011 | 0.00020 | 0.00023 | 0.00009 | - | 0.00008 |
| Reactant/Intermediate | ONU | 0.00008 | 0.00025 | - | - | - | - | - | 0.00009 |
| Processing Aid in Petrochemical Manufacturing | Worker | 0.00007 | 0.00026 | 0.00010 | 0.00019 | 0.00022 | 0.00002 | - | 0.00010 |
| Production of Maskant for Chemical Milling | Worker | 0.00019 | 0.00027 | 0.00011 | 0.00016 | - | - | - | 0.00012 |
| Use as Maskant for Chemical Milling | Worker | 0.00012 | 0.00024 | 0.00015 | 0.00023 | 0.00026 | 0.00008 | 0.00010 | 0.00016 |
| Use as Maskant for Chemical Milling | ONU | - | - | 0.00022 | 0.00019 | - | - | - | 0.00021 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | 0.00015 | 0.00027 | 0.00017 | 0.00024 | 0.00027 | 0.00007 | 0.00005 | 0.00017 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | 0.00014 | 0.00026 | 0.00014 | 0.00022 | 0.00024 | 0.00003 | - | 0.00016 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | 0.00011 | 0.00025 | 0.00005 | - | - | - | - | 0.00012 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | 0.00014 | 0.00023 | - | - | - | - | - | 0.00014 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | - | - | - | - | - | 0.00022 | 0.00005 | 0.00020 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | - | - | - | - | - | 0.00013 | 0.00004 | 0.00013 |
| Recycling and Disposal | Worker | 0.00003 | 0.00032 | 0.00011 | - | - | - | - | 0.00003 |
| Incorporation into Adhesive and Sealant Products | Worker | 0.00019 | 0.00027 | 0.00011 | 0.00016 | - | - | - | 0.00012 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | - | - | - | 0.00029 | 0.00028 | 0.00004 | - | 0.00013 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | 0.00019 | 0.00027 | 0.00011 | 0.00016 | - | - | - | 0.00012 |
| Laboratory Chemicals | Worker | - | - | 0.00029 | - | - | - | - | 0.00029 |
| Processing Aid, Except Petrochemical | Worker | 0.00007 | 0.00026 | 0.00010 | 0.00019 | 0.00022 | 0.00002 | - | 0.00010 |
| Adhesives and Sealants | Worker | 0.00009 | 0.00025 | 0.00009 | 0.00020 | - | - | - | 0.00011 |
| Paint and Coatings | Worker | 0.00009 | 0.00025 | 0.00012 | 0.00022 | 0.00028 | 0.00005 | - | 0.00013 |
| Aerosol Spray Cleaning/Degreasing | Worker | - | 0.00037 | 0.00021 | 0.00025 | 0.00028 | 0.00003 | - | 0.00023 |
| Aerosol Spray Cleaning/Degreasing | ONU | 0.00015 | 0.00033 | 0.00010 | - | - | - | - | 0.00015 |
| 1These 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.  2These values are calculated by multiplying the baseline exposure estimates in Table 8‑9 by the corresponding percentage shown in Table 8‑7.  3This average value is the weighted average across the seven thresholds. | | | | | | | | | |

| Table 8‑11: Estimated Incremental Reduction in LADC from One Year of Occupational Exposure Under WCPP, by Facility ECEL Threshold Category1 | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | <Action Level | Between Action Level and ECEL | 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 to <10,000 times the ECEL | Average Across All Thresholds |
| Manufacturing | Worker | - | - | 0.00084 | 0.00399 | 0.00890 | 0.06383 | - | 0.00243 |
| Manufacturing | ONU | - | - | - | - | - | - | - | - |
| Import/Repackage | Worker | - | - | 0.00100 | 0.00342 | - | - | - | 0.00103 |
| Reactant/Intermediate | Worker | - | - | 0.00084 | 0.00399 | 0.00890 | 0.06383 | - | 0.00243 |
| Reactant/Intermediate | ONU | - | - | - | - | - | - | - | - |
| Processing Aid in Petrochemical Manufacturing | Worker | - | - | 0.00078 | 0.00387 | 0.00845 | 0.01522 | - | 0.00056 |
| Production of Maskant for Chemical Milling | Worker | - | - | 0.00088 | 0.00319 | - | - | - | 0.00087 |
| Use as Maskant for Chemical Milling | Worker | - | - | 0.00118 | 0.00459 | 0.01019 | 0.06075 | 0.69421 | 0.03283 |
| Use as Maskant for Chemical Milling | ONU | - | - | 0.00172 | 0.00377 | - | - | - | 0.00225 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | - | - | 0.00127 | 0.00471 | 0.01044 | 0.04917 | 0.32960 | 0.01755 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | - | - | 0.00108 | 0.00432 | 0.00952 | 0.02353 | - | 0.00289 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | - | - | 0.00042 | - | - | - | - | 0.00008 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | - | - | - | - | - | - | - | - |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | - | - | - | - | - | 0.16036 | 0.34544 | 0.17331 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | - | - | - | - | - | 0.09518 | 0.31285 | 0.09736 |
| Recycling and Disposal | Worker | - | - | 0.00090 | - | - | - | - | 0.00004 |
| Incorporation into Adhesive and Sealant Products | Worker | - | - | 0.00088 | 0.00319 | - | - | - | 0.00087 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | - | - | - | 0.00574 | 0.01109 | 0.03024 | - | 0.02292 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | - | - | 0.00088 | 0.00319 | - | - | - | 0.00087 |
| Laboratory Chemicals | Worker | - | - | 0.00225 | - | - | - | - | 0.00225 |
| Processing Aid, Except Petrochemical | Worker | - | - | 0.00078 | 0.00387 | 0.00845 | 0.01522 | - | 0.00056 |
| Adhesives and Sealants | Worker | - | - | 0.00070 | 0.00402 | - | - | - | 0.00036 |
| Paint and Coatings | Worker | - | - | 0.00093 | 0.00443 | 0.01091 | 0.03739 | - | 0.00242 |
| Aerosol Spray Cleaning/Degreasing | Worker | - | - | 0.00186 | 0.00592 | 0.01323 | 0.03069 | - | 0.00634 |
| Aerosol Spray Cleaning/Degreasing | ONU | - | - | 0.00089 | - | - | - | - | 0.00037 |
| 1The estimates presented in this table are calculated as the difference between the values in Table 8‑9 and Table 8‑10. | | | | | | | | | |

## Excess Cancer Risk Estimates

The final risk evaluation calculates the inhalation unit risks as follows:

IUR = BMR/BMDL × DMCF

Where:

* IUR = inhalation unit risk (upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 µg/m³ in air)
* BMR = benchmark response level (a specified increase in incidence over background)
* BMDL = benchmark dose lower bound (a dose where the observable physical effect is less than the predetermined benchmark response)
* DMCF = dose metric conversion factor (a conversion factor used to convert an animal internal dose metric to a human equivalent internal dose metric)[[22]](#footnote-24)

Since using the inhalation unit risk is calculated using the BMDL, it is not a central estimate for excess risk. The BMD is used instead of the BMDL in order to obtain central estimates for the excess cancer risks from exposure to methylene chloride (using the BMDL, as is done for estimating an inhalation unit risk, would result in an upper bound estimate for excess cancer risk). Thus, in order to obtain central estimates for the excess cancer risk from exposure to PCE, this analysis calculates the inhalation excess cancer risk (IECR) as follows:

IECR = BMR/BMD \* DMCF

Where:

* IECR = inhalation excess cancer risk[[23]](#footnote-25) (central excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 µg/m³ in air)
* BMR = benchmark response level[[24]](#footnote-26)
* BMD = benchmark dose (a chemical dose or concentration that produces a predetermined change in the response rate of an adverse effect)
* DMCF = dose metric conversion factor

Table 8‑12 presents the excess cancer risk estimates used in this analysis and the parameters from which they are derived.

| Table 8‑12: Inhalation Excess Cancer Risk Estimates (ppm) | | | | | |
| --- | --- | --- | --- | --- | --- |
| Cancer Site | BMR | BMD1 | Slope Factor  (BMR/BMD) | DMCF2 | Inhalation Excess Cancer Risk (IECR) |
| Liver | 10% | 2.91314 | 0.0343272 | 0.0363 | 1.246E-03 |
| Kidney | 10% | 253.015 | 0.0003952 | 2.03 | 8.023E-04 |
| Brain Gliomas | 10% | 409.021 | 0.0002445 | 2.03 | 4.963E-04 |
| Testis | 10% | 30.2396 | 0.0033069 | 2.03 | 6.713E-03 |
| 1The BMDs in this table are from appendix D of the 2012 Toxicological review IRIS ([EPA 2012](#_ENREF_70)).  2The DMCF values in this table are from Table 5-18 of the 2012 Toxicological review IRIS ([EPA 2012](#_ENREF_70)). | | | | | |

## Reductions for Liver, Kidney, Brain Gliomas, and Testis Cancer Sites Per Individual Attributable to Reducing PCE Exposure Under the Options

This section presents the estimated reductions in cancer risk per individual attributable to reducing PCE exposure under the 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 WCPP (Table 8‑14), by use category, exposure type, and cancer site. Table 8‑14 only includes the use categories with a WCPP requirement under one of the options. 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. For example, the estimate for the liver microrisk reduction of 3.12 in the Manufacturing row of Table 8‑13 is calculated as 0.003458 × 1.246E-3 × 1,000,000.[[25]](#footnote-27) This 3.12 microrisk estimate means that eliminating one year of exposure would reduce the liver cancer risk for this worker by 3.12 in 1,000,000.

| Table 8‑13: Reduced Microrisk Per Exposed Individual from Eliminating One Year of Exposure, by Estimate and Cancer Site | | | | | |
| --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis |
| Manufacturing | Worker | 3.12 | 2.01 | 1.24 | 16.83 |
| Manufacturing | ONU | 0.11 | 0.07 | 0.04 | 0.58 |
| Import/Repackage | Worker | 1.45 | 0.94 | 0.58 | 7.83 |
| Reactant/Intermediate | Worker | 3.12 | 2.01 | 1.24 | 16.83 |
| Reactant/Intermediate | ONU | 0.11 | 0.07 | 0.04 | 0.58 |
| Processing Aid in Petrochemical Manufacturing | Worker | 0.82 | 0.53 | 0.33 | 4.44 |
| Production of Maskant for Chemical Milling | Worker | 1.24 | 0.80 | 0.49 | 6.67 |
| Use as Maskant for Chemical Milling | Worker | 41.11 | 26.47 | 16.37 | 221.46 |
| Use as Maskant for Chemical Milling | ONU | 3.07 | 1.98 | 1.22 | 16.55 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | 22.08 | 14.22 | 8.79 | 118.94 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | 3.81 | 2.45 | 1.52 | 20.51 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | 0.26 | 0.17 | 0.10 | 1.38 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | 0.18 | 0.12 | 0.07 | 0.96 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | 216.21 | 139.22 | 86.12 | 1,164.82 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | 121.48 | 78.22 | 48.38 | 654.45 |
| Recycling and Disposal | Worker | 0.09 | 0.06 | 0.04 | 0.48 |
| Incorporation into Adhesive and Sealant Products | Worker | 1.24 | 0.80 | 0.49 | 6.67 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Aerosol) | Worker | 28.72 | 18.49 | 11.44 | 154.73 |
| Incorporation into Other Formulation, Mixture, or Reaction Products (Other) | Worker | 1.24 | 0.80 | 0.49 | 6.67 |
| Laboratory Chemicals | Worker | 3.16 | 2.04 | 1.26 | 17.04 |
| Processing Aid, Except Petrochemical | Worker | 0.82 | 0.53 | 0.33 | 4.44 |
| Adhesives and Sealants | Worker | 0.58 | 0.38 | 0.23 | 3.14 |
| Paint and Coatings | Worker | 3.18 | 2.05 | 1.27 | 17.13 |
| Aerosol Spray Cleaning/Degreasing | Worker | 8.19 | 5.27 | 3.26 | 44.11 |
| Aerosol Spray Cleaning/Degreasing | ONU | 0.65 | 0.42 | 0.26 | 3.49 |
| Liquid and Spray Batch Cold Cleaning | Worker | 7.26 | 4.67 | 2.89 | 39.10 |
| Liquid and Spray Batch Cold Cleaning | ONU | 3.77 | 2.43 | 1.50 | 20.34 |
| Photographic Film Use | Worker | 53.06 | 34.16 | 21.13 | 285.83 |
| Lubricants and Greases | Worker | 6.28 | 4.05 | 2.50 | 33.86 |
| Lubricants and Greases | ONU | 0.50 | 0.32 | 0.20 | 2.68 |
| Wipe and Liquid Cleaning and Polishing | Worker | 458.52 | 295.23 | 182.63 | 2,470.23 |
| Wipe and Liquid Cleaning and Polishing | ONU | 0.25 | 0.16 | 0.10 | 1.33 |
| Inks and Ink Removal | Worker | 9.90 | 6.38 | 3.94 | 53.35 |
| Anti-Spatter Welding Aerosol | Worker | 6.28 | 4.05 | 2.50 | 33.86 |
| Anti-Spatter Welding Aerosol | ONU | 0.50 | 0.32 | 0.20 | 2.68 |
| Mold Cleaning, Release and Protectants | Worker | 0.16 | 0.11 | 0.07 | 0.89 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | Worker | 6.68 | 4.30 | 2.66 | 35.99 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | ONU | 0.13 | 0.09 | 0.05 | 0.72 |

| Table 8‑14: Reduced Microrisk Per Exposed Individual from One Year of Reduced Exposure Under a WCPP, by Estimate and Cancer Site | | | | | |
| --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis |
| Manufacturing | Worker | 3.03 | 1.95 | 1.21 | 16.30 |
| Manufacturing | ONU | - | - | - | - |
| Import/Repackage | Worker | 1.29 | 0.83 | 0.51 | 6.92 |
| Reactant/Intermediate | Worker | 3.03 | 1.95 | 1.21 | 16.30 |
| Reactant/Intermediate | ONU | - | - | - | - |
| Processing Aid in Petrochemical Manufacturing | Worker | 0.70 | 0.45 | 0.28 | 3.79 |
| Production of Maskant for Chemical Milling | Worker | 1.08 | 0.70 | 0.43 | 5.84 |
| Use as Maskant for Chemical Milling | Worker | 40.91 | 26.34 | 16.29 | 220.38 |
| Use as Maskant for Chemical Milling | ONU | 2.80 | 1.81 | 1.12 | 15.11 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | 21.86 | 14.08 | 8.71 | 117.78 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | 3.61 | 2.32 | 1.44 | 19.43 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | 0.10 | 0.07 | 0.04 | 0.57 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | - | - | - | - |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | 215.96 | 139.05 | 86.02 | 1163.45 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | 121.32 | 78.12 | 48.32 | 653.59 |
| Recycling and Disposal | Worker | 0.05 | 0.03 | 0.02 | 0.24 |
| Incorporation into Adhesive and Sealant Products | Worker | 1.08 | 0.70 | 0.43 | 5.84 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | 28.56 | 18.39 | 11.38 | 153.87 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | 1.08 | 0.70 | 0.43 | 5.84 |
| Laboratory Chemicals | Worker | 2.80 | 1.80 | 1.11 | 15.07 |
| Processing Aid, Except Petrochemical | Worker | 0.70 | 0.45 | 0.28 | 3.79 |
| Adhesives and Sealants | Worker | 0.45 | 0.29 | 0.18 | 2.40 |
| Paint and Coatings | Worker | 3.01 | 1.94 | 1.20 | 16.23 |
| Aerosol Spray Cleaning/Degreasing | Worker | 7.91 | 5.09 | 3.15 | 42.59 |
| Aerosol Spray Cleaning/Degreasing | ONU | 0.46 | 0.29 | 0.18 | 2.46 |

## Value of Microrisk Reductions for Liver, Kidney, and Brain Gliomas and Testis Cancer Sites

Table 8‑15 presents the low and high estimated monetized values for a cancer microrisk reduction by sector, cancer site, and discount rate. The values are estimated from willingness-to-pay values found in the literature ($0.40 for low estimate for avoiding liver and Testis cancer microrisk (unspecified cancer site) ([Bosworth, Cameron et al. (2009)](#_ENREF_7); $6.93 for the high estimate for avoiding a non-fatal liver, brain gliomas, and testis cancer microrisk ([Magat, Viscusi et al. (1996)](#_ENREF_28); $0.65 for the low estimate for avoiding a non-fatal kidney cancer microrisk ([Bosworth, Cameron et al. (2009)](#_ENREF_7); $5.35 for the low estimate for avoiding a non-fatal brain gliomas cancer microrisk ([Sloan (1998)](#_ENREF_48); and $12.98 for a mortality microrisk reduction. The value for mortality risk is estimated using EPA’s ([2014](#_ENREF_73)) recommended value for a statistical life (VSL) of $4.8 million in 1990 dollars and EPA’s ([2014](#_ENREF_73)) 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 CPI (U.S. BLS [2023a](#_ENREF_58)) and then adjusted for income growth using real GDP per capita ([U.S. Bureau of Economic Analysis 2023a](#_ENREF_55)) and an income elasticity of 0.4.[[26]](#footnote-28)

As noted in the [Abt Associates (2023)](#_ENREF_4) 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)](#_ENREF_4) report, *Estimated Values of Avoiding Cancer Risks by Cancer Site and Population*. As described in [Abt Associates (2023)](#_ENREF_4) report, the timing between exposure, diagnosis, and death (for fatal cancer) depend on the age at the time of exposure. Thus, the values presented in Table 8‑15 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 | Liver | $7.51 | $6.08 | $3.07 | $7.83 | $6.35 | $3.22 |
| Kidney | $3.61 | $2.87 | $1.37 | $3.61 | $2.87 | $1.37 |
| Brain Gliomas | $7.57 | $6.19 | $3.20 | $7.75 | $6.36 | $3.31 |
| Testis | $1.01 | $0.87 | $0.52 | $6.34 | $5.72 | $4.06 |
| Transportation and Public Utilities | Liver | $7.50 | $6.08 | $3.07 | $7.82 | $6.34 | $3.22 |
| Kidney | $3.60 | $2.87 | $1.37 | $3.60 | $2.87 | $1.37 |
| Brain Gliomas | $7.56 | $6.19 | $3.21 | $7.75 | $6.35 | $3.31 |
| Testis | $1.01 | $0.87 | $0.52 | $6.34 | $5.72 | $4.06 |
| Services | Liver | $7.34 | $5.91 | $2.96 | $7.66 | $6.17 | $3.10 |
| Kidney | $3.54 | $2.82 | $1.35 | $3.54 | $2.82 | $1.35 |
| Brain Gliomas | $7.48 | $6.11 | $3.18 | $7.67 | $6.28 | $3.29 |
| Testis | $1.04 | $0.90 | $0.56 | $6.35 | $5.74 | $4.08 |
| Source: [Abt Associates 2022b](#_ENREF_3) | | | | | | | |

## Total Benefits

Table 8‑16 through Table 8‑21 present the estimates for the total monetized cancer benefits for eliminating occupational exposure. Table 8‑22 through Table 8‑27 present the estimates for the total monetized cancer benefits for reducing occupational exposure with a WCPP. Table 8‑28 through Table 8‑30Table 8‑ present the low and high estimates for the total monetized benefits by option and use category, using 2, 3 and 7 percent discount rates respectively. These estimates are calculated by combining the number of individuals with exposure reductions from Table 8‑4, the cancer microrisk reductions from Table 8‑13 and Table 8‑14, the values for microrisk-reductions from Table 8‑15, and converting annual benefits to annualized benefits using equation 1 from section 7.2.

Figure 8‑2 walks through an example of the calculations for the steps summarized in Figure 8‑1 and described in the sections above. This example walks through the calculations used to arrive at the $89,704 estimate for the 2% 20-year annualized low benefits estimate for the manufacturing use category shown in Table 8‑28.

| Figure 8‑2: Example Explaining Calculations for the Option 1 Low 2% 20-Year Annualized Value of $89,704 for the Manufacturing Use Category in Table 8‑28 | |
| --- | --- |
| A purple hexagon with white text  Description automatically generated | **Section 8.2**  For example, there are an estimated 1,720 workers with baseline exposure in the Manufacturing Use Category (See Table 8‑3). |
| A blue hexagon with white text  Description automatically generated | **Section 8.3**  For example, the baseline exposure for a manufacturing worker is 0.002508 µg/m3 (see Table 8‑6). As shown in Table 8‑8, exposure is distributed across workers in six ECEL threshold categories: (1) <Action Level (66% of workers), (2) Between Action Level and Limit (4% of workers), (3) Between ECEL and 10 times the ECEL (21% of workers), (4) Between 10 and 25 times the ECEL (4% of workers), (5) Between 25 and 50 times the ECEL (2% of workers) and (6) Between 50 and 1,000 times the ECEL (3% of workers). As indicated in Table 8‑7, exposure under the WCPP as a percentage of baseline exposure is as follows: (1) Between ECEL and 10 times the ECEL (4.8%), (2) 10 to <25 times the ECEL (4.8%), (3) 25 to <50 times the ECEL (2.5%), (3) 50 to <1,000 times the ECEL (0.1%), (4) 1,000 to 10,000 times the ECEL (0.01%).  Given this, the post-compliance exposure under the WCPP is 0.00008 (See Table 8‑10; calculated as (0.00005\*66% + 0.00025\*4% + 0.00095\*21%\*11.5% + 0.00419\*4%\*4.8% + 0.00912\*2%\*2.5% + 0.06392\*3%\*0.1%). Thus, the incremental change in exposure is 0.00243 µg/m3 (see Table 8‑11; calculated as 0.002508 – 0.00008). |
| A green hexagon with white text  Description automatically generated | **Section 8.4**  For example, excess risk is 1.246E-03 for liver cancer, 8.023E-04 for kidney cancer, 4.963E-04 for brain gliomas, and 6.713E-03 for testis cancer as shown in Table 8‑12. |
| An orange hexagon with white text  Description automatically generated | **Section 8.5**  For example, the estimate for reduced liver cancer risk of 3.12 shown in Table 8‑14 is calculated as the product of:   * 1.246E-03 (Excess liver cancer estimate shown in Table 8‑12) * 0.00243 (the change in exposure, in µg/m3, from Table 8‑11 * 1,000,000 (to convert from risk to microrisk)   For example, the estimate for reduced kidney cancer risk of 1.95 shown in Table 8‑14 is calculated as the product of:   * 8.032E-04 (Excess lung cancer estimate shown in Table 8‑12) * 0.00243 (the change in exposure, in µg/m3, from Table 8‑11) * 1,000,000 (to convert from risk to microrisk)   The estimates for reduced brain gliomas and testis cancer risks are calculated using the same method. |
| A grey hexagon with white text  Description automatically generated | **Section 8.6**  For example, for the manufacturing use category, $7.51 is the low 2% value used for the estimate for liver cancer risk, $3.61 is the low 2% value used for the estimate for kidney cancer risk, $7.57 is the low 2% value used for the estimate for brain gliomas risk, and $1.01 is the low 2% value used for the estimate for testis cancer risk (See Table 8‑15). |
| A red and black hexagon with white text  Description automatically generated | **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 $89,704. This is calculated using equations 1 and 2 in section 7.2 and the corresponding annual value of $95,190 shown in Table 8‑22, The $95,190 includes a benefit of $39,085 for avoiding liver cancer risk, $12,088 for avoiding kidney cancer risk, $15,688 for avoiding brain gliomas cancer risk and $28,328 for avoiding testis cancer risk (also shown in Table 8‑22).  The $39,085 for avoiding liver cancer risk is calculated as the product of the following:   * 3.0265 (change in microrisk,Table 8‑14) * 1,720 (individuals affected, Table 8‑3) * $7.50836 (low 2% value of microrisk, Table 8‑15)   The $12,088 for avoiding kidney cancer risk is calculated as the product of the following:   * 1.9487 (change in microrisk, Table 8‑14) * 1,720 (individuals affected, Table 8‑3 * $3.6066 (low 2% value of microrisk, Table 8‑15)   The $15,688 for avoiding brain gliomas cancer risk and $28,328 for avoiding testis cancer risk are calculated using the same method. |

| Table 8‑16: Total Annual Cancer Benefits from Elimination of Occupational Exposure, by Cancer Site, Use Category and Exposure Type (Low Estimate, 2% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis | Total |
| Manufacturing | Worker | $40,352 | $12,480 | $16,197 | $29,246 | $98,275 |
| Manufacturing | ONU | $664 | $205 | $266 | $481 | $1,616 |
| Import/Repackage | Worker | $644 | $199 | $258 | $466 | $1,567 |
| Reactant/Intermediate | Worker | $7,742 | $2,394 | $3,107 | $5,611 | $18,855 |
| Reactant/Intermediate | ONU | $122 | $38 | $49 | $89 | $298 |
| Processing Aid in Petrochemical Manufacturing | Worker | $4,983 | $1,541 | $2,000 | $3,611 | $12,135 |
| Production of Maskant for Chemical Milling | Worker | $130 | $40 | $52 | $94 | $317 |
| Use as Maskant for Chemical Milling | Worker | $153,397 | $47,443 | $61,571 | $111,178 | $373,588 |
| Use as Maskant for Chemical Milling | ONU | $49,135 | $15,197 | $19,722 | $35,612 | $119,665 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | $98,633 | $30,506 | $39,590 | $71,487 | $240,215 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | $4,861 | $1,503 | $1,951 | $3,523 | $11,838 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | $189 | $58 | $76 | $137 | $461 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | $38 | $12 | $15 | $27 | $92 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | $22,728 | $7,029 | $9,123 | $16,472 | $55,352 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | $3,648 | $1,128 | $1,464 | $2,644 | $8,886 |
| Recycling and Disposal | Worker | $1,058 | $327 | $425 | $767 | $2,577 |
| Incorporation into Adhesive and Sealant Products | Worker | $2,342 | $724 | $940 | $1,698 | $5,704 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | $81,513 | $25,211 | $32,718 | $59,078 | $198,519 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | $2,537 | $785 | $1,018 | $1,839 | $6,180 |
| Laboratory Chemicals | Worker | $617 | $191 | $248 | $448 | $1,504 |
| Processing Aid, Except Petrochemical | Worker | $155 | $48 | $62 | $112 | $376 |
| Adhesives and Sealants | Worker | $112,153 | $34,687 | $45,016 | $81,285 | $273,141 |
| Paint and Coatings | Worker | $29,365 | $9,082 | $11,787 | $21,283 | $71,517 |
| Aerosol Spray Cleaning/Degreasing | Worker | $12,104,177 | $3,756,561 | $4,908,948 | $9,219,419 | $29,989,106 |
| Aerosol Spray Cleaning/Degreasing | ONU | $50,520 | $15,679 | $20,489 | $38,480 | $125,169 |
| Liquid and Spray Batch Cold Cleaning | Worker | $29,755 | $9,203 | $11,943 | $21,565 | $72,466 |
| Liquid and Spray Batch Cold Cleaning | ONU | $9,212 | $2,849 | $3,697 | $6,676 | $22,434 |
| Photographic Film Use | Worker | $12,748 | $3,943 | $5,117 | $9,239 | $31,046 |
| Lubricants and Greases | Worker | $144,117 | $44,573 | $57,846 | $104,452 | $350,988 |
| Lubricants and Greases | ONU | $1,521 | $470 | $610 | $1,102 | $3,704 |
| Wipe and Liquid Cleaning and Polishing | Worker | $8,314,579 | $2,580,450 | $3,372,046 | $6,332,986 | $20,600,061 |
| Wipe and Liquid Cleaning and Polishing | ONU | $597 | $185 | $242 | $455 | $1,480 |
| Inks and Ink Removal | Worker | $1,933 | $598 | $776 | $1,401 | $4,708 |
| Anti-Spatter Welding Aerosol | Worker | $14,157 | $4,378 | $5,682 | $10,261 | $34,478 |
| Anti-Spatter Welding Aerosol | ONU | $149 | $46 | $60 | $108 | $364 |
| Mold Cleaning, Release and Protectants | Worker | $371 | $115 | $149 | $269 | $905 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | Worker | $882,824 | $273,987 | $358,037 | $672,423 | $2,187,271 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | ONU | $4,390 | $1,363 | $1,781 | $3,344 | $10,878 |

| Table 8‑17: Total Annual Cancer Benefits from Elimination of Occupational Exposure, by Cancer Site, Use Category and Exposure Type (High Estimate, 2% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis | Total |
| Manufacturing | Worker | $42,078 | $12,480 | $16,597 | $183,591 | $254,746 |
| Manufacturing | ONU | $692 | $205 | $273 | $3,020 | $4,190 |
| Import/Repackage | Worker | $671 | $199 | $265 | $2,928 | $4,063 |
| Reactant/Intermediate | Worker | $8,073 | $2,394 | $3,184 | $35,224 | $48,876 |
| Reactant/Intermediate | ONU | $127 | $38 | $50 | $556 | $771 |
| Processing Aid in Petrochemical Manufacturing | Worker | $5,196 | $1,541 | $2,049 | $22,669 | $31,455 |
| Production of Maskant for Chemical Milling | Worker | $136 | $40 | $54 | $592 | $821 |
| Use as Maskant for Chemical Milling | Worker | $159,957 | $47,443 | $63,094 | $697,912 | $968,406 |
| Use as Maskant for Chemical Milling | ONU | $51,236 | $15,197 | $20,210 | $223,550 | $310,193 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | $102,851 | $30,506 | $40,569 | $448,753 | $622,679 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | $5,068 | $1,503 | $1,999 | $22,114 | $30,685 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | $197 | $58 | $78 | $860 | $1,194 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | $39 | $12 | $15 | $171 | $237 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | $23,700 | $7,029 | $9,348 | $103,405 | $143,482 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | $3,804 | $1,128 | $1,501 | $16,599 | $23,033 |
| Recycling and Disposal | Worker | $1,103 | $327 | $435 | $4,816 | $6,681 |
| Incorporation into Adhesive and Sealant Products | Worker | $2,442 | $724 | $963 | $10,656 | $14,787 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | $84,999 | $25,211 | $33,527 | $370,859 | $514,596 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | $2,646 | $785 | $1,044 | $11,544 | $16,019 |
| Laboratory Chemicals | Worker | $644 | $191 | $254 | $2,809 | $3,898 |
| Processing Aid, Except Petrochemical | Worker | $161 | $48 | $64 | $703 | $976 |
| Adhesives and Sealants | Worker | $116,949 | $34,687 | $46,130 | $510,264 | $708,030 |
| Paint and Coatings | Worker | $30,621 | $9,082 | $12,078 | $133,603 | $185,384 |
| Aerosol Spray Cleaning/Degreasing | Worker | $12,630,513 | $3,756,561 | $5,035,471 | $56,433,960 | $77,856,506 |
| Aerosol Spray Cleaning/Degreasing | ONU | $52,717 | $15,679 | $21,017 | $235,544 | $324,957 |
| Liquid and Spray Batch Cold Cleaning | Worker | $31,027 | $9,203 | $12,238 | $135,376 | $187,844 |
| Liquid and Spray Batch Cold Cleaning | ONU | $9,606 | $2,849 | $3,789 | $41,911 | $58,154 |
| Photographic Film Use | Worker | $13,293 | $3,943 | $5,243 | $57,998 | $80,476 |
| Lubricants and Greases | Worker | $150,280 | $44,573 | $59,277 | $655,692 | $909,822 |
| Lubricants and Greases | ONU | $1,586 | $470 | $625 | $6,919 | $9,600 |
| Wipe and Liquid Cleaning and Polishing | Worker | $8,676,128 | $2,580,450 | $3,458,957 | $38,765,510 | $53,481,045 |
| Wipe and Liquid Cleaning and Polishing | ONU | $623 | $185 | $248 | $2,785 | $3,842 |
| Inks and Ink Removal | Worker | $2,016 | $598 | $795 | $8,796 | $12,205 |
| Anti-Spatter Welding Aerosol | Worker | $14,762 | $4,378 | $5,823 | $64,410 | $89,374 |
| Anti-Spatter Welding Aerosol | ONU | $156 | $46 | $61 | $680 | $944 |
| Mold Cleaning, Release and Protectants | Worker | $387 | $115 | $153 | $1,690 | $2,345 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | Worker | $921,213 | $273,987 | $367,265 | $4,116,039 | $5,678,504 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | ONU | $4,581 | $1,363 | $1,826 | $20,470 | $28,240 |

| Table 8‑18: Total Annual Cancer Benefits from Elimination of Occupational Exposure, by Cancer Site, Use Category and Exposure Type (Low Estimate, 3% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis | Total |
| Manufacturing | Worker | $32,698 | $9,948 | $13,256 | $25,106 | $81,007 |
| Manufacturing | ONU | $538 | $164 | $218 | $413 | $1,332 |
| Import/Repackage | Worker | $522 | $159 | $211 | $400 | $1,292 |
| Reactant/Intermediate | Worker | $6,273 | $1,909 | $2,543 | $4,817 | $15,542 |
| Reactant/Intermediate | ONU | $99 | $30 | $40 | $76 | $245 |
| Processing Aid in Petrochemical Manufacturing | Worker | $4,037 | $1,228 | $1,637 | $3,100 | $10,003 |
| Production of Maskant for Chemical Milling | Worker | $105 | $32 | $43 | $81 | $261 |
| Use as Maskant for Chemical Milling | Worker | $124,300 | $37,815 | $50,391 | $95,438 | $307,945 |
| Use as Maskant for Chemical Milling | ONU | $39,815 | $12,113 | $16,141 | $30,570 | $98,639 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | $79,924 | $24,315 | $32,401 | $61,366 | $198,007 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | $3,939 | $1,198 | $1,597 | $3,024 | $9,758 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | $153 | $47 | $62 | $118 | $380 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | $30 | $9 | $12 | $23 | $76 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | $18,417 | $5,603 | $7,466 | $14,140 | $45,626 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | $2,956 | $899 | $1,199 | $2,270 | $7,324 |
| Recycling and Disposal | Worker | $857 | $261 | $348 | $659 | $2,124 |
| Incorporation into Adhesive and Sealant Products | Worker | $1,898 | $577 | $769 | $1,457 | $4,702 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | $66,051 | $20,094 | $26,777 | $50,714 | $163,637 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | $2,056 | $626 | $834 | $1,579 | $5,094 |
| Laboratory Chemicals | Worker | $500 | $152 | $203 | $384 | $1,240 |
| Processing Aid, Except Petrochemical | Worker | $125 | $38 | $51 | $96 | $310 |
| Adhesives and Sealants | Worker | $90,879 | $27,648 | $36,842 | $69,778 | $225,148 |
| Paint and Coatings | Worker | $23,795 | $7,239 | $9,647 | $18,270 | $58,951 |
| Aerosol Spray Cleaning/Degreasing | Worker | $9,742,082 | $2,989,240 | $4,011,574 | $7,968,171 | $24,711,068 |
| Aerosol Spray Cleaning/Degreasing | ONU | $40,662 | $12,476 | $16,744 | $33,258 | $103,139 |
| Liquid and Spray Batch Cold Cleaning | Worker | $24,111 | $7,335 | $9,775 | $18,512 | $59,733 |
| Liquid and Spray Batch Cold Cleaning | ONU | $7,464 | $2,271 | $3,026 | $5,731 | $18,493 |
| Photographic Film Use | Worker | $10,330 | $3,143 | $4,188 | $7,931 | $25,591 |
| Lubricants and Greases | Worker | $116,781 | $35,528 | $47,343 | $89,665 | $289,316 |
| Lubricants and Greases | ONU | $1,232 | $375 | $500 | $946 | $3,053 |
| Wipe and Liquid Cleaning and Polishing | Worker | $6,692,013 | $2,053,363 | $2,755,623 | $5,473,481 | $16,974,480 |
| Wipe and Liquid Cleaning and Polishing | ONU | $481 | $148 | $198 | $393 | $1,219 |
| Inks and Ink Removal | Worker | $1,567 | $477 | $635 | $1,203 | $3,881 |
| Anti-Spatter Welding Aerosol | Worker | $11,472 | $3,490 | $4,651 | $8,808 | $28,420 |
| Anti-Spatter Welding Aerosol | ONU | $121 | $37 | $49 | $93 | $300 |
| Mold Cleaning, Release and Protectants | Worker | $301 | $92 | $122 | $231 | $746 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | Worker | $710,544 | $218,022 | $292,586 | $581,163 | $1,802,314 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | ONU | $3,534 | $1,084 | $1,455 | $2,890 | $8,963 |

| Table 8‑19: Total Annual Cancer Benefits from Elimination of Occupational Exposure, by Cancer Site, Use Category and Exposure Type (High Estimate, 3% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis | Total |
| Manufacturing | Worker | $34,131 | $9,948 | $13,604 | $165,691 | $223,373 |
| Manufacturing | ONU | $561 | $164 | $224 | $2,725 | $3,674 |
| Import/Repackage | Worker | $544 | $159 | $217 | $2,643 | $3,563 |
| Reactant/Intermediate | Worker | $6,548 | $1,909 | $2,610 | $31,790 | $42,857 |
| Reactant/Intermediate | ONU | $103 | $30 | $41 | $502 | $676 |
| Processing Aid in Petrochemical Manufacturing | Worker | $4,214 | $1,228 | $1,680 | $20,459 | $27,582 |
| Production of Maskant for Chemical Milling | Worker | $110 | $32 | $44 | $534 | $720 |
| Use as Maskant for Chemical Milling | Worker | $129,748 | $37,815 | $51,715 | $629,867 | $849,145 |
| Use as Maskant for Chemical Milling | ONU | $41,560 | $12,113 | $16,565 | $201,755 | $271,992 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | $83,427 | $24,315 | $33,252 | $405,001 | $545,995 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | $4,111 | $1,198 | $1,639 | $19,958 | $26,906 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | $160 | $47 | $64 | $776 | $1,047 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | $32 | $9 | $13 | $154 | $208 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | $19,224 | $5,603 | $7,662 | $93,323 | $125,812 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | $3,086 | $899 | $1,230 | $14,981 | $20,196 |
| Recycling and Disposal | Worker | $894 | $261 | $357 | $4,346 | $5,858 |
| Incorporation into Adhesive and Sealant Products | Worker | $1,981 | $577 | $790 | $9,617 | $12,966 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | $68,946 | $20,094 | $27,480 | $334,701 | $451,222 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | $2,146 | $626 | $855 | $10,419 | $14,046 |
| Laboratory Chemicals | Worker | $522 | $152 | $208 | $2,535 | $3,418 |
| Processing Aid, Except Petrochemical | Worker | $131 | $38 | $52 | $635 | $856 |
| Adhesives and Sealants | Worker | $94,863 | $27,648 | $37,810 | $460,514 | $620,835 |
| Paint and Coatings | Worker | $24,838 | $7,239 | $9,900 | $120,577 | $162,554 |
| Aerosol Spray Cleaning/Degreasing | Worker | $10,176,114 | $2,989,240 | $4,121,404 | $50,961,233 | $68,247,992 |
| Aerosol Spray Cleaning/Degreasing | ONU | $42,473 | $12,476 | $17,202 | $212,702 | $284,853 |
| Liquid and Spray Batch Cold Cleaning | Worker | $25,168 | $7,335 | $10,031 | $122,177 | $164,711 |
| Liquid and Spray Batch Cold Cleaning | ONU | $7,792 | $2,271 | $3,106 | $37,824 | $50,992 |
| Photographic Film Use | Worker | $10,782 | $3,143 | $4,298 | $52,343 | $70,566 |
| Lubricants and Greases | Worker | $121,899 | $35,528 | $48,586 | $591,763 | $797,776 |
| Lubricants and Greases | ONU | $1,286 | $375 | $513 | $6,244 | $8,418 |
| Wipe and Liquid Cleaning and Polishing | Worker | $6,990,157 | $2,053,363 | $2,831,067 | $35,006,194 | $46,880,782 |
| Wipe and Liquid Cleaning and Polishing | ONU | $502 | $148 | $203 | $2,515 | $3,368 |
| Inks and Ink Removal | Worker | $1,635 | $477 | $652 | $7,938 | $10,702 |
| Anti-Spatter Welding Aerosol | Worker | $11,974 | $3,490 | $4,773 | $58,130 | $78,367 |
| Anti-Spatter Welding Aerosol | ONU | $126 | $37 | $50 | $614 | $827 |
| Mold Cleaning, Release and Protectants | Worker | $314 | $92 | $125 | $1,525 | $2,056 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | Worker | $742,200 | $218,022 | $300,597 | $3,716,883 | $4,977,702 |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | ONU | $3,691 | $1,084 | $1,495 | $18,485 | $24,755 |

| Table 8‑20: Total Annual Cancer Benefits from Elimination of Occupational Exposure, by Cancer Site, Use Category and Exposure Type (Low Estimate, 7% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis | Total | |
| Manufacturing | Worker | $16,503 | $4,741 | $6,860 | $15,122 | $43,227 | |
| Manufacturing | ONU | $271 | $78 | $113 | $249 | $711 | |
| Import/Repackage | Worker | $263 | $76 | $109 | $241 | $689 | |
| Reactant/Intermediate | Worker | $3,166 | $910 | $1,316 | $2,901 | $8,294 | |
| Reactant/Intermediate | ONU | $50 | $14 | $21 | $46 | $131 | |
| Processing Aid in Petrochemical Manufacturing | Worker | $2,038 | $585 | $847 | $1,867 | $5,338 | |
| Production of Maskant for Chemical Milling | Worker | $53 | $15 | $22 | $49 | $139 | |
| Use as Maskant for Chemical Milling | Worker | $62,737 | $18,024 | $26,078 | $57,486 | $164,325 | |
| Use as Maskant for Chemical Milling | ONU | $20,096 | $5,773 | $8,353 | $18,413 | $52,636 | |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | $40,340 | $11,589 | $16,768 | $36,963 | $105,660 | |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | $1,988 | $571 | $826 | $1,822 | $5,207 | |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | $77 | $22 | $32 | $71 | $203 | |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | $15 | $4 | $6 | $14 | $40 | |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | $9,295 | $2,671 | $3,864 | $8,517 | $24,347 | |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | $1,492 | $429 | $620 | $1,367 | $3,908 | |
| Recycling and Disposal | Worker | $433 | $124 | $180 | $399 | $1,137 | |
| Incorporation into Adhesive and Sealant Products | Worker | $958 | $275 | $398 | $878 | $2,509 | |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | $33,338 | $9,578 | $13,858 | $30,547 | $87,320 | |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | $1,038 | $298 | $431 | $951 | $2,718 | |
| Laboratory Chemicals | Worker | $253 | $73 | $105 | $231 | $661 | |
| Processing Aid, Except Petrochemical | Worker | $63 | $18 | $26 | $58 | $166 | |
| Adhesives and Sealants | Worker | $45,869 | $13,178 | $19,067 | $42,029 | $120,143 | |
| Paint and Coatings | Worker | $12,010 | $3,450 | $4,992 | $11,005 | $31,457 | |
| Aerosol Spray Cleaning/Degreasing | Worker | $4,872,569 | $1,437,337 | $2,088,773 | $4,932,266 | $13,330,947 | |
| Aerosol Spray Cleaning/Degreasing | ONU | $20,337 | $5,999 | $8,718 | $20,586 | $55,641 | |
| Liquid and Spray Batch Cold Cleaning | Worker | $12,169 | $3,496 | $5,059 | $11,151 | $31,875 | |
| Liquid and Spray Batch Cold Cleaning | ONU | $3,767 | $1,082 | $1,566 | $3,452 | $9,868 | |
| Photographic Film Use | Worker | $5,214 | $1,498 | $2,167 | $4,777 | $13,656 | |
| Lubricants and Greases | Worker | $58,942 | $16,934 | $24,501 | $54,008 | $154,385 | |
| Lubricants and Greases | ONU | $622 | $179 | $259 | $570 | $1,629 | |
| Wipe and Liquid Cleaning and Polishing | Worker | $3,347,056 | $987,333 | $1,434,816 | $3,388,063 | $9,157,269 | |
| Wipe and Liquid Cleaning and Polishing | ONU | $240 | $71 | $103 | $243 | $658 | |
| Inks and Ink Removal | Worker | $791 | $227 | $329 | $724 | $2,071 | |
| Anti-Spatter Welding Aerosol | Worker | $5,790 | $1,663 | $2,407 | $5,305 | $15,165 | |
| Anti-Spatter Welding Aerosol | ONU | $61 | $18 | $25 | $56 | $160 | |
| Mold Cleaning, Release and Protectants | Worker | $152 | $44 | $63 | $139 | $398 | |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | Worker | $355,383 | $104,833 | $152,346 | $359,737 | $972,299 | |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | ONU | $1,767 | $521 | $758 | $1,789 | $4,835 | |

| Table 8‑21: Total Annual Cancer Benefits from Elimination of Occupational Exposure, by Cancer Site, Use Category and Exposure Type (High Estimate, 7% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis | Total | |
| Manufacturing | Worker | $17,289 | $4,741 | $7,081 | $117,669 | $146,781 | |
| Manufacturing | ONU | $284 | $78 | $116 | $1,935 | $2,414 | |
| Import/Repackage | Worker | $276 | $76 | $113 | $1,877 | $2,341 | |
| Reactant/Intermediate | Worker | $3,317 | $910 | $1,359 | $22,576 | $28,162 | |
| Reactant/Intermediate | ONU | $52 | $14 | $21 | $356 | $444 | |
| Processing Aid in Petrochemical Manufacturing | Worker | $2,135 | $585 | $874 | $14,529 | $18,124 | |
| Production of Maskant for Chemical Milling | Worker | $56 | $15 | $23 | $379 | $473 | |
| Use as Maskant for Chemical Milling | Worker | $65,724 | $18,024 | $26,920 | $447,315 | $557,983 | |
| Use as Maskant for Chemical Milling | ONU | $21,052 | $5,773 | $8,623 | $143,281 | $178,729 | |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | $42,260 | $11,589 | $17,309 | $287,621 | $358,780 | |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | $2,083 | $571 | $853 | $14,174 | $17,680 | |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | $81 | $22 | $33 | $551 | $688 | |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | $16 | $4 | $7 | $110 | $137 | |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | $9,738 | $2,671 | $3,988 | $66,276 | $82,673 | |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | $1,563 | $429 | $640 | $10,639 | $13,271 | |
| Recycling and Disposal | Worker | $454 | $124 | $186 | $3,086 | $3,850 | |
| Incorporation into Adhesive and Sealant Products | Worker | $1,004 | $275 | $411 | $6,830 | $8,520 | |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | $34,925 | $9,578 | $14,305 | $237,696 | $296,503 | |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | $1,087 | $298 | $445 | $7,399 | $9,230 | |
| Laboratory Chemicals | Worker | $265 | $73 | $108 | $1,801 | $2,246 | |
| Processing Aid, Except Petrochemical | Worker | $66 | $18 | $27 | $451 | $562 | |
| Adhesives and Sealants | Worker | $48,053 | $13,178 | $19,682 | $327,045 | $407,958 | |
| Paint and Coatings | Worker | $12,582 | $3,450 | $5,153 | $85,631 | $106,816 | |
| Aerosol Spray Cleaning/Degreasing | Worker | $5,107,457 | $1,437,337 | $2,158,548 | $36,276,903 | $44,980,246 | |
| Aerosol Spray Cleaning/Degreasing | ONU | $21,318 | $5,999 | $9,009 | $151,413 | $187,739 | |
| Liquid and Spray Batch Cold Cleaning | Worker | $12,749 | $3,496 | $5,222 | $86,767 | $108,233 | |
| Liquid and Spray Batch Cold Cleaning | ONU | $3,947 | $1,082 | $1,617 | $26,862 | $33,508 | |
| Photographic Film Use | Worker | $5,462 | $1,498 | $2,237 | $37,173 | $46,369 | |
| Lubricants and Greases | Worker | $61,748 | $16,934 | $25,291 | $420,255 | $524,228 | |
| Lubricants and Greases | ONU | $652 | $179 | $267 | $4,434 | $5,532 | |
| Wipe and Liquid Cleaning and Polishing | Worker | $3,508,405 | $987,333 | $1,482,746 | $24,919,262 | $30,897,746 | |
| Wipe and Liquid Cleaning and Polishing | ONU | $252 | $71 | $107 | $1,790 | $2,220 | |
| Inks and Ink Removal | Worker | $828 | $227 | $339 | $5,637 | $7,032 | |
| Anti-Spatter Welding Aerosol | Worker | $6,066 | $1,663 | $2,484 | $41,282 | $51,496 | |
| Anti-Spatter Welding Aerosol | ONU | $64 | $18 | $26 | $436 | $544 | |
| Mold Cleaning, Release and Protectants | Worker | $159 | $44 | $65 | $1,083 | $1,351 | |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | Worker | $372,515 | $104,833 | $157,435 | $2,645,874 | $3,280,657 | |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | ONU | $1,853 | $521 | $783 | $13,158 | $16,315 | |

| Table 8‑22: Total Annual Cancer Benefits from WCPP, by Cancer Site, Use Category and Exposure Type (Low Estimate, 2% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis | Total |
| Manufacturing | Worker | $39,085 | $12,088 | $15,688 | $28,328 | $95,190 |
| Manufacturing | ONU | - | - | - | - | - |
| Import/Repackage | Worker | $569 | $176 | $229 | $413 | $1,387 |
| Reactant/Intermediate | Worker | $7,499 | $2,319 | $3,010 | $5,435 | $18,263 |
| Reactant/Intermediate | ONU | - | - | - | - | - |
| Processing Aid in Petrochemical Manufacturing | Worker | $4,255 | $1,316 | $1,708 | $3,084 | $10,363 |
| Production of Maskant for Chemical Milling | Worker | $114 | $35 | $46 | $83 | $278 |
| Use as Maskant for Chemical Milling | Worker | $152,649 | $47,212 | $61,270 | $110,636 | $371,767 |
| Use as Maskant for Chemical Milling | ONU | $44,853 | $13,872 | $18,003 | $32,508 | $109,236 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | $97,673 | $30,209 | $39,204 | $70,791 | $237,877 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | $4,604 | $1,424 | $1,848 | $3,337 | $11,214 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | $77 | $24 | $31 | $56 | $188 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | - | - | - | - | - |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | $22,701 | $7,021 | $9,112 | $16,453 | $55,287 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | $3,644 | $1,127 | $1,462 | $2,641 | $8,874 |
| Recycling and Disposal | Worker | $540 | $167 | $217 | $391 | $1,315 |
| Incorporation into Adhesive and Sealant Products | Worker | $2,052 | $635 | $824 | $1,487 | $4,998 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | $81,059 | $25,070 | $32,536 | $58,750 | $197,415 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | $2,223 | $688 | $892 | $1,611 | $5,414 |
| Laboratory Chemicals | Worker | $546 | $169 | $219 | $396 | $1,330 |
| Processing Aid, Except Petrochemical | Worker | $132 | $41 | $53 | $96 | $321 |
| Adhesives and Sealants | Worker | $85,572 | $26,466 | $34,347 | $62,020 | $208,405 |
| Paint and Coatings | Worker | $27,815 | $8,603 | $11,164 | $20,159 | $67,741 |
| Aerosol Spray Cleaning/Degreasing | Worker | $11,688,162 | $3,627,450 | $4,740,230 | $8,902,552 | $28,958,395 |
| Aerosol Spray Cleaning/Degreasing | ONU | $35,567 | $11,038 | $14,424 | $27,090 | $88,119 |

| Table 8‑23: Total Annual Cancer Benefits from WCPP, by Cancer Site, Use Category and Exposure Type (High Estimate, 2% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis | Total |
| Manufacturing | Worker | $40,757 | $12,088 | $16,076 | $177,828 | $246,749 |
| Manufacturing | ONU | - | - | - | - | - |
| Import/Repackage | Worker | $594 | $176 | $234 | $2,590 | $3,594 |
| Reactant/Intermediate | Worker | $7,820 | $2,319 | $3,084 | $34,118 | $47,341 |
| Reactant/Intermediate | ONU | - | - | - | - | - |
| Processing Aid in Petrochemical Manufacturing | Worker | $4,437 | $1,316 | $1,750 | $19,360 | $26,863 |
| Production of Maskant for Chemical Milling | Worker | $119 | $35 | $47 | $519 | $720 |
| Use as Maskant for Chemical Milling | Worker | $159,177 | $47,212 | $62,786 | $694,509 | $963,684 |
| Use as Maskant for Chemical Milling | ONU | $46,771 | $13,872 | $18,448 | $204,066 | $283,158 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | $101,850 | $30,209 | $40,174 | $444,386 | $616,619 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | $4,801 | $1,424 | $1,894 | $20,949 | $29,068 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | $81 | $24 | $32 | $351 | $488 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | - | - | - | - | - |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | $23,672 | $7,021 | $9,337 | $103,283 | $143,313 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | $3,799 | $1,127 | $1,499 | $16,578 | $23,003 |
| Recycling and Disposal | Worker | $563 | $167 | $222 | $2,457 | $3,409 |
| Incorporation into Adhesive and Sealant Products | Worker | $2,140 | $635 | $844 | $9,337 | $12,955 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | $84,526 | $25,070 | $33,341 | $368,797 | $511,734 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | $2,318 | $688 | $914 | $10,115 | $14,035 |
| Laboratory Chemicals | Worker | $570 | $169 | $225 | $2,485 | $3,448 |
| Processing Aid, Except Petrochemical | Worker | $138 | $41 | $54 | $600 | $833 |
| Adhesives and Sealants | Worker | $89,231 | $26,466 | $35,197 | $389,327 | $540,221 |
| Paint and Coatings | Worker | $29,004 | $8,603 | $11,441 | $126,549 | $175,597 |
| Aerosol Spray Cleaning/Degreasing | Worker | $12,196,408 | $3,627,450 | $4,862,405 | $54,494,351 | $75,180,615 |
| Aerosol Spray Cleaning/Degreasing | ONU | $37,113 | $11,038 | $14,796 | $165,824 | $228,772 |

| Table 8‑24: Total Annual Cancer Benefits from WCPP, by Cancer Site, Use Category and Exposure Type (Low Estimate, 3% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis | Total |
| Manufacturing | Worker | $31,672 | $9,635 | $12,840 | $24,318 | $78,464 |
| Manufacturing | ONU | - | - | - | - | - |
| Import/Repackage | Worker | $461 | $140 | $187 | $354 | $1,143 |
| Reactant/Intermediate | Worker | $6,077 | $1,849 | $2,463 | $4,666 | $15,054 |
| Reactant/Intermediate | ONU | - | - | - | - | - |
| Processing Aid in Petrochemical Manufacturing | Worker | $3,448 | $1,049 | $1,398 | $2,647 | $8,542 |
| Production of Maskant for Chemical Milling | Worker | $92 | $28 | $37 | $71 | $229 |
| Use as Maskant for Chemical Milling | Worker | $123,694 | $37,631 | $50,145 | $94,973 | $306,443 |
| Use as Maskant for Chemical Milling | ONU | $36,345 | $11,057 | $14,734 | $27,906 | $90,042 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | $79,146 | $24,078 | $32,086 | $60,769 | $196,080 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | $3,731 | $1,135 | $1,513 | $2,865 | $9,243 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | $63 | $19 | $25 | $48 | $155 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | - | - | - | - | - |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | $18,395 | $5,596 | $7,457 | $14,124 | $45,572 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | $2,953 | $898 | $1,197 | $2,267 | $7,315 |
| Recycling and Disposal | Worker | $437 | $133 | $177 | $336 | $1,084 |
| Incorporation into Adhesive and Sealant Products | Worker | $1,663 | $506 | $674 | $1,277 | $4,120 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | $65,684 | $19,983 | $26,628 | $50,432 | $162,727 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | $1,801 | $548 | $730 | $1,383 | $4,463 |
| Laboratory Chemicals | Worker | $443 | $135 | $179 | $340 | $1,096 |
| Processing Aid, Except Petrochemical | Worker | $107 | $33 | $43 | $82 | $265 |
| Adhesives and Sealants | Worker | $69,340 | $21,095 | $28,110 | $53,240 | $171,786 |
| Paint and Coatings | Worker | $22,539 | $6,857 | $9,137 | $17,305 | $55,838 |
| Aerosol Spray Cleaning/Degreasing | Worker | $9,407,252 | $2,886,501 | $3,873,698 | $7,694,308 | $23,861,760 |
| Aerosol Spray Cleaning/Degreasing | ONU | $28,626 | $8,784 | $11,788 | $23,413 | $72,610 |

| Table 8‑25: Total Annual Cancer Benefits from WCPP, by Cancer Site, Use Category and Exposure Type (High Estimate, 3% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis | Total |
| Manufacturing | Worker | $33,060 | $9,635 | $13,177 | $160,490 | $216,362 |
| Manufacturing | ONU | - | - | - | - | - |
| Import/Repackage | Worker | $482 | $140 | $192 | $2,338 | $3,152 |
| Reactant/Intermediate | Worker | $6,343 | $1,849 | $2,528 | $30,792 | $41,511 |
| Reactant/Intermediate | ONU | - | - | - | - | - |
| Processing Aid in Petrochemical Manufacturing | Worker | $3,599 | $1,049 | $1,435 | $17,472 | $23,555 |
| Production of Maskant for Chemical Milling | Worker | $96 | $28 | $38 | $468 | $631 |
| Use as Maskant for Chemical Milling | Worker | $129,115 | $37,631 | $51,463 | $626,795 | $845,004 |
| Use as Maskant for Chemical Milling | ONU | $37,938 | $11,057 | $15,121 | $184,170 | $248,286 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | $82,615 | $24,078 | $32,929 | $401,059 | $540,681 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | $3,895 | $1,135 | $1,552 | $18,906 | $25,488 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | $65 | $19 | $26 | $317 | $428 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | - | - | - | - | - |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | $19,201 | $5,596 | $7,653 | $93,213 | $125,664 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | $3,082 | $898 | $1,228 | $14,961 | $20,170 |
| Recycling and Disposal | Worker | $456 | $133 | $182 | $2,217 | $2,989 |
| Incorporation into Adhesive and Sealant Products | Worker | $1,736 | $506 | $692 | $8,426 | $11,360 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | $68,563 | $19,983 | $27,328 | $332,840 | $448,713 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | $1,880 | $548 | $749 | $9,128 | $12,306 |
| Laboratory Chemicals | Worker | $462 | $135 | $184 | $2,243 | $3,023 |
| Processing Aid, Except Petrochemical | Worker | $112 | $33 | $44 | $542 | $731 |
| Adhesives and Sealants | Worker | $72,379 | $21,095 | $28,849 | $351,368 | $473,692 |
| Paint and Coatings | Worker | $23,527 | $6,857 | $9,377 | $114,211 | $153,972 |
| Aerosol Spray Cleaning/Degreasing | Worker | $9,826,366 | $2,886,501 | $3,979,753 | $49,209,720 | $65,902,340 |
| Aerosol Spray Cleaning/Degreasing | ONU | $29,901 | $8,784 | $12,110 | $149,743 | $200,538 |

| Table 8‑26: Total Annual Cancer Benefits from WCPP, by Cancer Site, Use Category and Exposure Type (Low Estimate, 7% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis | Total |
| Manufacturing | Worker | $15,985 | $4,593 | $6,645 | $14,647 | $41,870 |
| Manufacturing | ONU | - | - | - | - | - |
| Import/Repackage | Worker | $233 | $67 | $97 | $213 | $610 |
| Reactant/Intermediate | Worker | $3,067 | $881 | $1,275 | $2,810 | $8,033 |
| Reactant/Intermediate | ONU | - | - | - | - | - |
| Processing Aid in Petrochemical Manufacturing | Worker | $1,740 | $500 | $723 | $1,595 | $4,558 |
| Production of Maskant for Chemical Milling | Worker | $47 | $13 | $19 | $43 | $122 |
| Use as Maskant for Chemical Milling | Worker | $62,431 | $17,936 | $25,951 | $57,205 | $163,524 |
| Use as Maskant for Chemical Milling | ONU | $18,344 | $5,270 | $7,625 | $16,809 | $48,048 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | $39,947 | $11,477 | $16,605 | $36,603 | $104,632 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | $1,883 | $541 | $783 | $1,726 | $4,932 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | $32 | $9 | $13 | $29 | $83 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | - | - | - | - | - |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | $9,284 | $2,667 | $3,859 | $8,507 | $24,318 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | $1,490 | $428 | $619 | $1,365 | $3,903 |
| Recycling and Disposal | Worker | $221 | $63 | $92 | $204 | $580 |
| Incorporation into Adhesive and Sealant Products | Worker | $839 | $241 | $349 | $769 | $2,198 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | $33,152 | $9,525 | $13,781 | $30,377 | $86,834 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | $909 | $261 | $378 | $833 | $2,382 |
| Laboratory Chemicals | Worker | $223 | $64 | $93 | $205 | $585 |
| Processing Aid, Except Petrochemical | Worker | $54 | $16 | $22 | $49 | $141 |
| Adhesives and Sealants | Worker | $34,998 | $10,055 | $14,548 | $32,068 | $91,668 |
| Paint and Coatings | Worker | $11,376 | $3,268 | $4,729 | $10,424 | $29,796 |
| Aerosol Spray Cleaning/Degreasing | Worker | $4,705,101 | $1,387,937 | $2,016,983 | $4,762,747 | $12,872,768 |
| Aerosol Spray Cleaning/Degreasing | ONU | $14,317 | $4,223 | $6,138 | $14,493 | $39,171 |

| Table 8‑27: Total Annual Cancer Benefits from WCPP, by Cancer Site, Use Category and Exposure Type (High Estimate, 7% Discount Rate, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Exposure Type | Liver | Kidney | Brain Gliomas | Testis | Total |
| Manufacturing | Worker | $16,746 | $4,593 | $6,859 | $113,976 | $142,174 |
| Manufacturing | ONU | - | - | - | - | - |
| Import/Repackage | Worker | $244 | $67 | $100 | $1,660 | $2,071 |
| Reactant/Intermediate | Worker | $3,213 | $881 | $1,316 | $21,867 | $27,278 |
| Reactant/Intermediate | ONU | - | - | - | - | - |
| Processing Aid in Petrochemical Manufacturing | Worker | $1,823 | $500 | $747 | $12,408 | $15,478 |
| Production of Maskant for Chemical Milling | Worker | $49 | $13 | $20 | $332 | $415 |
| Use as Maskant for Chemical Milling | Worker | $65,404 | $17,936 | $26,788 | $445,134 | $555,262 |
| Use as Maskant for Chemical Milling | ONU | $19,217 | $5,270 | $7,871 | $130,793 | $163,152 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | Worker | $41,849 | $11,477 | $17,141 | $284,822 | $355,288 |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | ONU | $1,973 | $541 | $808 | $13,427 | $16,749 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | Worker | $33 | $9 | $14 | $225 | $281 |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | ONU | - | - | - | - | - |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | Worker | $9,726 | $2,667 | $3,984 | $66,198 | $82,575 |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | ONU | $1,561 | $428 | $639 | $10,625 | $13,254 |
| Recycling and Disposal | Worker | $231 | $63 | $95 | $1,574 | $1,964 |
| Incorporation into Adhesive and Sealant Products | Worker | $879 | $241 | $360 | $5,984 | $7,465 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | Worker | $34,730 | $9,525 | $14,225 | $236,374 | $294,854 |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | Worker | $953 | $261 | $390 | $6,483 | $8,087 |
| Laboratory Chemicals | Worker | $234 | $64 | $96 | $1,593 | $1,987 |
| Processing Aid, Except Petrochemical | Worker | $57 | $16 | $23 | $385 | $480 |
| Adhesives and Sealants | Worker | $36,664 | $10,055 | $15,017 | $249,533 | $311,268 |
| Paint and Coatings | Worker | $11,917 | $3,268 | $4,881 | $81,110 | $101,177 |
| Aerosol Spray Cleaning/Degreasing | Worker | $4,931,916 | $1,387,937 | $2,084,360 | $35,030,083 | $43,434,296 |
| Aerosol Spray Cleaning/Degreasing | ONU | $15,008 | $4,223 | $6,343 | $106,595 | $132,169 |

| Table 8‑28: Total 20-Year Annualized Benefits by Use Category and Option (2 Percent Discount Rate) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Low Estimate | | High Estimate | | Notes | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $89,704 | $89,704 | $232,529 | $232,529 | WCPP | WCPP |
| Import/Repackage | $1,307 | $1,307 | $3,387 | $3,387 | WCPP | WCPP |
| Reactant/Intermediate | $17,211 | $17,211 | $44,613 | $44,613 | WCPP | WCPP |
| Processing Aid in Petrochemical Manufacturing | $9,766 | $9,766 | $25,315 | $25,315 | WCPP | WCPP |
| Production of Maskant for Chemical Milling | $262 | $262 | $678 | $678 | WCPP | WCPP |
| Use as Maskant for Chemical Milling | $453,281 | $453,281 | $1,174,983 | $1,174,983 | WCPP | WCPP |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD)1 | $234,735 | $139,663 | $608,475 | $362,032 | WCPP | Prohibition |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD)1 | $177 | $306 | $459 | $793 | WCPP | Prohibition |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD)1 | $60,535 | $60,535 | $156,918 | $156,918 | Prohibition | Prohibition |
| Recycling and Disposal | $1,239 | $1,239 | $3,213 | $3,213 | WCPP | WCPP |
| Incorporation into Adhesive and Sealant Products2 | $5,376 | $5,376 | $13,934 | $13,934 | Prohibition2 | Prohibition |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | $186,838 | $187,078 | $484,316 | $484,938 | Prohibition except WCPP for EEC | Prohibition |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | $5,824 | $5,824 | $15,096 | $15,096 | Prohibition | Prohibition |
| Laboratory Chemicals | $0 | $1,253 | $0 | $3,249 | Prescriptive Controls | WCPP |
| Processing Aid, Except Petrochemical | $303 | $355 | $785 | $919 | WCPP | Prohibition |
| Adhesives and Sealants2 | $257,400 | $257,400 | $667,225 | $667,225 | Prohibition | Prohibition |
| Paint and Coatings | $67,395 | $67,395 | $174,700 | $174,700 | Prohibition | Prohibition |
| Aerosol Spray Cleaning/Degreasing except EEC | $11,290,762 | $11,290,762 | $29,312,620 | $29,312,620 | Prohibition | Prohibition |
| Aerosol Spray Cleaning/Degreasing - EEC | $10,735 | $10,954 | $27,869 | $28,438 | Prescriptive Controls | Prohibition |
| Liquid and Spray Batch Cold Cleaning | $89,431 | $89,431 | $231,821 | $231,821 | Prohibition | Prohibition |
| Photographic Film Use | $29,257 | $29,257 | $75,838 | $75,838 | Prohibition | Prohibition |
| Lubricants and Greases | $334,250 | $334,250 | $866,434 | $866,434 | Prohibition | Prohibition |
| Wipe and Liquid Cleaning and Polishing | $19,414,230 | $19,414,230 | $50,402,439 | $50,402,439 | Prohibition | Prohibition |
| Inks and Ink Removal | $4,437 | $4,437 | $11,501 | $11,501 | Prohibition | Prohibition |
| Anti-Spatter Welding Aerosol | $32,834 | $32,834 | $85,112 | $85,112 | Prohibition | Prohibition |
| Mold Cleaning, Release and Protectants | $853 | $853 | $2,210 | $2,210 | Prohibition | Prohibition |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $988 | $319 | $2,565 | $827 | 10-Year Phase Out | 15-Year Phase Out |
| **Total** | **$32,599,129** | **$32,505,280** | **$84,625,036** | **$84,381,764** |  |  |
| 1 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  2While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | | |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Table 8‑29: Total 20-Year Annualized Benefits by Use Category and Option (3 Percent Discount Rate) | | | | | | | |
| Use Category | Low Estimate | | High Estimate | | Notes | | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 | |
| Manufacturing | $73,522 | $73,522 | $202,735 | $202,735 | WCPP | WCPP | |
| Import/Repackage | $1,071 | $1,071 | $2,953 | $2,953 | WCPP | WCPP | |
| Reactant/Intermediate | $14,106 | $14,106 | $38,897 | $38,897 | WCPP | WCPP | |
| Processing Aid in Petrochemical Manufacturing | $8,004 | $8,004 | $22,071 | $22,071 | WCPP | WCPP | |
| Production of Maskant for Chemical Milling | $214 | $214 | $591 | $591 | WCPP | WCPP | |
| Use as Maskant for Chemical Milling | $371,514 | $371,514 | $1,024,432 | $1,024,432 | WCPP | WCPP | |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD)1 | $192,391 | $110,963 | $530,511 | $305,974 | WCPP | Prohibition | |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD)1 | $145 | $243 | $401 | $670 | WCPP | Prohibition | |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD)1 | $49,615 | $49,615 | $136,812 | $136,812 | Prohibition | Prohibition | |
| Recycling and Disposal | $1,016 | $1,016 | $2,800 | $2,800 | WCPP | WCPP | |
| Incorporation into Adhesive and Sealant Products2 | $4,406 | $4,406 | $12,149 | $12,149 | Prohibition2 | Prohibition | |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Aerosol) | $153,134 | $153,331 | $422,260 | $422,803 | Prohibition except WCPP for EEC | Prohibition | |
| Incorporation into Other Formulation, Mixture, and Reaction Products (Other) | $4,773 | $4,773 | $13,161 | $13,161 | Prohibition | Prohibition | |
| Laboratory Chemicals | $0 | $1,027 | $0 | $2,833 | Prescriptive Controls | WCPP | |
| Processing Aid, Except Petrochemical | $248 | $291 | $685 | $802 | WCPP | Prohibition | |
| Adhesives and Sealants3 | $210,967 | $210,967 | $581,733 | $581,733 | Prohibition | Prohibition | |
| Paint and Coatings | $55,238 | $55,238 | $152,316 | $152,316 | Prohibition | Prohibition | |
| Aerosol Spray Cleaning/Degreasing except EEC | $9,250,784 | $9,250,784 | $25,549,178 | $25,549,178 | Prohibition | Prohibition | |
| Aerosol Spray Cleaning/Degreasing - EEC | $8,795 | $8,975 | $24,291 | $24,787 | Prescriptive Controls | Prohibition | |
| Liquid and Spray Batch Cold Cleaning | $73,299 | $73,299 | $202,118 | $202,118 | Prohibition | Prohibition | |
| Photographic Film Use | $23,979 | $23,979 | $66,121 | $66,121 | Prohibition | Prohibition | |
| Lubricants and Greases | $273,955 | $273,955 | $755,418 | $755,418 | Prohibition | Prohibition | |
| Wipe and Liquid Cleaning and Polishing | $15,906,531 | $15,906,531 | $43,931,278 | $43,931,278 | Prohibition | Prohibition | |
| Inks and Ink Removal | $3,637 | $3,637 | $10,028 | $10,028 | Prohibition | Prohibition | |
| Anti-Spatter Welding Aerosol | $26,911 | $26,911 | $74,206 | $74,206 | Prohibition | Prohibition | |
| Mold Cleaning, Release and Protectants | $699 | $699 | $1,927 | $1,927 | Prohibition | Prohibition | |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $775 | $242 | $2,139 | $669 | 10-Year Phase Out | 15-Year Phase Out | |
| **Total** | **$26,709,730** | **$26,629,312** | **$73,761,211** | **$73,539,462** |  |  | |
| 1 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  2While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | | | |
| Table 8‑30: Total 20-Year Annualized Benefits by Use Category and Option (7 Percent Discount Rate) | | | | | | |
| Use Category | Low Estimate | | High Estimate | | Notes | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $38,259 | $38,259 | $129,911 | $129,911 | WCPP | WCPP |
| Import/Repackage | $557 | $557 | $1,892 | $1,892 | WCPP | WCPP |
| Reactant/Intermediate | $7,340 | $7,340 | $24,925 | $24,925 | WCPP | WCPP |
| Processing Aid in Petrochemical Manufacturing | $4,165 | $4,165 | $14,143 | $14,143 | WCPP | WCPP |
| Production of Maskant for Chemical Milling | $112 | $112 | $379 | $379 | WCPP | WCPP |
| Use as Maskant for Chemical Milling | $193,324 | $193,324 | $656,450 | $656,450 | WCPP | WCPP |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD)1 | $100,114 | $50,933 | $339,948 | $172,947 | WCPP | Prohibition |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD)1 | $76 | $112 | $257 | $379 | WCPP | Prohibition |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD)1 | $25,818 | $25,818 | $87,669 | $87,669 | Prohibition | Prohibition |
| Recycling and Disposal | $530 | $530 | $1,795 | $1,795 | WCPP | WCPP |
| Incorporation into Adhesive and Sealant Products2 | $2,293 | $2,293 | $7,785 | $7,785 | Prohibition2 | Prohibition |
| Incorp. into Formulation, Mixture, and Reaction Products (Aerosol) | $79,686 | $79,788 | $270,582 | $270,930 | Prohibition except WCPP for EEC | Prohibition |
| Incorp. into Formulation, Mixture, and Reaction Products (Other) | $2,484 | $2,484 | $8,434 | $8,434 | Prohibition | Prohibition |
| Laboratory Chemicals | $0 | $535 | $0 | $1,815 | Prescriptive Controls | WCPP |
| Processing Aid, Except Petrochemical | $129 | $151 | $439 | $514 | WCPP | Prohibition |
| Adhesives and Sealants3 | $109,781 | $109,781 | $372,771 | $372,771 | Prohibition | Prohibition |
| Paint and Coatings | $28,744 | $28,744 | $97,603 | $97,603 | Prohibition | Prohibition |
| Aerosol Spray Cleaning/Degreasing except EEC | $4,866,615 | $4,866,615 | $16,420,554 | $16,420,554 | Prohibition | Prohibition |
| Aerosol Spray Cleaning/Degreasing - EEC | $4,627 | $4,721 | $15,612 | $15,931 | Prescriptive Controls | Prohibition |
| Liquid and Spray Batch Cold Cleaning | $38,142 | $38,142 | $129,516 | $129,516 | Prohibition | Prohibition |
| Photographic Film Use | $12,478 | $12,478 | $42,370 | $42,370 | Prohibition | Prohibition |
| Lubricants and Greases | $142,557 | $142,557 | $484,067 | $484,067 | Prohibition | Prohibition |
| Wipe and Liquid Cleaning and Polishing | $8,368,043 | $8,368,043 | $28,234,800 | $28,234,800 | Prohibition | Prohibition |
| Inks and Ink Removal | $1,892 | $1,892 | $6,426 | $6,426 | Prohibition | Prohibition |
| Anti-Spatter Welding Aerosol | $14,004 | $14,004 | $47,551 | $47,551 | Prohibition | Prohibition |
| Mold Cleaning, Release and Protectants | $364 | $364 | $1,235 | $1,235 | Prohibition | Prohibition |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $335 | $92 | $1,130 | $312 | 10-Year Phase Out | 15-Year Phase Out |
| **Total** | **$14,042,468** | **$13,993,833** | **$47,398,242** | **$47,233,101** |  |  |
| 1 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  2While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | | |

## Qualitative Discussion of the Benefits of Non-Cancer Risk Reductions

While the benefits analysis can only quantify and monetize reduced risk of cancer, the exposure values described in section 8.3 would also result in reduced non-cancer effects. The risk assessment approach used in the risk evaluation identifies unreasonable risk and provides information needed to establish a protective level of exposures. However, the approach does not provide the continuous dose-response functions needed to estimate the reduced incidence of many non-cancer effects that would result from the rule. Without estimates of reduced incidence it is not possible to express these benefits in quantitative or monetary terms. Therefore, while non-cancer benefits are expected from the rule, these effects cannot be included in net benefit calculations.

The 2020 Risk Evaluation for PCE evaluated the scientific literature and identified several types of non-cancer health effects associated with PCE exposure (EPA 2020h). This includes neurotoxicity, kidney toxicity, reproductive and developmental toxicity, immunotoxicity, and hematological (or blood-related effects.) Specific health endpoints for each of these types of effects were chosen for modeling in order to evaluate unreasonable risk, but that modeling did not include the full range of health endpoints identified in the risk evaluation. The descriptions here draw upon the 2020 Risk Evaluation for PCE (EPA 2020h).

Neurotoxic effects of PCE identified in human studies include visual deficits and impaired cognition. These could include significant effects to fenceline populations. Prenatal and early childhood exposure to PCE in drinking water were associated with more use or more than one major illicit drug, early and heavy smoking, and frequent or heavy drinking. The risk evaluation concluded that neurotoxicity following PCE exposure is supported by both clinical and mechanistic findings in animals (EPA 2020h). Reductions in exposure to PCE would be expected to reduce the incidence of neurotoxic health effects and therefore may be associated with important, but currently unmonetized, benefits to fenceline populations.

Based on effects seen in multiple studies in both animals and humans, the risk evaluation concluded that PCE also has toxic effects on the kidney (nephrotoxicity) and modeled urinary biomarkers for nephrotoxicity. Impaired kidney function can have a major impact on healthy functioning, and kidney failure requires costly dialysis or a kidney transplant. Though unquantified, reductions in exposure to PCE could provide benefits through reduced risk of these outcomes.

The risk evaluation also found support for reproductive and developmental toxicity following PCE exposure. Conclusions on reproductive toxicity are based on evidence of both male and female reproductive effects in animals and associations between exposure and female reproductive effects in humans. Developmental toxicity was indicated by both human and animal studies. Specific endpoints modeled in the risk evaluation to assess unreasonable risk are decreased fetal/placental weight, developmental neurotoxicity, and skeletal effects. Reductions in exposure to PCE could provide benefits through reduced risk of these adverse outcomes.

The risk evaluation also found that evidence suggests PCE exposure may lead to immunotoxicity (including autoimmune diseases like Sjogren’s), and to hematological endpoints such as decreased red blood cells and hemoglobin levels. Again, the potential benefit of reducing these types of effects through reduced PCE exposure cannot be included quantitatively in the benefits analysis.

# Comparison of Costs and Benefits and Monetized Net Benefits

This chapter presents estimates for the quantified net benefits of the options. Quantified net benefits are estimated by subtracting the total annualized quantified cost of the options (see Chapter 7) from the total annualized quantified benefits (see Chapter 8). Total quantified costs reflect costs of compliance with the options, including requirements for prohibition, and compliance with a workplace chemical protection plan (WCPP) for those uses where costs could be estimated. Total quantified benefits reflect the benefits of reduced risks for 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. Note under Option 2, there is a section 6(g) exemption for vapor degreasing that ends in year 10 under Option 2, driving the high Option 2 cost observed in that year.

Table 9‑2 through Table 9‑7 present the net benefits by use category estimated using 2, 3, and 7 percent discounts rate using the low and high benefits estimates. Note that costs and benefits for formulators of PCE-containing products are accounted for under the end-use categories. Table 9‑8 summarizes the six net benefits estimates that were estimated.

Note that the costs of prohibition are not fully quantified for some uses, so they are estimated using the costs under a WCPP as a proxy for the prohibition costs. Since switching to alternatives is an available compliance strategy under the uses with a WCPP requirement option, it is reasonable to assume that affected entities would simply switch to alternatives if it were less costly to switch compared to the costs of compliance with a WCPP. Thus, it is possible that the WCPP compliance costs are overstated if there are instances where switching to alternatives is less costly. It follows that compliance costs under a prohibition would exceed the costs of compliance with a WCPP.

Section 7.14 in Chapter 7 provides additional discussion of unquantified costs that affect the options. Similarly, Chapter 8 notes that there are also unquantified benefits. Unquantified benefits are mostly subclinical but may include possibly monetizable benefits like reduction in drug and alcohol use for those exposed in utero or in early childhood. 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 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 proposed regulatory action is to prevent cancer cases resulting from exposure to PCE. The final option costs $3.1 million per potential cancer case avoided while the alternative option  
costs $4.4 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), indicating that the final rule option is more cost effective compared to the alternative option.

| 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 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| 0 | $260 | $537 |  |  |  |  | ($260) | ($537) | ($260) | ($537) |
| 1 | $30 | $26 | $35 | $34 | $90 | $89 | $5 | $8 | $60 | $63 |
| 2 | $30 | $26 | $35 | $34 | $90 | $89 | $5 | $8 | $60 | $63 |
| 3 | $30 | $26 | $35 | $34 | $90 | $89 | $5 | $8 | $60 | $63 |
| 4 | $30 | $26 | $35 | $34 | $90 | $89 | $5 | $8 | $60 | $63 |
| 5 | $30 | $26 | $35 | $34 | $90 | $89 | $5 | $8 | $60 | $63 |
| 6 | $30 | $26 | $35 | $34 | $90 | $89 | $5 | $8 | $60 | $63 |
| 7 | $30 | $26 | $35 | $34 | $90 | $89 | $5 | $8 | $60 | $63 |
| 8 | $30 | $26 | $35 | $34 | $90 | $89 | $5 | $8 | $60 | $63 |
| 9 | $30 | $26 | $35 | $34 | $90 | $89 | $5 | $8 | $60 | $63 |
| 10 | $31 | $151 | $35 | $34 | $90 | $89 | $4 | ($117) | $59 | ($62) |
| 11 | $30 | $27 | $35 | $35 | $90 | $90 | $4 | $8 | $60 | $63 |
| 12 | $30 | $27 | $35 | $35 | $90 | $90 | $4 | $8 | $60 | $63 |
| 13 | $30 | $27 | $35 | $35 | $90 | $90 | $4 | $8 | $60 | $63 |
| 14 | $30 | $27 | $35 | $35 | $90 | $90 | $4 | $8 | $60 | $63 |
| 15 | $30 | $28 | $35 | $35 | $90 | $90 | $4 | $7 | $60 | $62 |
| 16 | $30 | $27 | $35 | $35 | $90 | $90 | $4 | $7 | $59 | $63 |
| 17 | $30 | $27 | $35 | $35 | $90 | $90 | $4 | $7 | $59 | $63 |
| 18 | $30 | $27 | $35 | $35 | $90 | $90 | $4 | $7 | $59 | $63 |
| 19 | $30 | $27 | $35 | $35 | $90 | $90 | $4 | $7 | $60 | $63 |
| 20 | $30 | $27 | $35 | $35 | $90 | $90 | $4 | $7 | $60 | $63 |

| Table 9‑2: Total 20-Year Annualized Net Benefits by Use Category and Option (Low Benefits Estimate, 2 Percent Discount Rate, 2022$, $1,000s) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $1,996 | $1,996 | $90 | $90 | ($1,906) | ($1,906) |
| Import/Repackage | $204 | $204 | $1 | $1 | ($203) | ($203) |
| Reactant/Intermediate | $386 | $386 | $17 | $17 | ($369) | ($369) |
| Processing Aid in Petrochemical Manufacturing | $1,042 | $1,042 | $10 | $10 | ($1,033) | ($1,033) |
| Production of Maskant for chemical milling | $44 | $44 | $0 | $0 | ($43) | ($43) |
| Use as Maskant for Chemical Milling | $1,428 | $1,428 | $453 | $453 | ($975) | ($975) |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $11,093 | $25,553 | $235 | $140 | ($10,858) | ($25,414) |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100 | $4,209 | $0 | $0 | ($100) | ($4,208) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $635 | $635 | $61 | $61 | ($574) | ($574) |
| Recycling and Disposal | $769 | $769 | $1 | $1 | ($768) | ($768) |
| Laboratory Chemicals | $0 | $113 | $0 | $1 | ($0) | ($112) |
| Processing Aid, except petrochemical | $32 | $32 | $0 | $0 | ($32) | ($32) |
| Adhesives and Sealants | $166 | $166 | $263 | $263 | $97 | $97 |
| Paint and Coatings | $4 | $4 | $68 | $68 | $64 | $64 |
| Aerosol Spray Cleaning/Degreasing except EEC | $893 | $893 | $11,435 | $11,435 | $10,542 | $10,542 |
| Aerosol Spray Cleaning/Degreasing - EEC | $20,240 | $20,240 | $54 | $54 | ($20,186) | ($20,186) |
| Liquid and Spray Batch Cold Cleaning | $4,125 | $4,125 | $89 | $89 | ($4,036) | ($4,036) |
| Photographic Film Use | $0 | $0 | $29 | $29 | $29 | $29 |
| Lubricants and Greases | $103 | $103 | $338 | $338 | $235 | $235 |
| Wipe and Liquid Cleaning and Polishing | $31 | $31 | $19,415 | $19,415 | $19,384 | $19,384 |
| Inks and Ink Removal | $4 | $4 | $5 | $5 | $1 | $1 |
| Anti-Spatter Welding Aerosol | $8 | $8 | $33 | $33 | $25 | $25 |
| Mold Cleaning, Release and Protectants | $23 | $23 | $2 | $2 | ($21) | ($21) |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $106 | $45 | $1 | $1 | ($105) | ($45) |
| **Total** | **$43,432** | **$62,054** | **$32,599** | **$32,505** | **($10,833)** | **($29,548)** |

| Table 9‑3: Total 20-Year Annualized Net Benefits by Use Category and Option (High Benefits Estimate, 2 Percent Discount Rate, 2022$, $1,000s) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $1,996 | $1,996 | $233 | $233 | ($1,763) | ($1,763) |
| Import/Repackage | $204 | $204 | $3 | $3 | ($201) | ($201) |
| Reactant/Intermediate | $386 | $386 | $45 | $45 | ($341) | ($341) |
| Processing Aid in Petrochemical Manufacturing | $1,042 | $1,042 | $25 | $25 | ($1,017) | ($1,017) |
| Production of Maskant for chemical milling | $44 | $44 | $1 | $1 | ($43) | ($43) |
| Use as Maskant for Chemical Milling | $1,428 | $1,428 | $1,175 | $1,175 | ($253) | ($253) |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $11,093 | $25,553 | $608 | $362 | ($10,484) | ($25,191) |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100 | $4,209 | $0 | $1 | ($100) | ($4,208) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $635 | $635 | $157 | $157 | ($478) | ($478) |
| Recycling and Disposal | $769 | $769 | $3 | $3 | ($766) | ($766) |
| Laboratory Chemicals | $0 | $113 | $0 | $3 | ($0) | ($110) |
| Processing Aid, except petrochemical | $32 | $32 | $1 | $1 | ($32) | ($31) |
| Adhesives and Sealants | $166 | $166 | $681 | $681 | $516 | $516 |
| Paint and Coatings | $4 | $4 | $175 | $175 | $171 | $171 |
| Aerosol Spray Cleaning/Degreasing except EEC | $893 | $893 | $29,686 | $29,686 | $28,793 | $28,793 |
| Aerosol Spray Cleaning/Degreasing - EEC | $20,240 | $20,240 | $139 | $140 | ($20,100) | ($20,100) |
| Liquid and Spray Batch Cold Cleaning | $4,125 | $4,125 | $232 | $232 | ($3,893) | ($3,893) |
| Photographic Film Use | $0 | $0 | $76 | $76 | $76 | $76 |
| Lubricants and Greases | $103 | $103 | $875 | $875 | $772 | $772 |
| Wipe and Liquid Cleaning and Polishing | $31 | $31 | $50,405 | $50,405 | $50,374 | $50,374 |
| Inks and Ink Removal | $4 | $4 | $12 | $12 | $8 | $8 |
| Anti-Spatter Welding Aerosol | $8 | $8 | $86 | $86 | $78 | $78 |
| Mold Cleaning, Release and Protectants | $23 | $23 | $4 | $4 | ($19) | ($19) |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $106 | $45 | $4 | $2 | ($103) | ($43) |
| **Total** | **$43,432** | **$62,054** | **$84,625** | **$84,382** | **$41,193** | **$22,328** |

| Table 9‑4: Total 20-Year Annualized Net Benefits by Use Category and Option (Low Benefits Estimate, 3 Percent Discount Rate, 2022$, $1,000s) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $1,992 | $1,992 | $74 | $74 | ($1,918) | ($1,918) |
| Import/Repackage | $204 | $204 | $1 | $1 | ($203) | ($203) |
| Reactant/Intermediate | $385 | $385 | $14 | $14 | ($371) | ($371) |
| Processing Aid in Petrochemical Manufacturing | $1,041 | $1,041 | $8 | $8 | ($1,033) | ($1,033) |
| Production of Maskant for chemical milling | $44 | $44 | $0 | $0 | ($43) | ($43) |
| Use as Maskant for Chemical Milling | $1,427 | $1,427 | $372 | $372 | ($1,056) | ($1,056) |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $11,585 | $27,206 | $192 | $111 | ($11,392) | ($27,095) |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100 | $4,481 | $0 | $0 | ($100) | ($4,481) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $688 | $688 | $50 | $50 | ($639) | ($639) |
| Recycling and Disposal | $770 | $770 | $1 | $1 | ($769) | ($769) |
| Laboratory Chemicals | $0 | $113 | $0 | $1 | ($0) | ($112) |
| Processing Aid, except petrochemical | $32 | $32 | $0 | $0 | ($32) | ($32) |
| Adhesives and Sealants | $181 | $181 | $215 | $215 | $34 | $34 |
| Paint and Coatings | $4 | $4 | $55 | $55 | $51 | $51 |
| Aerosol Spray Cleaning/Degreasing except EEC | $976 | $976 | $9,369 | $9,369 | $8,393 | $8,393 |
| Aerosol Spray Cleaning/Degreasing - EEC | $20,466 | $20,466 | $44 | $44 | ($20,422) | ($20,422) |
| Liquid and Spray Batch Cold Cleaning | $4,474 | $4,474 | $73 | $73 | ($4,401) | ($4,401) |
| Photographic Film Use | $0 | $0 | $24 | $24 | $24 | $24 |
| Lubricants and Greases | $112 | $112 | $277 | $277 | $164 | $164 |
| Wipe and Liquid Cleaning and Polishing | $34 | $34 | $15,907 | $15,907 | $15,874 | $15,874 |
| Inks and Ink Removal | $4 | $4 | $4 | $4 | ($1) | ($1) |
| Anti-Spatter Welding Aerosol | $9 | $9 | $27 | $27 | $18 | $18 |
| Mold Cleaning, Release and Protectants | $25 | $25 | $1 | $1 | ($24) | ($24) |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $109 | $44 | $1 | $1 | ($108) | ($43) |
| **Total** | **$44,664** | **$64,714** | **$26,710** | **$26,629** | **($17,955)** | **($38,085)** |

| Table 9‑5: Total 20-Year Annualized Net Benefits by Use Category and Option (High Benefits Estimate, 3 Percent Discount Rate, 2022$, $1,000s) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $1,992 | $1,992 | $203 | $203 | ($1,789) | ($1,789) |
| Import/Repackage | $204 | $204 | $3 | $3 | ($201) | ($201) |
| Reactant/Intermediate | $385 | $385 | $39 | $39 | ($346) | ($346) |
| Processing Aid in Petrochemical Manufacturing | $1,041 | $1,041 | $22 | $22 | ($1,019) | ($1,019) |
| Production of Maskant for chemical milling | $44 | $44 | $1 | $1 | ($43) | ($43) |
| Use as Maskant for Chemical Milling | $1,427 | $1,427 | $1,024 | $1,024 | ($403) | ($403) |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $11,585 | $27,206 | $531 | $306 | ($11,054) | ($26,900) |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100 | $4,481 | $0 | $1 | ($100) | ($4,480) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $688 | $688 | $137 | $137 | ($552) | ($552) |
| Recycling and Disposal | $770 | $770 | $3 | $3 | ($767) | ($767) |
| Laboratory Chemicals | $0 | $113 | $0 | $3 | ($0) | ($111) |
| Processing Aid, except petrochemical | $32 | $32 | $1 | $1 | ($32) | ($32) |
| Adhesives and Sealants | $181 | $181 | $594 | $594 | $413 | $413 |
| Paint and Coatings | $4 | $4 | $153 | $153 | $148 | $148 |
| Aerosol Spray Cleaning/Degreasing except EEC | $976 | $976 | $25,874 | $25,875 | $24,899 | $24,899 |
| Aerosol Spray Cleaning/Degreasing - EEC | $20,466 | $20,466 | $121 | $122 | ($20,345) | ($20,344) |
| Liquid and Spray Batch Cold Cleaning | $4,474 | $4,474 | $202 | $202 | ($4,272) | ($4,272) |
| Photographic Film Use | $0 | $0 | $66 | $66 | $66 | $66 |
| Lubricants and Greases | $112 | $112 | $763 | $763 | $650 | $650 |
| Wipe and Liquid Cleaning and Polishing | $34 | $34 | $43,933 | $43,933 | $43,900 | $43,900 |
| Inks and Ink Removal | $4 | $4 | $10 | $10 | $6 | $6 |
| Anti-Spatter Welding Aerosol | $9 | $9 | $75 | $75 | $66 | $66 |
| Mold Cleaning, Release and Protectants | $25 | $25 | $4 | $4 | ($22) | ($22) |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $109 | $44 | $3 | $2 | ($106) | ($42) |
| **Total** | **$44,664** | **$64,714** | **$73,761** | **$73,539** | **$29,097** | **$8,825** |

| Table 9‑6: Total 20-Year Annualized Net Benefits by Use Category and Option (Low Benefits Estimate, 7 Percent Discount Rate, 2022$, $1,000s) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $1,975 | $1,975 | $38 | $38 | ($1,937) | ($1,937) |
| Import/Repackage | $203 | $203 | $1 | $1 | ($203) | ($203) |
| Reactant/Intermediate | $383 | $383 | $7 | $7 | ($375) | ($375) |
| Processing Aid in Petrochemical Manufacturing | $1,037 | $1,037 | $4 | $4 | ($1,033) | ($1,033) |
| Production of Maskant for chemical milling | $43 | $43 | $0 | $0 | ($43) | ($43) |
| Use as Maskant for Chemical Milling | $1,421 | $1,421 | $193 | $193 | ($1,228) | ($1,228) |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $13,724 | $34,275 | $100 | $51 | ($13,624) | ($34,224) |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100 | $5,645 | $0 | $0 | ($100) | ($5,645) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $922 | $922 | $26 | $26 | ($896) | ($896) |
| Recycling and Disposal | $773 | $773 | $1 | $1 | ($772) | ($772) |
| Laboratory Chemicals | $0 | $114 | $0 | $1 | ($0) | ($113) |
| Processing Aid, except petrochemical | $32 | $32 | $0 | $0 | ($32) | ($32) |
| Adhesives and Sealants | $248 | $248 | $112 | $112 | ($136) | ($136) |
| Paint and Coatings | $6 | $6 | $29 | $29 | $23 | $23 |
| Aerosol Spray Cleaning/Degreasing except EEC | $1,336 | $1,336 | $4,928 | $4,928 | $3,592 | $3,592 |
| Aerosol Spray Cleaning/Degreasing - EEC | $21,450 | $21,450 | $23 | $23 | ($21,427) | ($21,427) |
| Liquid and Spray Batch Cold Cleaning | $5,993 | $5,993 | $38 | $38 | ($5,955) | ($5,955) |
| Photographic Film Use | $0 | $0 | $12 | $12 | $12 | $12 |
| Lubricants and Greases | $154 | $154 | $144 | $144 | ($10) | ($10) |
| Wipe and Liquid Cleaning and Polishing | $46 | $46 | $8,368 | $8,368 | $8,322 | $8,322 |
| Inks and Ink Removal | $6 | $6 | $2 | $2 | ($4) | ($4) |
| Anti-Spatter Welding Aerosol | $12 | $12 | $14 | $14 | $2 | $2 |
| Mold Cleaning, Release and Protectants | $34 | $34 | $1 | $1 | ($34) | ($34) |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $128 | $38 | $0 | $0 | ($127) | ($38) |
| **Total** | **$50,028** | **$76,147** | **$14,042** | **$13,994** | **($35,986)** | **($62,154)** |

| Table 9‑7: Total 20-Year Annualized Net Benefits by Use Category and Option (High Benefits Estimate, 7 Percent Discount Rate, 2022$, $1,000s) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Use Category | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $1,975 | $1,975 | $130 | $130 | ($1,845) | ($1,845) |
| Import/Repackage | $203 | $203 | $2 | $2 | ($201) | ($201) |
| Reactant/Intermediate | $383 | $383 | $25 | $25 | ($358) | ($358) |
| Processing Aid in Petrochemical Manufacturing | $1,037 | $1,037 | $14 | $14 | ($1,023) | ($1,023) |
| Production of Maskant for chemical milling | $43 | $43 | $0 | $0 | ($43) | ($43) |
| Use as Maskant for Chemical Milling | $1,421 | $1,421 | $656 | $656 | ($765) | ($765) |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD) | $13,724 | $34,275 | $340 | $173 | ($13,384) | ($34,102) |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD) | $100 | $5,645 | $0 | $0 | ($100) | ($5,645) |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD) | $922 | $922 | $88 | $88 | ($834) | ($834) |
| Recycling and Disposal | $773 | $773 | $2 | $2 | ($771) | ($771) |
| Laboratory Chemicals | $0 | $114 | $0 | $2 | ($0) | ($112) |
| Processing Aid, except petrochemical | $32 | $32 | $0 | $1 | ($32) | ($32) |
| Adhesives and Sealants | $248 | $248 | $381 | $381 | $133 | $133 |
| Paint and Coatings | $6 | $6 | $98 | $98 | $92 | $92 |
| Aerosol Spray Cleaning/Degreasing except EEC | $1,336 | $1,336 | $16,629 | $16,629 | $15,293 | $15,293 |
| Aerosol Spray Cleaning/Degreasing - EEC | $21,450 | $21,450 | $78 | $78 | ($21,372) | ($21,372) |
| Liquid and Spray Batch Cold Cleaning | $5,993 | $5,993 | $130 | $130 | ($5,863) | ($5,863) |
| Photographic Film Use | $0 | $0 | $42 | $42 | $42 | $42 |
| Lubricants and Greases | $154 | $154 | $489 | $489 | $335 | $335 |
| Wipe and Liquid Cleaning and Polishing | $46 | $46 | $28,236 | $28,236 | $28,190 | $28,190 |
| Inks and Ink Removal | $6 | $6 | $7 | $7 | $1 | $1 |
| Anti-Spatter Welding Aerosol | $12 | $12 | $48 | $48 | $36 | $36 |
| Mold Cleaning, Release and Protectants | $34 | $34 | $2 | $2 | ($32) | ($32) |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $128 | $38 | $2 | $1 | ($126) | ($37) |
| **Total** | **$50,028** | **$76,147** | **$47,398** | **$47,233** | **($2,630)** | **($28,914)** |

| Table 9‑8: Total 20-Year Annualized Net Benefits by Option, (Millions, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Estimate | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Low Benefits, 2 Percent Discount Rate | $43 | $62 | $33 | $33 | ($11) | ($30) |
| High Benefits, 2 Percent Discount Rate | $43 | $62 | $85 | $84 | $41 | $22 |
| Low Benefits, 3 Percent Discount Rate | $45 | $65 | $27 | $27 | ($18) | ($38) |
| High Benefits, 3 Percent Discount Rate | $45 | $65 | $74 | $74 | $29 | $9 |
| Low Benefits, 7 Percent Discount Rate | $50 | $76 | $14 | $14 | ($36) | ($62) |
| High Benefits, 7 Percent Discount Rate | $50 | $76 | $47 | $47 | ($3) | ($29) |

# 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 final rule on the following:

* 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 (UMRA; 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).

## Protection of Children from Environmental Health Risks and Safety Risks

Executive Order 13045 applies if the regulatory action is economically significant and concerns an environmental health risk or safety risk that may disproportionately affect children. The action described in this economic analysis is not subject to Executive Order 13045 (62 FR 19885, April 23, 1997) because it is not economically significant as defined in Executive Order 12866, and because EPA does not believe the environmental health or safety risks addressed by this action present a disproportionate risk to children as reflected by the conclusions of the PCE risk evaluation. However, EPA’s *2021 Policy on Children’s Health* applies. Accordingly, this action’s health and risk assessments are contained in Unit III.A.3, III.B.2, VI.A. and B., of the NPRM and the 2020 Risk Evaluation for PCE and this Economic Analysis.

## 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. When some of the specific affected entities are known, NAICS, employment, and revenue data are retrieved from the [Experian (2023)](#_ENREF_19) or the Dun and Bradstreet Hoovers database ([Dun & Bradstreet 2022](#_ENREF_18)), [[27]](#footnote-29) and these data are used (1) to make the small business determinations, and (2) for comparing costs with revenues. When the specific entities affected are not known, [U.S. Census Bureau (2021)](#_ENREF_65) county business patterns data by enterprise receipt size are used to estimate the percentage of affected entities that are small and the distribution of revenues for small businesses that are used for the comparison of costs and revenues. The cost to revenue impact ratios are calculated using the 7 percent annualized cost estimates described in Chapter 7.

Small entity impacts are estimated by use category, for the following use categories:

* Use categories where specific entities affected are known:
  + Manufacturing
  + Import/Repackage
  + Processing as a Reactant
  + Processing Aid in Petrochemical Manufacturing
  + Production of Maskant for Chemical Milling
  + Vapor Degreasing
  + Incorporation Into Formulation, Mixture, or Reaction Product
  + Processing Aid, Except Petrochemical
* Use categories where specific entities affected are not known:
  + Use as maskant for Chemical Milling
  + Recycling and Disposal
  + Laboratory Use
  + Dry Cleaning

There are no small entities processing PCE as a reactant (NAICS 326113), producing maskant (NAICS 325211) with PCE or using PCE as a processing aid outside the petrochemical sector (NAICS 111998) according to the SBA’s small business thresholds ([SBA 2023](#_ENREF_100)).

Except for liquid and spray batch cold cleaning and dry cleaning machines, no cost impacts are estimated for users of products that contain PCE who will need to switch to alternative products that do not contain PCE (e.g., PCE aerosol spray cleaners and degreasers). As noted in Chapter 5, alternative products with similar costs and efficacy are generally available. However, in some cases some effort might be required by firms using PCE 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 in the Economic Analysis.

The final rule has a ten-year phaseout of PCE in dry cleaning and EPA estimates that only about 60 PCE dry cleaning machines would remain at the end of the phaseout (see Section 7.7.3). Many of these firms would likely choose to purchase non-PCE machines or become drop shops (do dry cleaning at another site) rather than close. There are no standard generally accepted approaches for estimating the cost impacts of a firm closure, but it is possible to characterize the potentially affected firms in terms of their revenue and profit. Based on the estimated revenues per firm presented in Table 3‑1 and the 6,000 estimated number of dry cleaning establishments using PCE as dry cleaning solvent (see Section 6.1.5 and 6.2.24), the total revenue for dry cleaning firms using PCE as dry cleaning solvent is approximately $5.3 billion. According to IRS (2013) data, profit in this sector is about 4.8% of sales, implying that total profit of firms using PCE as dry cleaning solvent is about $254 million. However, this suggests that the rule would affect firms that have a combined $53 million of total revenue and about $2.5 million of profit.

Section 10.2.1 discusses the regulatory requirements for this analysis. Section 10.2.2 presents the estimated numbers of affected small entities. Section 10.2.3 presents the estimated cost impacts of the rule on the affected small entities.

|  |
| --- |
| Figure 10‑1: Overview of small business analysis approach, which differs depending on whether the specific entities affected are known |
|  |

### 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, as defined by the RFA. 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 RFA, the definition of a small business is determined by the U.S. Small Business Administration’s (SBA) 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 regulation: (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.

### Estimated Number of Affected Small Entities

To conduct a small entity screening analysis, the EPA obtained the most recent annual revenue and number of employees using either [Experian (2023)](#_ENREF_19) data, the [Dun & Bradstreet (2022)](#_ENREF_18) data,[[28]](#footnote-30) or [U.S. Census Bureau (2021)](#_ENREF_65) data. SBA size standards are defined for each NAICS code based on either annual revenue or number of employees. For the known affected entities, EPA determines whether the entity is small based on its annual revenues or number of employees. To assess the potential impacts on small entities, EPA calculates the cost-to-sales ratio for each entity.

#### 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 based on size standards defined by the SBA for the different use categories. Note that small businesses are defined by the size of the parent company and not just an individual firm. Sufficient data on all but one firm were available to make a small business determination using [Dun & Bradstreet (2022)](#_ENREF_18) and [Experian (2023)](#_ENREF_19) data.[[29]](#footnote-31) If revenue data were not available for firms defined as small based on their employment size, their revenue was imputed as the minimum revenue among other small firms with the same NAICS and Use Category (or in the same Use Category if there were no other small firms with the same NAICS).

| Table 10‑1: Number of Affected Small Entities for Use Categories with Some Known Individual Affected Entities | | | |
| --- | --- | --- | --- |
| Use Category | Small Entity NAICS | Affected Entities (Including Firms that are not Small) | Estimated Number of Affected Small Entities |
| Manufacturing | 424690 | 13 | 1 |
| Import/Repackage | 339999, 541613, 325998, 424690, 423990, 541714, 325180 | 16 | 8 |
| Processing as a Reactant | - | 8 | 0 |
| Processing Aid in Petrochemical Manufacturing | 324110, 424720, 541613, 331492 | 64 | 6 |
| Production of Maskant for Chemical Milling | - | 1 | 0 |
| Vapor Degreasing | 331110, 333415, 339999, 333517, 423990, 339992, 336413, 332999, 332913, 332812 | 101 | 10 |
| Incorporation into other formulation, mixture, and reaction products | 325180, 424690, 325998, 325612, 425120, 336390, 325611, 333517, 325520, 423990, 333310, 423830, 339999, 424910, 325510, 325130, 334220 | 31 | 25 |
| Processing Aid, Except Petrochemical | - | 1 | 0 |

#### Use Categories without Known Individual Affected Entities

[U.S. Census Bureau (2021)](#_ENREF_65) county business patterns data by enterprise receipt size is used to estimate the number of small entities for the following use categories:

* + Use as maskant for chemical milling
  + Recycling and disposal
  + Laboratory use
  + Adhesives and Sealants
  + Paint and Coatings
  + Aerosol Spray Cleaning/Degreasing
  + Aerosol Spray Cleaning/Degreasing – Energized Electrical Cleaners
  + Liquid and Spray Batch Cold Cleaning
  + Photographic Film Use
  + Lubricants and Greases
  + Wipe and Liquid Cleaning and Polishing
  + Inks and Ink Removal
  + Anti-Spatter Welding Aerosol
  + Mold Cleaning, Release and Protectants
  + Dry cleaning

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). 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 |
| Use as Maskant for Chemical Milling | 424690, 325998, 423220, 325520, 324110, 325611, 325612, 423120, 333517, 326199, 423840, 541990, 423850, 332216, 325180, 333914, 333249, 325120, 423990 | 71 | 97% | 69 |
| Recycling and Disposal | 562211, 562212, 562213, 562219, 562920, 562998 | 94 | 93% | 87 |
| Laboratory Chemicals | 541380 | 26 | 92% | 24 |
| Adhesives and Sealants | 325998, 326291, 326299, 332812, 332993, 336211, 336390, 336611 | 853 | 94% | 800 |
| Paint and Coatings | 322220, 326199, 326291, 326299, 327110, 331492, 332812, 332813, 332993, 333996, 333999, 336211, 336214, 336411, 336413, 336415, 336611, 481111, 541715 | 30 | 93% | 28 |
| Aerosol Spray Cleaning/Degreasing | 4411, 451110, 811111, 811112, 811113, 811118, 811121, 811122, 811191, 811198, 811211, 811212, 811213, 811219, 811310, 811411, 811490 | 148,296 | 18% | 26,050 |
| Aerosol Spray Cleaning/Degreasing - EEC | 121,759 | 98% | 119,523 |
| Liquid and Spray Batch Cold Cleaning | 332811, 336412, 333992, 3329, 339992, 333999, 33641, 333994, 332119, 332215, 332618 | 13 | 100% | 13 |
| Photographic Film Use | 51219 | 60 | 100% | 60 |
| Lubricants and Greases | 332999, 332993 | 1,018 | 98% | 1,000 |
| Wipe and Liquid Cleaning and Polishing | 4411, 451110, 811111, 811112, 811113, 811118, 811121, 811122, 811191, 811198, 811211, 811212, 811213, 811219, 811310, 811411, 811490 | 823 | 98% | 808 |
| Inks and Ink Removal | 323113 | 28 | 100% | 28 |
| Anti-Spatter Welding Aerosol | 811113, 811118, 811121, 811310 | 100 | 98% | 98 |
| Mold Cleaning, Release and Protectants | 3399, 321911, 325110, 325199, 325212, 326113, 326199, 326220, 326299, 541715 | 100 | 96% | 96 |
| Dry Cleaning | 812320, 812332 | 6,000 | 99% | 5,949 |

### Estimated Costs and Small Business Impacts

Below the costs and impacts are described for the use categories complying with the preferred options of dermal protection and WCPP requirements, reformulating their products, and switching to a production process that uses alternatives to PCE. Note that the final rule requires a fume hood and dermal protection for laboratory chemicals, but it is assumed that laboratories are already in compliance with these requirements.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 10‑3: Per Firm Cost Impacts for Small Businesses | | | |
| Use Category | Estimated per Facility Costs (2022$ 7 percent Annualized Costs) | Range for Estimated Small Business Revenues (thousands, 2022$) | Notes |
| Manufacturing | $58,986 | $9,435 | Costs of compliance with WCPP requirements |
| Import/Repackage | $12,703 | $670 - $44,410 | Costs of compliance with WCPP requirements |
| Processing as a Reactant | - | - | No small entities affected |
| Processing Aid in Petrochemical Manufacturing | $6,850 - $16,199 | $3,163 - $56,412 | Costs of compliance with WCPP requirements |
| Production of Maskant for Chemical Milling | - | - | No small entities affected |
| Use as Maskant for Chemical Milling | $20,019 | $3,086 - $118,074 | Costs of compliance with WCPP requirements |
| Vapor Degreasing | $139,641 | $141 - $384,941 | Costs of switching to an alternative |
| Recycling and Disposal | $8,223 | $2,778 - $47,000 | Costs of compliance with WCPP requirements |
| Incorporation into other formulation, mixture, and reaction products | $4,035 - $60,479 | $174 - $815,689 | Cost of reformulation |
| Laboratory Chemicals | $18 | $104 - $19,000 | Rule Familiarization Costs (baseline compliance with fume hood and dermal protection is assumed) |
| Processing Aid, except petrochemical | - | - | No small entities affected |
| Adhesives and Sealants | $291 | $83 - $118,074 | Cost of reformulation |
| Paint and Coatings | $8 | $83 - $118,074 | Rule Familiarization Costs |
| Aerosol Spray Cleaning/Degreasing | $50 | $57 - $118,074 | Cost of reformulation |
| Aerosol Spray Cleaning/Degreasing - EEC | $176 | $57 - $118,074 | Cost of Compliance with PC requirements (Labels, respirator (APF 50) in confined/enclosed space, dermal PPE, self-certification) |
| Liquid and Spray Batch Cold Cleaning | $8 | $83 - $118,074 | Rule Familiarization Costs |
| Photographic Film Use | $8 | $104 - $39,000 | Rule Familiarization Costs |
| Lubricants and Greases | $8 | $83 - $118,074 | Rule Familiarization Costs |
| Wipe and Liquid Cleaning and Polishing | $8 | $57 - $118,074 | Rule Familiarization Costs |
| Inks and Ink Removal | $8 | $83 - $118,074 | Rule Familiarization Costs |
| Anti-Spatter Welding Aerosol | $8 | $104 - $12,500 | Rule Familiarization Costs |
| Mold Cleaning, Release and Protectants | $8 | $83 - $118,074 | Rule Familiarization Costs |
| Dry Cleaning | $8 | $104 - $47,000 | Rule Familiarization Costs |

### Summary of Estimated Small Business Impacts

Table 10‑4 presents a summary of the small business impacts overall and for each of the use categories where small business impacts were estimated. Affected vapor degreasing firms have the highest costs and therefore the largest proportion of small firms with impacts above 1 and 3 percent of revenues. Costs for reformulating products are large enough to exceed 1 and 3 percent of revenues for three and one firm, respectively. WCPP costs for Import/Repackage firms exceed 1 percent of revenues for 2 small firms.

Except for liquid and batch spray cold cleaning and dry cleaning machines, no cost impacts are estimated for users of products that contain PCE who will need to switch to alternative products that do not contain PCE (e.g., PCE aerosol spray cleaners and degreasers). As noted in Chapter 5, alternative products with similar costs and efficacy are generally available. However, in some cases some effort might be required by firms using PCE 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 in the Economic Analysis.

| Table 10‑4: Summary of Small Business Impacts using 20-Year Annualized Costs | | | | | |
| --- | --- | --- | --- | --- | --- |
| Use Category | Number of Small Firms | Average Cost (2022$, 20-Year Annualized, 7% Discount Rate) | Number and Percent of Firms by Cost-Revenue Impact Threshold | | |
| <1% | 1–3% | >3% |
| Manufacturing | 1 | $58,986 | 1 (100%) | - | - |
| Import/Repackage | 8 | $12,703 | 6 (75%) | 2 (25%) | - |
| Processing Aid in Petrochemical Manufacturing | 6 | $13,698 | 6 (100%) | - | - |
| Use as Maskant for Chemical Milling | 69 | $20,019 | 69 (100%) | - | - |
| Vapor Degreasing | 10 | $139,641 | 4 (40%) | 3 (30%) | 3 (30%) |
| Recycling and Disposal | 87 | $8,223 | 87 (100%) | - | - |
| Incorporation into other formulation, mixture, and reaction products | 25 | $37,676 | 20 (80%) | 3 (12%) | 2 (8%) |
| Laboratory Chemicals | 24 | $18 | 24 (100%) | - | - |
| Adhesives and Sealants | 800 | $291 | 800 (100%) | - | - |
| Paint and Coatings | 28 | $8 | 28 (100%) | - | - |
| Aerosol Spray Cleaning/Degreasing | 26,050 | $50 | 26,050 (100%) | - | - |
| Aerosol Spray Cleaning/Degreasing - EEC | 119,523 | $176 | 119,523 (100%) | - | - |
| Liquid and Spray Batch Cold Cleaning | 13 | $8 | 13 (100%) | - | - |
| Photographic Film Use | 60 | $8 | 60 (100%) | - | - |
| Lubricants and Greases | 1,000 | $8 | 1,000 (100%) | - | - |
| Wipe and Liquid Cleaning and Polishing | 808 | $8 | 808 (100%) | - | - |
| Inks and Ink Removal | 28 | $8 | 28 (100%) | - | - |
| Anti-Spatter Welding Aerosol | 98 | $8 | 98 (100%) | - | - |
| Mold Cleaning, Release and Protectants | 96 | $8 | 96 (100%) | - | - |
| Dry Cleaning | 5,949 | $8 | 5,949 (100%) | - | - |
| **All Use Categories** | **154,683** | **$177** | **154,670 (99.99%)** | **8 (0.01%)** | **5 (0.003%)** |

As a sensitivity analysis, EPA also estimated average costs and the cost to revenue impact ratios by annualizing costs over 10 years, which is a shorter timeframe than used throughout the economic analysis. The estimated average costs and cost to revenue impact ratios using this shorter timeframe are presented in Table 10‑5. Using the shorter timeframe, one additional firm has a cost impact between 1 and 3 percent of their revenue and one additional firm has a cost impact that exceeds 3% of their revenue.

| Table 10‑5: Summary of Small Business Impacts using 10-Year Annualized Costs | | | | | |
| --- | --- | --- | --- | --- | --- |
| Use Category | Number of Small Firms | Average Cost (2022$, 10-Year Annualized, 7% Discount Rate) | Number and Percent of Firms by Cost-Revenue Impact Threshold | | |
| <1% | 1–3% | >3% |
| Manufacturing | 1 | $58,255 | 1 (100%) | - | - |
| Import/Repackage | 8 | $12,616 | 6 (75%) | 2 (25%) | - |
| Processing Aid in Petrochemical Manufacturing | 6 | $13,619 | 6 (100%) | - | - |
| Use as Maskant for Chemical Milling | 69 | $19,887 | 69 (100%) | - | - |
| Vapor Degreasing | 10 | $170,825 | 3 (30%) | 4 (40%) | 3 (30%) |
| Recycling and Disposal | 87 | $8,274 | 87 (100%) | - | - |
| Incorporation into other formulation, mixture, and reaction products | 25 | $54,441 | 20 (80%) | 3 (12%) | 2 (8%) |
| Laboratory Chemicals | 24 | $27 | 24 (100%) | - | - |
| Adhesives and Sealants | 800 | $420 | 800 (100%) | - | - |
| Paint and Coatings | 28 | $12 | 28 (100%) | - | - |
| Aerosol Spray Cleaning/Degreasing | 26,050 | $73 | 26,050 (100%) | - | - |
| Aerosol Spray Cleaning/Degreasing - EEC | 119,523 | $190 | 119,523 (100%) | - | - |
| Liquid and Spray Batch Cold Cleaning | 13 | $12 | 13 (100%) | - | - |
| Photographic Film Use | 60 | $12 | 60 (100%) | - | - |
| Lubricants and Greases | 1,000 | $12 | 1,000 (100%) | - | - |
| Wipe and Liquid Cleaning and Polishing | 808 | $12 | 808 (100%) | - | - |
| Inks and Ink Removal | 28 | $12 | 28 (100%) | - | - |
| Anti-Spatter Welding Aerosol | 98 | $12 | 98 (100%) | - | - |
| Mold Cleaning, Release and Protectants | 96 | $12 | 96 (100%) | - | - |
| Dry Cleaning | 5,949 | $12 | 5,949 (100%) | - | - |
| **All Use Categories** | **154,683** | **$196** | **154,669 (99.99%)** | **9 (0.01%)** | **5 (0.003%)** |

## 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](#_ENREF_5)). Even if they are mitigated by long-run market adjustments to full employment, many regulatory actions have transitional effects in the short run ([OMB 2015](#_ENREF_99)). 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 are 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 their 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.

* + 1. **Baseline Employment**

Facilities using consumer/commercial products containing PCE are not expected to experience any cost impacts associated with switching to PCE-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 PCE, 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 Statistics1** | | | | | | | **Affected Facilities2** | |
| **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** |
| Manufacturing | 22,919 | 27,895 | 534,997 | 19 | 6% | $114,559 | $646,183,023 | 13 | 2,535 |
| Import/Repackage | 69,230 | 109,316 | 1,204,506 | 11 | 14% | $84,953 | $817,510,843 | 16 | 176 |
| Reactant/Intermediate | 5,420 | 6,411 | 247,756 | 39 | -6% | $114,018 | $269,291,462 | 8 | 480 |
| Processing Aid in Petrochemical Manufacturing | 194,159 | 205,787 | 2,234,389 | 11 | 13% | $89,136 | $2,107,790,444 | 64 | 1,152 |
| Production of maskant for chemical milling | 1,064 | 1,230 | 36,900 | 30 | 12% | $90,244 | $25,778,668 | 1 | 75 |
| Use as Maskant for Chemical Milling | 69,836 | 89,094 | 1,728,691 | 19 | 11% | $78,389 | $1,762,813,491 | 71 | 2,627 |
| Vapor Degreasing | 21,859 | 23,407 | 843,378 | 36 | -2% | $86,156 | $525,400,999 | 85 | 3,063 |
| 1Industry Statistics are from Table 3‑1 and 2009 U.S. Statistics of U.S. Business data ([U.S. Census Bureau 2012](#_ENREF_63)), aggregated according to use category.  2Employees 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 6‑11, whichever is greater. | | | | | | | | | |

### Potential Employment Impacts of the Rule

As noted above, facilities using consumer/commercial products containing PCE are not expected to experience any cost impacts associated with switching to PCE-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 PCE-free alternatives and importers and repackagers of these products will import or repackage PCE-free alternatives. Thus, EPA expects minimal employment impacts from eliminating PCE from consumer/commercial products because there are adequate substitutes and little to no changes in equipment or processes necessary. Many current suppliers of PCE products also provide PCE-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. The costs of WCPP compliance can be substantial and the estimated annualized costs range from about $23,000 to $13.2 million at these facilities. Given these costs, affected facilities may opt to comply with the proposed rule by closing or shifting operations abroad where PCE use is not regulated or reduce their capacity.[[30]](#footnote-32) 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 PCE, 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](#_ENREF_38)).

Upstream impacts on facilities that use PCE might include impacts on workers at firms that may be developing alternatives or substitutes to PCE. For example, there may be increased temporary employment associated with reformulating PCE-free alternatives and converting production processes to use PCE substitute technologies.

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 PCE-free alternative processes could all result in downstream impacts from supply chain disruptions, including potential employment impacts.

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](#_ENREF_38)).

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 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, large employment impacts are not expected. Instead, workers currently using PCE are expected to continue employment while shifting away from PCE 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 PCE.

## 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 3 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 as part of their usual business practices.

* Rule Familiarization
  + The 122,185 facilities complying with WCPP or PC requirements are assumed to incur an initial cost of $214 for a 3-hour burden associated with rule familiarization.
* Downstream Notification
  + Each person who processes or distributes in commerce PCE or PCE-containing products for any use must, prior to or concurrent with the shipment, notify companies to whom PCE is shipped, in writing, of the restrictions on its use. It is assumed that 29 respondents (manufacturers, importers, and repackagers) accomplish this by modifying the SDS to update the restrictions. The burden associated with the downstream notification requirements, including the related recordkeeping, is 2 hours, with an associated labor cost of $189.
* Self-Certification
  + EPA estimates an initial cost of $143 per facility cost for self-certification by users of aerosol energized electrical cleaners, which is calculated as 2 hours of labor with the fully loaded certified industrial hygienist wage rate.
* Product Labeling
  + Producers of energized electrical cleaning products will need to comply with labeling requirements under option 1 of the final rule. The initial per product burden associated with product labeling is 3.5 hours resulting in an initial labor cost of $330. There is also an initial per-product non-labor cost of $659.
* Dermal Protection
  + Under the final rule, facilities required to comply with dermal controls include those involved in the recycling and disposal of PCE, those using PCE as a laboratory chemical, and facilities complying with the rule through a WCPP. These facilities would be required to:
    - Develop a dermal protection control plan (estimated 37 initial hours per facility)
    - Conduct dermal inspections (estimated 4 hours per facility annually)
    - Document dermal protection control plan compliance (10 minutes per affected worker annually)
    - Recordkeeping associated with dermal protection compliance (15 minutes per affected worker plus 10 minutes for 5 percent of workers for records of dermal exposures annually).
  + EPA estimates that 426 respondents will incur a total cost of $2.5 million for dermal protection over the first 3 years of the rule from a 3-year total time burden of 35,604 hours.
* Respiratory Protection
  + Under the final rule, the 275 facilities complying with the rule respiratory protection requirements through a WCPP would be required to develop exposure control plans; monitor exposure levels and 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 employees 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 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 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 in Table 10‑9.
  + EPA estimates that 275 respondents will incur a total cost of $25.8 million for respiratory protection over the first 3 years of the rule from a 3-year total time burden of 128,598 hours (468 hours and $61,585 per respondent) and $8.8 million in non-labor costs.

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, Self-Certification, Product Labeling and Dermal Exposure Control | | | | |
| --- | --- | --- | --- | --- |
| Activity | Number of Respondents | Average Annual Burden Per Respondent | Average Annual Total Burden | Average Annual Total Cost |
| Rule Familiarization (WCPP and PC)1 | 122,185 | 1 | 122,185 | $8,714,234 |
| Rule Familiarization (Firms discontinuing PCE use)2 | 35,575 | 0.33 | 11,740 | $1,916,576 |
| Downstream Notification (SDS)2 | 29 | 0.67 | 19 | $2,747 |
| Self-Certification1 | 121,759 | 2 | 243,518 | $17,367,704 |
| Product Labeling2 | 6 | 1.16 | 7 | $659 |
| Develop Dermal Exposure Control Plan1 | 426 | 12.33 | 5,253 | $374,614 |
| Conduct Regular Inspections1 | 426 | 4 | 1,704 | $121,529 |
| PPE Program Plan Documentation1 | 426 | 4.52 | 1,926 | $137,328 |
| Records Documenting Plan Implementation1 | 426 | 6.78 | 2,888 | $205,992 |
| Records of Dermal Exposure1 | 426 | 0.23 | 98 | $6,988 |
| 1A wage of $71.32was used to calculate the labor cost (see Certified Industrial Hygienist wage in Table 7‑3).  2A wage of $94.74was used to calculate the labor cost (see Manufacturing/Managerial wage in Table 7‑3) | | | | |

| 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 |
| <Action Level  (1 event in first year) | 68 | 2,919 | 2.0 | 0.6 | 1,888 | $107,653 |
| Between Action Level and ECEL  (2 events per year) | 11 | 224 | 6.0 | 3.6 | 870 | $49,607 |
| 1 to <10 times the ECEL  (4 events per year) | 95 | 2,788 | 6.0 | 7.2 | 20,641 | $1,173,429 |
| 10 to <25 times the ECEL  (4 events per year) | 35 | 911 | 6.0 | 7.2 | 6,765 | $384,649 |
| 25 to <50 times the ECEL  (4 events per year) | 22 | 207 | 6.0 | 7.2 | 1,625 | $92,690 |
| 50 to <1,000 times the ECEL  (4 events per year) | 42 | 364 | 6.0 | 7.2 | 2,875 | $164,050 |
| 1,000 to <10,000 times the ECEL  (4 events per year) | 2 | 17 | 6.0 | 7.2 | 136 | $7,783 |
| **All Respondents** | **275** | **7,430** | **-** | **-** | **34,800** | **$1,979,860** |
| A blended wage for a Certified Industrial Hygienist and Technical Specialist was used to calculate the labor cost (see wage rates in Table 7‑3). The wages were weighted according to the labor mix presented in Table 7‑59. | | | | | | |

| 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 |
| <Action Level  (1 event in first year) | 68 | 2,919 | 2.7 | 0.06 | 357 | $33,822 |
| Between Action Level and ECEL  (2 events per year) | 11 | 224 | 8.0 | 0.33 | 160 | $15,158 |
| 1 to <10 times the ECEL  (4 events per year) | 95 | 2,788 | 16.0 | 0.67 | 3,386 | $320,790 |
| 10 to <25 times the ECEL  (4 events per year) | 35 | 911 | 16.0 | 0.67 | 1,164 | $110,277 |
| 25 to <50 times the ECEL  (4 events per year) | 22 | 207 | 16.0 | 0.67 | 494 | $46,802 |
| 50 to <1,000 times the ECEL  (4 events per year) | 42 | 364 | 16.0 | 0.67 | 914 | $86,592 |
| 1,000 to <10,000 times the ECEL  (4 events per year) | 2 | 17 | 16.0 | 0.67 | 50 | $4,737 |
| **All Respondents** | **275** | **7,430** | **-** | **-** | **6,525** | **$618,179** |
| A wage of $94.74 was used to calculate the labor cost (see Manufacturing/Managerial wage in Table 7‑3). | | | | | | |

| 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 |
| <Action Level  (1 event in first year) | 68 | 2,919 | - | 0.03 | 88 | $8,337 |
| Between Action Level and ECEL  (2 events per year) | 11 | 224 | - | 0.17 | 38 | $3,600 |
| 1 to <10 times the ECEL  (4 events per year) | 95 | 2,788 | - | 0.33 | 920 | $87,161 |
| 10 to <25 times the ECEL  (4 events per year) | 35 | 911 | - | 0.33 | 301 | $28,517 |
| 25 to <50 times the ECEL  (4 events per year) | 22 | 207 | - | 0.33 | 68 | $6,442 |
| 50 to <1,000 times the ECEL  (4 events per year) | 42 | 364 | - | 0.33 | 120 | $11,369 |
| 1,000 to <10,000 times the ECEL  (4 events per year) | 2 | 17 | - | 0.33 | 6 | $568 |
| **All Respondents** | **275** | **7,430** | **-** | **-** | **1,541** | **$145,994** |
| A wage of $94.74 was used to calculate the labor cost (see Manufacturing/Managerial wage in Table 7‑3). | | | | | | |

| Table 10‑10: Paperwork Non-Labor Cost Associated with Respiratory Monitoring and Product Labeling | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Activity | 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 |
| Respiratory Monitoring: <Action Level  (1 event in first year) | 68 | 2,919 | $80 | $139 | $6,025 | $411,269 |
| Respiratory Monitoring: Between Action Level and ECEL  (2 events per year) | 11 | 224 | $160 | $278 | $5,917 | $63,905 |
| Respiratory Monitoring: 1 to <10 times the ECEL  (4 events per year) | 95 | 2,788 | $320 | $556 | $16,658 | $1,580,320 |
| Respiratory Monitoring: 10 to <25 times the ECEL  (4 events per year) | 35 | 911 | $320 | $556 | $14,954 | $517,421 |
| Respiratory Monitoring: 25 to <50 times the ECEL  (4 events per year) | 22 | 207 | $320 | $556 | $5,511 | $122,287 |
| Respiratory Monitoring: 50 to <1,000 times the ECEL  (4 events per year) | 42 | 364 | $320 | $556 | $5,161 | $215,987 |
| Respiratory Monitoring: 1,000 to <10,000 times the ECEL  (4 events per year) | 2 | 17 | $320 | $556 | $4,221 | $10,173 |
| Product Labeling | 6 | - | $659 | - | $220 | $1,318 |
| **All Respondents** | **281** | **7,430** | - | - | **$10,402** | **$2,922,680** |
| See Table 7‑59. | | | | | | |

| 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 (hours) | 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 PC) | 122,185 | 0.33 | 1 | 122,185 | $8,714,234 | - | $8,714,234 |
| Rule Familiarization (Firms discontinuing PCE use) | 35,575 | 0.33 | 0.33 | 11,740 | $1,916,576 | - | $1,916,576 |
| Downstream Notification (SDS) | 29 | 1 | 0.67 | 19 | $2,747 | - | $2,747 |
| Self-Certification | 121,759 | 1 | 2 | 243,518 | $17,367,704 | - | $17,367,704 |
| Product Labeling | 6 | 1 | 1.16 | 7 | $659 | $1,318 | $1,977 |
| Develop Exposure Control Plan | 426 | 1 | 12.33 | 5,253 | $374,614 | - | $374,614 |
| Conduct Regular Inspections | 426 | 1 | 4.00 | 1,704 | $121,529 | - | $121,529 |
| PPE Program Plan Documentation | 426 | 1 | 4.52 | 1,926 | $137,328 | - | $137,328 |
| Records Documenting Plan Implementation | 426 | 1 | 6.78 | 2,888 | $205,992 | - | $205,992 |
| Records of Dermal Exposure | 426 | 1 | 0.23 | 98 | $ 6,988 | - | $6,988 |
| Respiratory Monitoring | 275 | 3.01 | 126.55 | 34,800 | $1,979,860 | $2,921,363 | $4,901,223 |
| Respiratory Recordkeeping | 275 | 3.01 | 23.73 | 6,525 | $618,179 | - | $618,179 |
| Respiratory Notifications | 275 | 3.01 | 5.60 | 1,541 | $145,994 | - | $145,994 |
| **All Activities** | **157,760** |  | **2.74** | **432,203** | $**31,592,405** | **$2,922,680** | **$34,515,086** |

## 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 $183 million in 2023$ ($100 million in 1995$ adjusted for inflation using the GDP implicit price deflator) or more in any one year. The final rule “Regulation of Perchloroethylene Under TSCA Section 6(a),” is not expected to affect state, local, or tribal governments because the rule affects entities that use PCEs and the use of PCE 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 $183 million.

## Executive Order 12898 – Environmental Justice Impacts

EPA’s “Technical Guidance for Assessing Environmental Justice in Regulatory Analysis[[31]](#footnote-33)” 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](#_ENREF_75)). This analysis presents information about the facilities, workforce, and communities potentially affected by the regulatory options under current conditions before the final rule goes into effect. It draws on publicly available data provided by EPA, U.S. Census, and CDC, including the Toxics Release Inventory (TRI), EPA Enforcement and Compliance History Online (ECHO), National Air Toxics Assessment (NATA), the American Community Survey, and the Behavioral Risk Factor Surveillance System.

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 PCE 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.

In choosing COUs, EPA used TRI to highlight categories of point sources that might have significant fenceline exposure from air emissions. No point sources were found to have significant fenceline exposure from water emissions. Eight occupational exposure scenarios (OESs) had fenceline exposure from air emissions:

* Maskant for chemical milling
* Incorporation into formulation, mixture, or reaction product
* Industrial processing aid (mostly catalyst regeneration for petrochemical manufacturing)
* Metalworking fluids
* Other industrial uses – textile processing
* Degreasing (batch open-top degreasing, batch closed-loop degreasing, web vapor degreasing, and cold cleaning)
* Manufacturing (PCE)
* Processing as a reactant (mostly refrigerant manufacture).

EPA excluded metalworking fluids and other industrial uses – textile processing from this EJ analysis. Use of PCE in metalworking fluids only presented unreasonable risk for dermal exposure in the risk evaluation, so it was not included in the EJ analysis. Other industrial uses – textile manufacturing only had one site present unreasonable risk (Phifer Inc. Tuscaloosa, AL) and this entity’s use may be atypical for their NAICS code, so it was not included in the EJ analysis.[[32]](#footnote-34)

For all six of the remaining OESs, EPA is presenting a more granular assessment of facilities and communities with possible fenceline exposure. This analysis also presents an assessment of worker demographics for five of these OESs (all but degreasing). The analysis excludes degreasing because degreasing could take place in a wide variety of NAICS.

EPA also assessed worker demographics for dry cleaning. A large number of dry cleaning workers would be affected by this regulation and the effects of this regulation on such workers would depend on the phaseout period of the final regulation (the final and alternate options include 10-year and 15-year phaseouts, respectively).

PCE regulation will affect many other workers, but this assessment is limited to the workers noted above because most other uses will be prohibited under all regulatory options.

This analysis also presents sociodemographic characteristics for 14 communities near individual facilities. These facilities were chosen for industries with a few facilities or for facilities that had a large number of nearby facilities reporting to TRI. This analysis chose facilities with fenceline risk, which was defined as inhalation risk above at least one benchmark at a distance of 5 meters or more from the site. Benchmark risks for PCE are defined in Table 10‑12 {EPA 2022}.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 10‑12: Inhalation Hazard Values Used in Risk Estimation for Perchloroethylene (Fenceline and Multi-Year Analyses) | | | |
| Multi-Year Analyses Scenario | Endpoint | Inhalation  Hazard Value  (Exposure Durations) | Benchmark |
| Acute | Neurological:  Increased latency in visual signaling | 1.7 ppm (24-hr exposure/day) | **10** |
| Chronic | Neurological:  Visual and cognitive effects | 5.2 ppm (24-hr exposure/day over 365 days/year) | **100** |
| Cancer | Hepatocellular tumors | 2E−03 per ppm (24-hr exposure/day over 365 days/year for 33 years) | **1E−6**  (Gen. Pop.) |
| Gen. Pop. (General population): The total of individuals inhabiting an area or making up a whole group (as defined in the 2011 Exposure Factors Handbook).  For purposes of the fenceline and multi-year analyses, the general population includes, but is not limited to, residents living and individuals employed at a facility that is not the releasing facility within an area where calculated risk estimates are greater than the benchmark for cancer or less than the benchmark Margin of Exposure (MOE) for non-cancer. | | | |

The Benefits Analysis chapter 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. This analysis also provides information on the sociodemographic characteristics of nearby communities and non-workers.

This analysis characterizes baseline conditions, so it does not provide information about the relative merits of the alternative regulatory options. The PCE Final Risk Evaluation found unreasonable risk for all conditions of use except for distribution in commerce. The final rule prohibits most uses of PCE. Several options would be controlled either in primary or alternative options with a WCPP. The uses assessed here would all be controlled by a WCPP, except dry cleaning, which is regulated via a phaseout of 10 years.

The risk evaluation did not evaluate potential unreasonable risk beyond the fenceline for PCE. 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 more likely to be people of color than the general population in affected states, although this varied by use assessed.

Overall, EPA did not find evidence that a higher proportion of Black or Hispanic populations live near plants using PCE for chemical milling compared to the national average. However, there is a higher percent Black, Asian, and Hispanic population than the national average within 1 mile of the Spirit Aerosystems plant in Wichita, KS, and has by far the largest PCE emissions on any plant using PCE in chemical milling.

There are higher than average percent Black and Hispanic populations near plants that manufacture PCE. Most of these plants are in Texas and Louisiana, and there are many other TRI emitters within 1, 3, and 5 miles of PCE manufacturing facilities. Plants that use PCE as a reactant to make other chemicals have higher percent Black populations living near the plants compared to the national average, although there are very few people (around one thousand) living within one mile of those facilities. Chemical manufacturing workers are mostly white.

Plants that use PCE for degreasing have a higher percent Black and Hispanic population living nearby compared to the national average. These plants are also close to many other TRI-emitting facilities. Plants that use PCE as a proceeding aid (mostly in catalyst regeneration and petrochemical manufacturing) and in incorporation into formulation, mixture, or reaction products have a higher percent Hispanic population near their plants compared to the national average. Dry cleaning workers are overwhelmingly minority, with significant percent Black, Hispanic, and Asian populations.

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 individuals affected by the COUs and the substitute technologies and practices that would be adopted at regulated entities in response to the rule. While the regulatory options are anticipated to eliminate unreasonable risks from exposure to PCE, 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-PCE-using technologies or practices that firms may adopt in response to the regulation to determine whether any such changes could pose environmental justice concerns. However, this regulation will likely result in reducing disproportionate impacts to dry cleaning workers because a disproportionate percentage of dry cleaning workers are Black or Hispanic.

### Overview of Environmental Justice Analysis

Table 10‑13 presents average information on communities surrounding all existing facilities – as identified in EPA’s 2019 Toxics Release Inventory (TRI) – 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 5-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 1, 3 and 5 miles of each facility. The table presents rural in addition to overall national statistics for comparison because 53 of the 210 facilities are located in 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 PCE Facilities across all conditions of use, population weighted averages | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $62,193 | $67,540 | $70,802 |
| **White** | 70.4% | 87.6% | 62.2% | 59.4% | 59.1% |
| **Black** | 12.6% | 5.8% | 15.9% | 17.1% | 17.1% |
| **American Indian** | 0.8% | 1.7% | 0.7% | 0.7% | 0.6% |
| **Asian** | 5.6% | 1.2% | 6.8% | 8.0% | 8.1% |
| **Pacific Islander** | 0.2% | 0.1% | 0.1% | 0.2% | 0.2% |
| **Other** | 10.3% | 3.6% | 14.2% | 14.6% | 14.9% |
| **Hispanic** | 18.2% | 2.4% | 25.0% | 28.6% | 28.3% |
| **2x Poverty Line** | 29.8% | 26.0% | 36.7% | 35.6% | 34.0% |
| **Below Poverty Line** | 12.8% | 9.6% | 16.3% | 16.1% | 15.5% |
| **Total Population** |  |  | 742,767 | 9,153,103 | 24,741,152 |
| **NATA Cancer Risk** | 30 |  | 37 | 35 | 34 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.41 | 0.42 | 0.43 |

Table 10‑13 indicates that in general, communities within 1, 3 and 5 miles of PCE facilities have a higher proportion of Black or African Americans, Hispanic Americans, Asian Americans, and Americans identifying as a race other than those listed in the table, than national or rural averages. Median incomes in such communities are not significantly different from national averages, but poverty rates tend to be higher. NATA cancer risks near PCE facilities are slightly higher than national averages, while NATA respiratory risks are slightly lower than national averages.

### Masking and Chemical Milling

Table 10‑14 presents average information on communities surrounding the seven facilities using perchloroethylene as a maskant likely to be affected by the regulation compared to the overall national average. The analysis uses socioeconomic and demographic data from the American Community Survey 5-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 1, 3 and 5 miles of each facility. None of the facilities are in rural areas.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 10‑14: Demographics of communities within 1-, 3-, and 5-mile radii of PCE chemical milling Facilities across all conditions of use, population weighted average | | | | |
| Demographic | National | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $66,003 | $78,095 | $81,549 |
| **White** | 70.4% | 74.0% | 72.3% | 70.8% |
| **Black** | 12.6% | 9.2% | 5.9% | 5.1% |
| **American Indian** | 0.8% | 1.1% | 0.7% | 0.7% |
| **Asian** | 5.6% | 5.4% | 8.5% | 9.4% |
| **Pacific Islander** | 0.2% | 0.3% | 0.4% | 0.3% |
| **Other** | 10.3% | 10.0% | 12.2% | 13.7% |
| **Hispanic** | 18.2% | 20.7% | 27.4% | 27.3% |
| **2x Poverty Line** | 29.8% | 33.6% | 31.6% | 29.9% |
| **Below Poverty Line** | 12.8% | 12.8% | 13.5% | 12.8% |
| **Total Population** |  | 40,040 | 492,466 | 1,427,589 |
| **NATA Cancer Risk** | 30 | 48 | 41 | 39 |
| **NATA Respiratory Hazard Score** | 0.44 | 0.42 | 0.42 | 0.42 |

Table 10‑14 indicates that communities within 1, 3, and 5 miles of facilities using perchloroethylene as a maskant had a slightly higher proportion of Hispanic individuals than national averages. Median incomes within these communities were at or above national averages, and poverty rates and other demographic characteristics were similar to or below the national averages. Communities near PCE chemical milling facilities tend to have higher NATA cancer risks and similar NATA respiratory hazard scores to national averages.

Table 10‑15 through Table 10‑21 provide profiles of communities surrounding each facility individually, again focusing on populations located within 1, 3 and 5 miles. For comparison, the tables provide the national averages, as all facilities are located in urban areas.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Table 10‑15: Spirit Aerosystems, Wichita, KS | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $40,250 | $44,748 | $51,206 |
| **White** | 70.4% | 87.6% | 59.6% | 63.9% | 69.8% |
| **Black** | 12.6% | 5.8% | 13.1% | 11.0% | 9.8% |
| **American Indian** | 0.8% | 1.7% | 1.4% | 1.0% | 1.1% |
| **Asian** | 5.6% | 1.2% | 9.1% | 7.1% | 5.0% |
| **Pacific Islander** | 0.2% | 0.1% | 0.0% | 0.0% | 0.1% |
| **Other** | 10.3% | 3.6% | 16.7% | 17.0% | 14.2% |
| **Hispanic** | 18.2% | 2.4% | 16.6% | 24.4% | 19.5% |
| **2x Poverty Line** | 29.8% | 26.0% | 60.5% | 49.4% | 41.9% |
| **Below Poverty Line** | 12.8% | 9.6% | 23.6% | 23.2% | 19.6% |
| **Total Population** |  |  | 1,022 | 40,523 | 153,303 |
| **NATA Cancer Risk** | 30 |  | 30 | 30 | 29 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.41 | 0.45 | 0.43 |

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| --- | --- | --- | --- | --- | --- |
| Table 10‑16: Boeing Co of Portland, Portland, OR | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $61,784 | $61,619 | $67,842 |
| **White** | 70.4% | 87.6% | 72.8% | 71.6% | 72.9% |
| **Black** | 12.6% | 5.8% | 6.9% | 6.7% | 5.4% |
| **American Indian** | 0.8% | 1.7% | 1.0% | 1.2% | 1.2% |
| **Asian** | 5.6% | 1.2% | 5.3% | 7.7% | 9.0% |
| **Pacific Islander** | 0.2% | 0.1% | 1.6% | 1.1% | 1.2% |
| **Other** | 10.3% | 3.6% | 12.5% | 11.7% | 10.4% |
| **Hispanic** | 18.2% | 2.4% | 27.8% | 20.7% | 16.9% |
| **2x Poverty Line** | 29.8% | 26.0% | 32.2% | 37.6% | 33.7% |
| **Below Poverty Line** | 12.8% | 9.6% | 8.8% | 15.3% | 14.4% |
| **Total Population** |  |  | 6,296 | 88,741 | 274,093 |
| **NATA Cancer Risk** | 30 |  | 69 | 50 | 44 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.58 | 0.57 | 0.56 |

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| --- | --- | --- | --- | --- | --- |
| Table 10‑17: Ducommun Aerostructures Inc, Orange, CA | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $94,358 | $90,261 | $91,805 |
| **White** | 70.4% | 87.6% | 66.7% | 66.3% | 61.3% |
| **Black** | 12.6% | 5.8% | 1.3% | 1.6% | 1.9% |
| **American Indian** | 0.8% | 1.7% | 2.1% | 0.8% | 0.6% |
| **Asian** | 5.6% | 1.2% | 14.1% | 13.1% | 14.3% |
| **Pacific Islander** | 0.2% | 0.1% | 0.1% | 0.4% | 0.2% |
| **Other** | 10.3% | 3.6% | 15.6% | 17.8% | 21.6% |
| **Hispanic** | 18.2% | 2.4% | 39.7% | 49.6% | 49.8% |
| **2x Poverty Line** | 29.8% | 26.0% | 18.7% | 29.5% | 29.7% |
| **Below Poverty Line** | 12.8% | 9.6% | 7.7% | 12.6% | 12.3% |
| **Total Population** |  |  | 9,246 | 194,610 | 590,761 |
| **NATA Cancer Risk** | 30 |  | 34 | 31 | 31 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.42 | 0.41 | 0.40 |

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| --- | --- | --- | --- | --- | --- |
| Table 10‑18: Fraen Machining Corp., Woburn, MA | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $116,044 | $118,306 | $120,008 |
| **White** | 70.4% | 87.6% | 81.5% | 86.2% | 86.7% |
| **Black** | 12.6% | 5.8% | 1.8% | 1.9% | 2.2% |
| **American Indian** | 0.8% | 1.7% | 0.1% | 0.0% | 0.0% |
| **Asian** | 5.6% | 1.2% | 10.8% | 7.5% | 7.2% |
| **Pacific Islander** | 0.2% | 0.1% | 0.0% | 0.1% | 0.1% |
| **Other** | 10.3% | 3.6% | 5.8% | 4.3% | 3.8% |
| **Hispanic** | 18.2% | 2.4% | 4.6% | 3.8% | 3.3% |
| **2x Poverty Line** | 29.8% | 26.0% | 10.3% | 10.2% | 10.5% |
| **Below Poverty Line** | 12.8% | 9.6% | 4.6% | 3.8% | 4.0% |
| **Total Population** |  |  | 3,480 | 73,448 | 190,092 |
| **NATA Cancer Risk** | 30 |  | 30 | 30 | 30 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.30 | 0.30 | 0.30 |

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| --- | --- | --- | --- | --- | --- |
| Table 10‑19: Tech Met Inc., Glassport, PA | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $56,566 | $50,383 | $56,333 |
| **White** | 70.4% | 87.6% | 88.4% | 76.2% | 78.8% |
| **Black** | 12.6% | 5.8% | 7.8% | 19.4% | 15.6% |
| **American Indian** | 0.8% | 1.7% | 0.3% | 0.1% | 0.1% |
| **Asian** | 5.6% | 1.2% | 0.6% | 0.9% | 1.9% |
| **Pacific Islander** | 0.2% | 0.1% | 0.2% | 0.0% | 0.0% |
| **Other** | 10.3% | 3.6% | 2.7% | 3.4% | 3.6% |
| **Hispanic** | 18.2% | 2.4% | 3.7% | 2.3% | 2.4% |
| **2x Poverty Line** | 29.8% | 26.0% | 32.5% | 39.0% | 33.8% |
| **Below Poverty Line** | 12.8% | 9.6% | 13.7% | 17.9% | 15.1% |
| **Total Population** |  |  | 5,191 | 40,911 | 127,123 |
| **NATA Cancer Risk** | 30 |  | 97 | 110 | 94 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.33 | 0.34 | 0.34 |

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| --- | --- | --- | --- | --- | --- |
| Table 10‑20: Radius Aerospace Inc., Hot Springs, AR | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $34,264 | $39,767 | $45,316 |
| **White** | 70.4% | 87.6% | 64.4% | 72.4% | 77.5% |
| **Black** | 12.6% | 5.8% | 25.4% | 18.0% | 13.9% |
| **American Indian** | 0.8% | 1.7% | 0.7% | 1.1% | 1.2% |
| **Asian** | 5.6% | 1.2% | 0.4% | 1.6% | 1.3% |
| **Pacific Islander** | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% |
| **Other** | 10.3% | 3.6% | 9.1% | 6.8% | 6.1% |
| **Hispanic** | 18.2% | 2.4% | 13.5% | 9.4% | 7.6% |
| **2x Poverty Line** | 29.8% | 26.0% | 58.2% | 48.2% | 43.7% |
| **Below Poverty Line** | 12.8% | 9.6% | 24.9% | 22.6% | 20.8% |
| **Total Population** |  |  | 9,282 | 30,763 | 51,316 |
| **NATA Cancer Risk** | 30 |  | 40 | 40 | 40 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.50 | 0.50 | 0.50 |

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| Table 10‑21: Weatherford Aerospace LLC, Weatherford, TX | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $58,786 | $69,799 | $84,084 |
| **White** | 70.4% | 87.6% | 88.0% | 89.8% | 90.9% |
| **Black** | 12.6% | 5.8% | 2.9% | 3.0% | 2.5% |
| **American Indian** | 0.8% | 1.7% | 1.2% | 0.7% | 0.7% |
| **Asian** | 5.6% | 1.2% | 0.1% | 0.5% | 0.5% |
| **Pacific Islander** | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% |
| **Other** | 10.3% | 3.6% | 7.9% | 5.9% | 5.3% |
| **Hispanic** | 18.2% | 2.4% | 19.8% | 14.4% | 13.1% |
| **2x Poverty Line** | 29.8% | 26.0% | 29.7% | 26.9% | 23.4% |
| **Below Poverty Line** | 12.8% | 9.6% | 8.2% | 8.5% | 7.3% |
| **Total Population** |  |  | 5,523 | 23,470 | 40,901 |
| **NATA Cancer Risk** | 30 |  | 30 | 29 | 28 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.30 | 0.31 | 0.32 |

The data in the tables above suggest that the Spirit Aerosystems facility in Wichita, KS, the Techmet Inc. facility in Glassport, PA, and the Radius Aerospace Inc. facility in Hot Springs, AR, all had median incomes well below national averages; poverty rates in communities surrounding these facilities were also higher than national averages. The Radius Aerospace Inc. facility in Hot Springs, AR, had a higher proportion of Black or African American workers than national averages, and the Spirit Aerosystems facility in Wichita, KS, had a higher proportion of individuals identifying as a race other than those listed. Communities surrounding the Fraen Machining Corp. facility in Woburn, MA, as well as the Ducommun Aerostructures Inc. facility in Orange, CA, had higher incomes than national averages. The communities surrounding the Ducommun Aerostructures facilities had a higher proportion of Hispanic individuals than national averages. Communities surrounding the Techmet Inc. facility in Glassport, PA, had NATA cancer scores higher than national averages. NATA cancer risks were especially high in areas around the Boeing facility in Portland, OR, the Tech Met facility in Glassport, PA, and the Radius Aerospace Facility in Hot Springs, AR.

Table 10‑22 presents the density of other TRI facilities located within 1-, 3- and 5-mile distances of the seven facilities using perchloroethylene as a maskant. 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. The Ducommun Aerostructures Inc facility in Orange, CA, has the greatest density of nearby facilities – eight within 1 mile, 18 within 3 miles, and 31 within 5 miles. The Fraen Machining Corp, in Woburn, MA, also had a high density of nearby facilities – ten within 1 mile, 14 within 3 miles, and 18 within 5 miles. None of the other facilities had a high density of facilities within 1, 3, or 5 miles. Given the data above it is possible to conclude that (1) there is evidence of clustering of economic activity, and (2) 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.

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| Table 10‑22: Total Number of Other TRI Facilities within 1, 3 and 5 Miles of Masking Facilities | | | | |
| Facility Name | Location | 1-Mile | 3-Mile | 5-Mile |
| BOEING CO OF PORTLAND | PORTLAND, OR | 1 | 5 | 8 |
| DUCOMMUN AEROSTRUCTURES INC ORANGE FACILITY | ORANGE, CA | 8 | 18 | 31 |
| FRAEN MACHINING CORP | WOBURN, MA | 10 | 14 | 18 |
| WEATHERFORD AEROSPACE LLC | WEATHERFORD, TX | 3 | 4 | 6 |
| TECH MET INC | GLASSPORT, PA | 0 | 4 | 10 |
| SPIRIT AEROSYSTEMS INC | WICHITA, KS | 0 | 3 | 4 |
| RADIUS AEROSPACE INC DBA RADIUS AEROSPACE-HOT SPRINGS | HOT SPRINGS, AR | 0 | 1 | 2 |

Table 10‑23 shows the characteristics of aircraft and parts manufacturing workers and workers in the general population in locations with facilities using perchloroethylene as a maskant and nationally. The table presents simple averages across all surveyed individuals in the affected PUMAs;[[33]](#footnote-35) it does not put extra weight on surveyed individuals in the two PUMAs that contain multiple facilities. The table indicates that nationally and within affected communities, workers who are Black, Hispanic, or a race other than Black or White are somewhat underrepresented in the aircraft and parts manufacturing industry compared to their representation in the overall workforce. Aircraft and parts manufacturing workers in communities surrounding facilities using perchloroethylene as a maskant are more likely to be White, less likely to be Black or a race other than White or Black, and have lower incomes on average than aircraft and parts workers nationally. (This table reports personal income, consistent with the focus on workers, instead of household income, as reported in the community profiles above.) The proportion of Hispanic individuals among workers in these communities is also lower than national averages. The general population in communities with such facilities using perchloroethylene in a formulation has a lower share of Black workers and workers of a race other than White or Black, higher incomes, and lower poverty rates than the general worker population nationally.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 10‑23: Characteristics of Aircraft and Parts Manufacturing in General Population in Areas where Perchloroethylene is Used in Masking Facilities and Nationally | | | | |
| Demographic | Working population in affected communities + NAICS | Working population in affected communities | Natl working population in NAICS | Natl working population |
| White | 82.5% | 84.5% | 79.8% | 72.5% |
| Black or African American | 2.1% | 3.8% | 5.1% | 12.7% |
| Other | 15.5% | 11.6% | 15.0% | 14.8% |
| Hispanic | 5.3% | 13.2% | 11.6% | 18.0% |
| Average Personal Income | $85,515 | $54,756 | $95,179 | $41,487 |
| Below Poverty Line | 0.8% | 6.0% | 1.3% | 13.2% |
| Below Half the Poverty Line | 6.5% | 18.1% | 5.4% | 30.3% |
| Number of Surveyed Individuals | 627 | 16,951 | 35,506 | 7,760,637 |

Table 10‑24 presents characteristics of aircraft and parts manufacturing workers at the five aircraft and parts manufacturing facilities using perchloroethylene as a maskant. Aircraft and parts manufacturing workers at the Sprit Aerosystems Inc. facility in Wichita, KS, and the Radius Aerospace Inc. facility in Hot Springs, AR, earned incomes below national industry averages. Workers at the other three facilities had incomes exceeding national industry averages (see Table 10‑23). Workers at the Spirit Aerosystems facility, the Radius Aerospace facility, and the Ducommun Aerostructures facility in Orange, CA, had higher representations of individuals identifying as a race other than those listed. The Ducommun Aerostructures facility also had a higher proportion of Hispanic workers than industry or national averages.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 10‑24: Demographics of Aircraft and Parts Manufacturing Workers in Areas with Perchloroethylene Using Masking Facilities | | | | | | | | | |
| Facility Name | Location | White | Black or African American | Other | Hispanic | Average Personal Income (2020$) | Below Poverty Line | Below 2x Poverty Line | Number of Surveyed Individuals |
| SPIRIT AEROSYSTEMS INC | WICHITA, KS | 78.8% | 2.8% | 18.4% | 4.3% | $67,134 | 1.3% | 9.5% | 391 |
| BOEING CO OF PORTLAND | PORTLAND, OR | 93.1% | 0.0% | 6.9% | 0.0% | $98,143 | 0.0% | 3.4% | 29 |
| DUCOMMUN AEROSTRUCTURES INC ORANGE FACILITY | ORANGE, CA | 76.7% | 0.0% | 23.3% | 16.3% | $120,992 | 0.0% | 0.0% | 43 |
| RADIUS AEROSPACE INC DBA RADIUS AEROSPACE-HOT SPRINGS | HOT SPRINGS, AR | 84.2% | 0.0% | 15.8% | 0.0% | $73,830 | 0.0% | 5.3% | 19 |
| WEATHERFORD AEROSPACE LLC | WEATHER­FORD, TX | 91.7% | 1.4% | 6.9% | 6.2% | $123,562 | 0.0% | 1.4% | 145 |

### Chemical Manufacturing

Table 10‑25 presents average information on communities surrounding the 12 perchloroethylene manufacturing 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 5-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 1, 3, and 5 miles of each facility. The table presents rural in addition to overall national statistics for comparison because 6 of the 12 facilities are in 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.

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| --- | --- | --- | --- | --- | --- |
| Table 10‑25: Demographics of communities within 1-, 3-, and 5-mile radii of Perchloroethylene Manufacturing Facilities across all conditions of use, population weighted average | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $45,225 | $53,509 | $62,120 |
| **White** | 70.4% | 87.6% | 63.6% | 50.1% | 57.9% |
| **Black** | 12.6% | 5.8% | 19.8% | 39.8% | 33.2% |
| **American Indian** | 0.8% | 1.7% | 1.6% | 0.6% | 0.4% |
| **Asian** | 5.6% | 1.2% | 0.2% | 0.4% | 1.0% |
| **Pacific Islander** | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% |
| **Other** | 10.3% | 3.6% | 14.8% | 9.0% | 7.5% |
| **Hispanic** | 18.2% | 2.4% | 41.8% | 24.6% | 21.3% |
| **2x Poverty Line** | 29.8% | 26.0% | 51.9% | 45.1% | 38.1% |
| **Below Poverty Line** | 12.8% | 9.6% | 17.6% | 21.0% | 18.0% |
| **Total Population** |  |  | 7,569 | 101,845 | 406,128 |
| **NATA Cancer Risk** | 30 |  | 52 | 66 | 67 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.90 | 0.74 | 0.61 |

Table 10‑25 indicates that communities within 1, 3, and 5 miles of perchloroethylene manufacturing facilities have higher proportions of Black or African American individuals, and lower proportions of White individuals, than national or rural averages. Such communities also have a higher representation of Hispanic individuals than national or rural averages. Median incomes in communities surrounding perchloroethylene manufacturing facilities are lower than national averages (lower than rural averages within 1 mile), and poverty rates are generally higher than national or rural averages. Both NATA cancer risk and the NATA respiratory hazard scores for PCE manufacturing facilities are much higher than the national average.

Table 10‑26 presents the density of other TRI facilities located within 1-, 3- and 5-mile distances of the 12 perchloroethylene manufacturing facilities. 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. The Oxy Vinyls LP La Porte VCM Plant in La Porte, TX, has the greatest density of nearby facilities – 8 within 1 mile, 38 within 3 miles, and 66 within 5 miles. The Westlake Vinyls site in Geismar, LA, also has a high density of nearby facilities – 8 within 1 mile, 18 within 3 miles, and 21 within 5 miles., as does the Formosa Plastics Corp. facility in Baton Rouge, LA – 7 within 1 mile, 16 within 3 miles, and 26 within 5 miles. Given the data above it is possible to conclude that (1) there is evidence of clustering of economic activity, and (2) 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.

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| --- | --- | --- | --- | --- |
| Table 10‑26: Total Number of Other TRI Facilities within 1, 3, and 5 Miles of Chemical Manufacturing Facilities | | | | |
| Facility Name | Location | 1 Mile | 3 Miles | 5 Miles |
| SHINTECH PLAQUEMINE PLANT | PLAQUEMINE, LA | 2 | 3 | 8 |
| OCCIDENTAL CHEMICAL CORP | GREGORY, TX | 1 | 3 | 5 |
| WESTLAKE VINYLS CO | GEISMAR, LA | 8 | 18 | 21 |
| DOW CHEMICAL CO FREEPORT FACILITY | FREEPORT, TX | 4 | 13 | 18 |
| OXY VINYLS LP LA PORTE VCM PLANT | LA PORTE, TX | 8 | 38 | 66 |
| FORMOSA PLASTICS CORP LOUISIANA | BATON ROUGE, LA | 7 | 16 | 26 |
| OLIN BLUE CUBE FREEPORT TX | FREEPORT, TX | 2 | 13 | 18 |
| BLUE CUBE OPERATIONS LLC - PLAQUEMINE SITE | PLAQUEMINE, LA | 4 | 7 | 9 |
| OCCIDENTAL CHEMICAL HOLDING CORP - GEISMAR PLANT | GEISMAR, LA | 2 | 12 | 15 |
| INEOS OLIGOMERS CHOCOLATE BAYOU | ALVIN, TX | 0 | 0 | 1 |
| EAGLE US 2 LLC | WESTLAKE, LA | 0 | 12 | 19 |
| FORMOSA PLASTICS CORP TEXAS | POINT COMFORT, TX | 0 | 1 | 1 |

Table 10‑27 shows the characteristics of chemical manufacturing workers and workers in the general population in locations with perchloroethylene manufacturing facilities and nationally. The table presents simple averages across all surveyed individuals in the affected PUMAs; it does not put extra weight on surveyed individuals in the two PUMAs that contain multiple facilities. The table indicates that nationally and within affected communities, workers who are Black, Hispanic, or a race other than Black or White are somewhat underrepresented in the chemical manufacturing industry compared to their representation in the overall workforce. Chemical manufacturing workers in communities surrounding perchloroethylene manufacturing facilities are more likely to be White, less likely to be Black or a race other than White or Black, and have higher incomes on average than chemical workers nationally. (This table reports personal income, consistent with the focus on workers, instead of household income, as reported in the community profiles above.) The proportion of Hispanic individuals among workers in these communities is also lower than national averages. The general population in communities with such facilities using perchloroethylene in a formulation has a lower share of Black workers and workers of a race other than White or Black, higher incomes, and lower poverty rates than the general worker population nationally.

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| Table 10‑27: Characteristics of Chemical Manufacturing Workers in General Population in Areas with Perchloroethylene Manufacturing Facilities and Nationally | | | | | | | | |
| Demographic | White | Black | Other | Hispanic | Total Income | Below Poverty Line | Below 2x Poverty Line | Number of Individuals Surveyed |
| Working population in affected communities + NAICS | 90.5% | 6.4% | 3.1% | 11.4% | $100,606 | 1.2% | 3.8% | 906 |
| Working population in affected communities | 83.5% | 10.6% | 5.9% | 21.7% | $55,072 | 5.8% | 18.0% | 20,637 |
| Natl working population in NAICS | 84.2% | 8.0% | 7.8% | 7.9% | $89,484 | 1.7% | 7.0% | 21,616 |
| Natl working population | 72.5% | 12.7% | 14.8% | 18.0% | $41,487 | 13.2% | 30.3% | 7,760,637 |

Table 10‑28 presents characteristics of chemical manufacturing workers in perchloroethylene manufacturing facilities. With the exception of the Shintech plant and Plaquemine, LA, and the Formosa Plastics Corp. plants in Baton Rouge, LA, and Point Comfort, TX, employees at the facilities in general earned incomes at or exceeding national averages for chemical manufacturing workers. The Occidental Chemical Corp facility in Gregory, TX, and the Formosa Plastics Corp facility in Point Comfort, TX, had higher proportions of Hispanic workers than national or industry averages. Chemical manufacturing workers in the Formosa Plastics Corp. facility in Point Comfort, TX, had poverty rates exceeding industry averages.

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| Table 10‑28: Demographics of Chemical Manufacturing Workers in Areas with Perchloroethylene Chemical Manufacturing Facilities | | | | | | | | | |
| Facility Name | Location | White | Black or African American | Other | Hispanic | Average Personal Income (2020$) | Below Poverty Line | Below 2x Poverty Line | Number of Surveyed Individuals |
| SHINTECH PLAQUEMINE PLANT | PLAQUEMINE, LA | 81.8% | 18.2% | 0.0% | 0.0% | $74,813 | 0.0% | 0.0% | 11 |
| OCCIDENTAL CHEMICAL CORP | GREGORY, TX | 95.2% | 0.0% | 4.8% | 26.2% | $97,420 | 0.0% | 4.8% | 42 |
| WESTLAKE VINYLS CO | GEISMAR, LA | 83.3% | 16.7% | 0.0% | 0.0% | $111,137 | 0.0% | 0.0% | 6 |
| DOW CHEMICAL CO FREEPORT FACILITY | FREEPORT, TX | 91.6% | 4.9% | 3.6% | 14.9% | $103,227 | 1.6% | 4.2% | 308 |
| OXY VINYLS LP LA PORTE VCM PLANT | LA PORTE, TX | 89.5% | 2.3% | 8.1% | 19.8% | $100,064 | 0.0% | 3.5% | 86 |
| INEOS OLIGOMERS CHOCOLATE BAYOU | ALVIN, TX | 94.2% | 2.5% | 3.3% | 17.5% | $105,553 | 0.0% | 2.5% | 120 |
| FORMOSA PLASTICS CORP LOUISIANA | BATON ROUGE, LA | 50.0% | 50.0% | 0.0% | 0.0% | $84,349 | 0.0% | 25.0% | 4 |
| OLIN BLUE CUBE FREEPORT TX | FREEPORT, TX | 91.6% | 4.9% | 3.6% | 14.9% | $103,227 | 1.6% | 4.2% | 308 |
| BLUE CUBE OPERATIONS LLC - PLAQUEMINE SITE | PLAQUEMINE, LA | 82.4% | 16.7% | 0.9% | 0.0% | $89,849 | 1.9% | 5.6% | 108 |
| EAGLE US 2 LLC | WESTLAKE, LA | 92.3% | 6.2% | 1.5% | 2.3% | $99,694 | 1.5% | 3.8% | 130 |
| FORMOSA PLASTICS CORP TEXAS | POINT COMFORT, TX | 78.3% | 4.8% | 16.9% | 43.4% | $66,699 | 3.6% | 8.4% | 83 |
| OCCIDENTAL CHEMICAL HOLDING CORP - GEISMAR PLANT | GEISMAR, LA | 88.4% | 10.7% | 0.9% | 4.5% | $101,137 | 1.8% | 1.8% | 112 |

### Degreasing

Table 10‑29 presents average information on communities surrounding the 15 facilities using perchloroethylene as a degreaser 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 5-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 1, 3, and 5 miles of each facility. The table presents rural in addition to overall national statistics for comparison because 6 of the 15 facilities are in 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.

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| Table 10‑29: Demographics of communities within 1-, 3-, and 5-mile radii of Perchloroethylene using Degreasing Facilities across all conditions of use, population weighted average | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $57,047 | $66,933 | $69,906 |
| **White** | 70.4% | 87.6% | 58.0% | 66.4% | 66.9% |
| **Black** | 12.6% | 5.8% | 18.4% | 16.3% | 14.2% |
| **American Indian** | 0.8% | 1.7% | 0.7% | 0.6% | 0.4% |
| **Asian** | 5.6% | 1.2% | 5.1% | 5.1% | 6.3% |
| **Pacific Islander** | 0.2% | 0.1% | 0.1% | 0.1% | 0.2% |
| **Other** | 10.3% | 3.6% | 17.8% | 11.6% | 12.0% |
| **Hispanic** | 18.2% | 2.4% | 30.7% | 23.7% | 23.5% |
| **2x Poverty Line** | 29.8% | 26.0% | 38.5% | 33.9% | 32.8% |
| **Below Poverty Line** | 12.8% | 9.6% | 15.4% | 14.1% | 13.8% |
| **Total Population** |  |  | 62,042 | 500,511 | 1,376,182 |
| **NATA Cancer Risk** | 30 |  | 41 | 37 | 35 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.40 | 0.39 | 0.39 |

Table 10‑29 indicates that communities within 1, 3, and 5 miles of facilities using perchloroethylene as a degreaser had a higher proportion of Hispanic individuals, and slightly higher proportions of Black or African American individuals and individuals who identify as a race other than those listed, than national or rural averages. Median incomes were lower than national averages but higher than rural averages among communities within 1 mile of these facilities but approached national averages for communities within 3 and 5 miles of said facilities. Poverty rates among these communities were slightly higher than national averages. NATA cancer risks and NATA respiratory hazard scores were similar to national averages.

Table 10‑30 presents the density of other TRI facilities located within 1-, 3-, and 5-mile distances of the 15 facilities using perchloroethylene as a degreaser. 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. The Metal Impact LLC facility in Cook, IL, has the greatest density of nearby facilities – 11 within 1 mile, 40 within 3 miles, and 47 within 5 miles. The Westlake Vinyls site in Calvert City, KY, has the greatest density of nearby facilities– 5 within 1 mile, 10 within 3 miles, and 10 within 5 miles. The ExxonMobil Chemical Co Baytown Olefins Plant in Harris, TX, also has a high density of nearby facilities – 2 within 1 mile, 8 within 3 miles, and 24 within 5 miles, as does the Bell Plant 5 facility in Tarrant, TX – 3 within 1 mile, 16 within 3 miles, and 27 within 5 miles. Given the data above it is possible to conclude that (1) there is evidence of clustering of economic activity, and (2) 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.

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| Table 10‑30: *Total Number of Other TRI Facilities within 1, 3 and 5 Miles of Degreasing Facilities* | | | | |
| Name | Location | 1 Mile | 3 Miles | 5 Miles |
| METAULLICS SYSTEMS A DIV OF PYROTEK-INC | NIAGARA, NY | 1 | 4 | 14 |
| GETZEN CO INC | WALWORTH, WI | 4 | 4 | 4 |
| SIERRA BULLETS LLC | PETTIS, MO | 4 | 10 | 12 |
| FOREST RIVER INC CHEROKEE DIV | LAGRANGE, IN | 3 | 3 | 3 |
| SGL COMPOSITES INC | CLARK, AR | 1 | 2 | 3 |
| TESLA GIGAFACTORY | STOREY, NV | 1 | 3 | 4 |
| EXXONMOBIL CHEMICAL CO BAYTOWN OLEFINS PLANT (PART) | HARRIS, TX | 2 | 8 | 24 |
| ROLLS-ROYCE CORP-PLANTS 5 & 8 | MARION, IN | 1 | 9 | 23 |
| BELL PLANT 5 | TARRANT, TX | 3 | 16 | 27 |
| CHAMPION BRANDS LLC | HENRY, MO | 1 | 2 | 2 |
| DRS NIS LLC | DALLAS, TX | 3 | 4 | 17 |
| METAL IMPACT LLC | COOK, IL | 11 | 40 | 47 |
| HINES PRECISION INC | DAVIESS, KY | 0 | 0 | 1 |
| UNIMETAL SURFACE FINISHING LLC | LITCHFIELD, CT | 0 | 2 | 7 |
| ARCOS INDUSTRIES LLC | NORTHUMBERLAND, PA | 0 | 1 | 1 |

The following tables provide profiles of communities surrounding each facility identified to have a high density of surrounding additional facilities, again focusing on populations located within 1, 3, and 5 miles. For comparison, the tables provide the national averages, as all three facilities are located in urban areas.

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| Table 10‑31: Exxon Mobil Chemical Co Baytown Olefins Plant, Harris, TX | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $56,070 | $55,626 | $58,168 |
| **White** | 70.4% | 87.6% | 63.1% | 66.1% | 69.2% |
| **Black** | 12.6% | 5.8% | 22.6% | 17.2% | 15.2% |
| **American Indian** | 0.8% | 1.7% | 0.5% | 0.3% | 0.2% |
| **Asian** | 5.6% | 1.2% | 2.7% | 1.5% | 1.0% |
| **Pacific Islander** | 0.2% | 0.1% | 0.7% | 0.1% | 0.1% |
| **Other** | 10.3% | 3.6% | 10.5% | 14.8% | 14.4% |
| **Hispanic** | 18.2% | 2.4% | 40.8% | 54.6% | 50.7% |
| **2x Poverty Line** | 29.8% | 26.0% | 41.7% | 43.8% | 39.8% |
| **Below Poverty Line** | 12.8% | 9.6% | 15.2% | 20.2% | 18.6% |
| **Total Population** |  |  | 2,036 | 42,180 | 90,326 |
| **NATA Cancer Risk** | 30 |  | 70 | 58 | 50 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.50 | 0.48 | 0.46 |

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| Table 10‑32: Metal Impact LLC, Cook, IL | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $63,838 | $82,564 | $88,137 |
| **White** | 70.4% | 87.6% | 61.5% | 74.7% | 76.2% |
| **Black** | 12.6% | 5.8% | 4.4% | 3.0% | 2.5% |
| **American Indian** | 0.8% | 1.7% | 2.5% | 0.6% | 0.5% |
| **Asian** | 5.6% | 1.2% | 14.0% | 10.9% | 10.2% |
| **Pacific Islander** | 0.2% | 0.1% | 0.1% | 0.2% | 0.1% |
| **Other** | 10.3% | 3.6% | 17.3% | 10.6% | 10.5% |
| **Hispanic** | 18.2% | 2.4% | 39.4% | 21.3% | 18.8% |
| **2x Poverty Line** | 29.8% | 26.0% | 30.1% | 22.1% | 19.3% |
| **Below Poverty Line** | 12.8% | 9.6% | 6.7% | 7.2% | 6.4% |
| **Total Population** |  |  | 7,693 | 75,061 | 236,865 |
| **NATA Cancer Risk** | 30 |  | 30 | 32 | 31 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.46 | 0.44 | 0.44 |

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| --- | --- | --- | --- | --- | --- |
| Table 10‑33: Bell Plant 5, Tarrant, TX | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $61,921 | $59,855 | $57,882 |
| **White** | 70.4% | 87.6% | 50.0% | 51.8% | 54.1% |
| **Black** | 12.6% | 5.8% | 33.8% | 30.0% | 21.2% |
| **American Indian** | 0.8% | 1.7% | 0.1% | 0.3% | 0.4% |
| **Asian** | 5.6% | 1.2% | 5.9% | 5.0% | 6.7% |
| **Pacific Islander** | 0.2% | 0.1% | 0.0% | 0.6% | 0.7% |
| **Other** | 10.3% | 3.6% | 10.1% | 12.4% | 17.0% |
| **Hispanic** | 18.2% | 2.4% | 25.6% | 33.0% | 40.3% |
| **2x Poverty Line** | 29.8% | 26.0% | 28.1% | 34.9% | 39.5% |
| **Below Poverty Line** | 12.8% | 9.6% | 9.9% | 14.5% | 16.8% |
| **Total Population** |  |  | 11,484 | 69,508 | 241,723 |
| **NATA Cancer Risk** | 30 |  | 92 | 70 | 53 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.40 | 0.40 | 0.40 |

The tables above indicate that median incomes in communities surrounding two of the three facilities – the ExxonMobil facility in Harris, TX, and Bell Plant 5 facility in Tarrant, TX, had median incomes lower than the national average, and poverty rates higher than the national average (though communities within 1 mile of the Bell Plant 5 facility had a lower poverty rate than the national average). Communities surrounding the Metal Impact LLC facility in Cook, IL, had higher median incomes than the national average, and poverty rates lower than the national average. All three facilities had communities with a higher proportion of Hispanic individuals than the national average. Communities surrounding the ExxonMobil and Bell Plant 5 facilities had a higher proportion of Black or African American individuals, and communities surrounding the Metal Impact LLC facility had a higher proportion of Asian individuals than national averages. The ExxonMobil Plant in Harris, TX, and the Bell Plant 5 in Tarrant, TX, had higher NATA cancer scores than the national average.

### Processing as a Reactant

Table 10‑34 presents average information on communities surrounding the four facilities using perchloroethylene for processing as a reactant 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 5-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 1, 3, and 5 miles of each facility. The table presents rural in addition to overall national statistics for comparison because two of the four facilities are in 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.

The percentage shares of the Black population and the population living below the poverty line are substantially higher near these facilities compared to the national population. NATA cancer and respiratory hazard risks are also significantly above the national average.

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| Table 10‑34: Demographics of communities within 1-, 3-, and 5-mile radii of facilities using perchloroethylene in processing as a reactant across, population weighted average | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $39,189 | $45,041 | $52,639 |
| **White** | 70.4% | 87.6% | 14.9% | 33.0% | 40.2% |
| **Black** | 12.6% | 5.8% | 84.4% | 62.8% | 54.6% |
| **American Indian** | 0.8% | 1.7% | 0.0% | 0.2% | 0.3% |
| **Asian** | 5.6% | 1.2% | 0.0% | 0.6% | 1.4% |
| **Pacific Islander** | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% |
| **Other** | 10.3% | 3.6% | 0.7% | 3.4% | 3.6% |
| **Hispanic** | 18.2% | 2.4% | 0.9% | 6.8% | 8.7% |
| **2x Poverty Line** | 29.8% | 26.0% | 52.7% | 51.2% | 46.7% |
| **Below Poverty Line** | 12.8% | 9.6% | 29.8% | 26.9% | 24.6% |
| **Total Population** |  |  | 1,120 | 61,662 | 179,434 |
| **NATA Cancer Risk** | 30 |  | 60 | 55 | 57 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 1.01 | 0.80 | 0.68 |

The following tables provide profiles of communities surrounding each facility individually, 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.

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| Table 10‑35: The Chemours Co., Gregory, TX | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 |  | $74,862 | $74,863 |
| **White** | 70.4% | 87.6% |  | 91.4% | 89.8% |
| **Black** | 12.6% | 5.8% |  | 1.8% | 1.9% |
| **American Indian** | 0.8% | 1.7% |  | 0.1% | 0.3% |
| **Asian** | 5.6% | 1.2% |  | 1.0% | 0.9% |
| **Pacific Islander** | 0.2% | 0.1% |  | 0.0% | 0.2% |
| **Other** | 10.3% | 3.6% |  | 5.7% | 6.9% |
| **Hispanic** | 18.2% | 2.4% |  | 44.4% | 45.6% |
| **2x Poverty Line** | 29.8% | 26.0% |  | 29.3% | 27.9% |
| **Below Poverty Line** | 12.8% | 9.6% |  | 7.1% | 8.3% |
| **Total Population** |  |  |  | 6,828 | 23,827 |
| **NATA Cancer Risk** | 30 |  |  | 20 | 20 |
| **NATA Respiratory Hazard Score** | 0.44 |  |  | 0.20 | 0.21 |

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| Table 10‑36: Honeywell International, Carville, LA | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 |  | $76,868 | $88,608 |
| **White** | 70.4% | 87.6% |  | 56.0% | 57.9% |
| **Black** | 12.6% | 5.8% |  | 40.5% | 39.1% |
| **American Indian** | 0.8% | 1.7% |  | 0.0% | 0.0% |
| **Asian** | 5.6% | 1.2% |  | 0.1% | 0.6% |
| **Pacific Islander** | 0.2% | 0.1% |  | 0.0% | 0.0% |
| **Other** | 10.3% | 3.6% |  | 3.4% | 2.3% |
| **Hispanic** | 18.2% | 2.4% |  | 5.5% | 5.9% |
| **2x Poverty Line** | 29.8% | 26.0% |  | 30.9% | 25.0% |
| **Below Poverty Line** | 12.8% | 9.6% |  | 16.2% | 10.9% |
| **Total Population** |  |  |  | 765 | 13,969 |
| **NATA Cancer Risk** | 30 |  |  | 140 | 130 |
| **NATA Respiratory Hazard Score** | 0.44 |  |  | 0.55 | 0.53 |

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| Table 10‑37: Honeywell International, Baton Rouge, LA | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $38,977 | $39,597 | $44,744 |
| **White** | 70.4% | 87.6% | 13.7% | 21.4% | 27.4% |
| **Black** | 12.6% | 5.8% | 85.6% | 74.6% | 67.6% |
| **American Indian** | 0.8% | 1.7% | 0.0% | 0.2% | 0.3% |
| **Asian** | 5.6% | 1.2% | 0.0% | 0.6% | 1.6% |
| **Pacific Islander** | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% |
| **Other** | 10.3% | 3.6% | 0.6% | 3.2% | 3.2% |
| **Hispanic** | 18.2% | 2.4% | 0.9% | 2.1% | 2.8% |
| **2x Poverty Line** | 29.8% | 26.0% | 52.9% | 55.6% | 52.9% |
| **Below Poverty Line** | 12.8% | 9.6% | 30.1% | 30.5% | 29.4% |
| **Total Population** |  |  | 1,104 | 51,271 | 136,169 |
| **NATA Cancer Risk** | 30 |  | 60 | 59 | 57 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 1.00 | 0.82 | 0.74 |

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| Table 10‑38: Westlake Vinyls Inc., Calvert City, KY | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $53,804 | $63,334 | $60,525 |
| **White** | 70.4% | 87.6% | 96.9% | 97.0% | 97.5% |
| **Black** | 12.6% | 5.8% | 0.0% | 0.0% | 0.3% |
| **American Indian** | 0.8% | 1.7% | 0.0% | 0.2% | 0.3% |
| **Asian** | 5.6% | 1.2% | 0.0% | 0.3% | 0.2% |
| **Pacific Islander** | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% |
| **Other** | 10.3% | 3.6% | 3.1% | 2.5% | 1.7% |
| **Hispanic** | 18.2% | 2.4% | 2.0% | 2.7% | 2.4% |
| **2x Poverty Line** | 29.8% | 26.0% | 38.7% | 29.8% | 30.1% |
| **Below Poverty Line** | 12.8% | 9.6% | 12.5% | 12.2% | 11.4% |
| **Total Population** |  |  | 16 | 2,798 | 5,469 |
| **NATA Cancer Risk** | 30 |  | 40 | 39 | 37 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 2.00 | 1.90 | 1.60 |

The communities surrounding the Chemours Co. facility in Gregory, TX, have a higher proportion of Hispanic individuals than national or rural averages; such communities also have median incomes that are higher than national or rural averages, and poverty rates that are significantly lower. Communities surrounding both of the Honeywell International facilities – in Carville, LA, and Baton Rouge, LA – have higher proportions of Black or African-American individuals. Median incomes in communities surrounding the Carville facility are higher than national or rural averages, while median incomes are significantly lower, and poverty rates significantly higher, than national or rural averages in communities surrounding the Baton Rouge facility. Communities surrounding the Honeywell International facility Carville, LA, have NATA cancer scores significantly higher than national averages, and communities surrounding the Honeywell International facility in Baton Rouge, LA, as well as the Westlake Vinyls facility in Calvert City, KY, have significantly higher respiratory hazard scores than national or rural averages.

Table 10‑39 presents the density of other TRI facilities located within 1-, 3-, and 5-mile distances of the four chemical manufacturing facilities. 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. The Westlake Vinyls site in Calvert City, KY, has the greatest density of nearby facilities –5 within 1 mile, 10 within 3 miles, and 10 within 5 miles. Both Honeywell International facilities – in Carville, LA, and Baton Rouge, LA, had a high density of nearby facilities; 4 within a mile of the Carville facility, 20 within 3 miles, and 30 within 5 miles; 1 additional facility was located within a mile of the Baton Rouge facility, 14 within 3 miles, and 19 within 5 miles. Given the data above it is possible to conclude that (1) there is evidence of clustering of economic activity, and (2) 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.

NATA cancer risks are significantly higher than average for the Honeywell plants in Baton Rouge, LA, and Carville, LA. NATA respiratory hazard risks are significantly higher than average for the Honeywell plant in Baton Rouge, LA, and the Westlake Vinyls plant in Calvert City, KY.

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| Table 10‑39: Total Number of Other TRI Facilities within 1, 3 and 5 miles of facilities using perchloroethylene in processing as a reactant | | | | |
| Name | Location | 1-mile | 3-mile | 5-mile |
| THE CHEMOURS CO | GREGORY, TX | 1 | 3 | 5 |
| HONEYWELL INTERNATIONAL INC GEISMAR PLANT | CARVILLE, LA | 4 | 20 | 30 |
| HONEYWELL INTERNATIONAL INC-BATON ROUGE PLANT | BATON ROUGE, LA | 1 | 14 | 19 |
| WESTLAKE VINYLS INC | CALVERT CITY, KY | 5 | 10 | 10 |

Table 10‑40 presents characteristics of chemical manufacturing workers in facilities using perchloroethylene as a reactant. Incomes of workers at all facilities were significantly higher than rural or national averages. The Chemours Co. facility in Gregory, TX, had a higher proportion of Hispanic workers than national averages. The Honeywell International facility in Baton Rouge, LA, had a higher proportion of Black or African American workers than national or rural averages.

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| Table 10‑40: Demographics of Chemical Manufacturing workers in facilities using perchloroethylene in processing as a reactant | | | | | | | | | |
| Facility Name | Location | White | Black or African American | Other | Hispanic | Average Personal Income (2020$) | Below Poverty Line | Below 2x Poverty Line | Number of Surveyed Individuals |
| THE CHEMOURS CO | GREGORY, TX | 95.2% | 0.0% | 4.8% | 26.2% | $97,420 | 0.0% | 4.8% | 42 |
| HONEYWELL INTERNATIONAL INC GEISMAR PLANT | CARVILLE, LA | 88.4% | 10.7% | 0.9% | 4.5% | $101,137 | 1.8% | 1.8% | 112 |
| HONEYWELL INTERNATIONAL INC-BATON ROUGE PLANT | BATON ROUGE, LA | 55.6% | 42.6% | 1.9% | 0.0% | $93,685 | 1.9% | 11.1% | 54 |
| WESTLAKE VINYLS INC | CALVERT CITY, KY | 97.5% | 1.2% | 1.2% | 1.2% | $94,989 | 0.0% | 2.5% | 81 |

### Processing Aid

Table 10‑41 presents average information on communities surrounding the 70 facilities using perchloroethylene as a processing aid 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 5-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 1, 3, and 5 miles of each facility. The table presents rural in addition to overall national statistics for comparison because 11 of the 70 facilities are in 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.

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| Table 10‑41: Demographics of communities within 1-, 3-, and 5-mile radii of facilities using perchloroethylene as a processing aid population weighted average | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $52,964 | $63,986 | $65,065 |
| **White** | 70.4% | 87.6% | 67.5% | 64.9% | 65.0% |
| **Black** | 12.6% | 5.8% | 9.7% | 13.0% | 14.0% |
| **American Indian** | 0.8% | 1.7% | 1.5% | 1.0% | 0.9% |
| **Asian** | 5.6% | 1.2% | 3.4% | 4.6% | 5.3% |
| **Pacific Islander** | 0.2% | 0.1% | 0.3% | 0.3% | 0.2% |
| **Other** | 10.3% | 3.6% | 17.5% | 16.2% | 14.6% |
| **Hispanic** | 18.2% | 2.4% | 49.5% | 43.6% | 39.7% |
| **2x Poverty Line** | 29.8% | 26.0% | 40.5% | 37.6% | 37.0% |
| **Below Poverty Line** | 12.8% | 9.6% | 18.8% | 16.6% | 16.4% |
| **Total Population** |  |  | 155,275 | 2,880,435 | 7,703,847 |
| **NATA Cancer Risk** | 30 |  | 39 | 36 | 36 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.43 | 0.41 | 0.40 |

Table 10‑41 indicates that, in general, communities within 1-, 3-, and 5- miles of facilities using perchloroethylene as a processing aid have a higher proportion of Hispanic individuals, as well as individuals identifying as a race other than those listed, than national averages. The data suggest that incomes in communities within 1 mile of such facilities are significantly lower than national averages and similar to rural averages; within 3- and 5- miles, incomes are closer to national averages; poverty rates in such communities are significantly higher than national or rural averages. NATA cancer risks and respiratory hazard scores are similar to the national average.

Table 10‑42 shows the characteristics of petroleum refinery workers and workers in the general population in locations with facilities using perchloroethylene as a processing aid and nationally. The table presents simple averages across all surveyed individuals in the affected PUMAs; it does not put extra weight on surveyed individuals in the two PUMAs that contain multiple facilities. The table indicates that nationally and within affected communities, workers who are Black, Hispanic, or a race other than Black or White are somewhat underrepresented in the petroleum refining industry compared to their representation in the overall workforce. Petroleum refining workers in communities with facilities using perchloroethylene as a processing aid are more likely to be White, less likely to be Black or a race other than White or Black and have higher incomes on average than chemical workers nationally. (This table reports personal income, consistent with the focus on workers, instead of household income, as reported in the community profiles above.) The proportion of Hispanic individuals among workers in these communities is also lower than national averages. The general population in communities with such facilities using perchloroethylene in a formulation has a lower share of Black workers, Hispanic workers and workers of a race other than White or Black; higher incomes; and lower poverty rates than the general worker population nationally.

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| Table 10‑42: Characteristics of Petroleum Refining Workers in General Population in Areas with Perchloroethylene Manufacturing Facilities and Nationally | | | | | | | | |
| Demographic | White | Black | Other | Hispanic | Total Income | Below Poverty LIne | Below 2x Poverty Line | Number of Individuals Surveyed |
| Working population in affected communities + NAICS | 87.50% | 6.1% | 6.4% | 12.8% | $103,581 | 1.4% | 5.6% | 1,630 |
| Working population in affected communities | 78.1% | 10.0% | 11.8% | 15.0% | $52,312 | 6.5% | 19.2% | 212,644 |
| Natl working population in NAICS | 82.5% | 6.4% | 11.1% | 16.8% | $109,613 | 1.9% | 7.0% | 8,670 |
| Natl working population | 72.5% | 12.7% | 14.8% | 18.0% | $41,487 | 13.2% | 30.3% | 7,760,637 |

### Processing – Incorporation into Formulation. Mixture, or Reaction Product

Table 10‑43 presents average information on communities surrounding the 28 facilities processing perchloroethylene into chemical formulations, mixtures, or reaction products 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 5-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 1, 3, and 5 miles of each facility. The table presents rural in addition to overall national statistics for comparison because 3 of the 28 facilities are in 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.

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| Table 10‑43: Demographics of communities within 1-, 3-, and 5-mile radii of facilities processing perchloroethylene into formulations, mixtures or reaction products, population weighted average | | | | | |
| Demographic | National | Rural | 1-Mile Average | 3-Mile Average | 5-Mile Average |
| **Median Income** | $64,994 | $51,878 | $50,863 | $60,216 | $63,455 |
| **White** | 70.4% | 87.6% | 64.1% | 67.5% | 67.7% |
| **Black** | 12.6% | 5.8% | 13.1% | 15.0% | 15.3% |
| **American Indian** | 0.8% | 1.7% | 0.9% | 0.7% | 0.6% |
| **Asian** | 5.6% | 1.2% | 3.5% | 3.3% | 3.1% |
| **Pacific Islander** | 0.2% | 0.1% | 0.0% | 0.1% | 0.1% |
| **Other** | 10.3% | 3.6% | 18.4% | 13.5% | 13.3% |
| **Hispanic** | 18.2% | 2.4% | 41.4% | 35.2% | 32.9% |
| **2x Poverty Line** | 29.8% | 26.0% | 40.9% | 38.5% | 36.4% |
| **Below Poverty Line** | 12.8% | 9.6% | 19.1% | 16.3% | 15.2% |
| **Total Population** |  |  | 169,860 | 1,435,636 | 3,533,196 |
| **NATA Cancer Risk** | 30 |  | 50 | 42 | 39 |
| **NATA Respiratory Hazard Score** | 0.44 |  | 0.49 | 0.46 | 0.46 |

Table 10‑43 indicates that communities within 1-, 3-, and 5- miles of facilities processing perchloroethylene into chemical formulations, mixtures, or reaction products have higher proportions of Hispanic, and people identifying as a race other than those listed, than both national and rural averages. The data also suggests that median incomes are lower than national averages (though around equal within 5 miles), and poverty rates are higher than both national and rural averages. NATA cancer risks are significantly higher than national averages within 1 and 3 miles from PCE facilities processing PCE into formulations, mixtures, or reaction products.

Table 10‑44 shows the characteristics of chemical industry workers and workers in the general population in locations with facilities processing perchloroethylene into formulations and nationally. The table presents simple averages across all surveyed individuals in the affected PUMAs; it does not put extra weight on surveyed individuals in the two PUMAs that contain multiple facilities. The table indicates that nationally and within affected communities, workers who are Black, Hispanic, or a race other than Black or White are somewhat underrepresented in the chemicals industry compared to their representation in the overall workforce. Chemical workers in communities with chemical manufacturing facilities are more likely to be White, less likely to be Black or a race other than White or Black and have higher incomes on average than chemical workers nationally. (This table reports personal income, consistent with the focus on workers, instead of household income, as reported in the community profiles above.) The proportion of Hispanic individuals among workers in these communities is also lower than national averages. The general population in communities with such facilities processing perchloroethylene into formulations has a lower share of Black workers, Hispanic workers, and workers of a race other than White or Black; higher incomes; and lower poverty rates than the general worker population nationally.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 10‑44: Characteristics of Chemical Manufacturing Workers in General Population in Areas with Facilities Processing Perchloroethylene into Formulations, Mixtures or Reaction products and Nationally | | | | | | | | |
| category | White | Black | Other | Hispanic | Total Income | Below Poverty Line | Below 2x Poverty Line | Number of Individuals Surveyed |
| Working population in affected communities + NAICS | 91.3% | 4.6% | 4.1% | 13.4% | $98,224 | 1.5% | 5.3% | 543 |
| Working population in affected communities | 84.2% | 7.9% | 7.9% | 15.7% | $55,489 | 6.0% | 17.8% | 29,011 |
| Natl working population in NAICS | 84.2% | 8.0% | 7.8% | 7.9% | $89,483 | 1.7% | 7.0% | 21,616 |
| Natl working population | 72.5% | 12.7% | 14.8% | 18.0% | $41,487 | 13.2% | 30.3% | 7,760,637 |

### Dry Cleaning

Table 10‑45 shows the demographics of individuals in the dry cleaning occupation compared to the national population and the overall employed population ([U.S. Census Bureau 2010-2022](#_ENREF_62)). The table indicates that individuals who are not White and have incomes below 1.5 times the poverty line are overrepresented in the dry cleaning occupation compared to their representation in the overall workforce.

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| Table 10‑45: Demographics of the Dry Cleaning Worker Population | | | |
| Demographic | National  Population | Employed Population | Dry Cleaning |
| **White** | 60% | 62% | 31% |
| **Black** | 13% | 12% | 24% |
| **Asian** | 7% | 7% | 9% |
| **Hispanic** | 19% | 18% | 35% |
| **Other** | 1% | 1% | 1% |
| **1.5x Poverty Line** | 81% | 90% | 73% |
| **1.25-1.5x Poverty Line** | 4% | 3% | 8% |
| **1-1.25x Poverty Line** | 4% | 2% | 6% |
| **Below Poverty Line** | 11% | 5% | 12% |
| Source: [U.S. Census Bureau 2010-2022](#_ENREF_62) | | | |

## 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 final rule, 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 the GDP (See Memorandum from Sally Katzen, “Guidance for Implementing Title II of [UMRA],” March 31, 1995). Given the current GDP, this is equivalent to a cost of $40 billion to $80 billion. 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 PCE 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 PCE. Consistent with the Agency’s Performance Based Measurement System (PBMS), EPA is not requiring 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 meet the criteria are included in Appendix A of the ECEL memo.

## Executive Order 13132 – Federalism

Executive Order 13132, 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). 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 final action to permit them to have meaningful and timely input into its development. EPA invited the following national organizations representing state and local elected officials to a meeting on July 22, 2021: American Water Works Association, Association of Clean Water Administrators, Association of Metropolitan Water Agencies, Association of State Drinking Water Administrators, Environmental Council of the States, National Association of Counties, National Conference of State Legislatures, National Governors Association. National League of Cities, National Water Resources Association, and United States Conference of Mayors.

A summary of the meeting with these organizations, including the views that they expressed, is available in the docket. During the consultation, participants and EPA discussed preemption, the authority given under TSCA section 6 to regulate identified unreasonable risks, what activities would be regulated in the final rule, and the relationship between TSCA and existing statutes – particularly the Clean Water Act and Safe Drinking Water Act. EPA provided an opportunity for these organizations to provide follow-up comments in writing but did not receive any such comments.

## Executive Order 13175 – Tribal Implications

Executive Order 13175, 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 PCE 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 met with tribal officials via teleconference on July 22, 2021, concerning the prospective regulation of the PCE conditions of use under TSCA section 6. 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 those meetings nor by follow-up comments.

# Sensitivity Analyses

This chapter presents several sensitivity analyses related to the costs and benefits for the estimated costs, benefits, and net benefits of the regulatory options for dry cleaning machines. The sensitivity analysis results are presented below in Table 11‑1.

Sensitivity analyses 1 and 2 consider the alternative estimates for the number of affected dry cleaning machines discussed above in section 6.1.5 (3,000 and 11,000 PCE dry cleaning machines, respectively, versus the primary estimate of 6,000 machines). Costs, benefits, and net benefits are estimated to be proportionally lower and higher than the primary estimate according to the differences in the estimated numbers of machines.

Since there is uncertainty about when dry cleaning machines will reach the end of their useful life and require replacement, alternative assumptions about the useful life of dry cleaning machines are considered here. Note that there are almost no new PCE machines being purchased, so even without any EPA action PCE machines are expected to be replaced with alternatives. Sensitivity analyses 3 and 4, respectively, consider useful lives for dry cleaning machines that are 5 years earlier and 5 years later compared to the primary estimate. Under sensitivity 3, costs and benefits are smaller because there are fewer machines that need to be replaced and fewer individuals exposed in the baseline. Since costs decrease more than benefits, net benefits are higher. Under sensitivity 4, costs and benefits are larger because there are more machines that need to be replaced and more individuals exposed in the baseline. Since costs increase more than benefits, net benefits are lower.

Since the costs and benefits associated with the options for dry cleaning machines are a relatively small percentage of the total for all uses, the sensitivity results are only presented for the dry cleaning use.

| Table 11‑1: Total Annualized Net Benefits for the Dry Cleaning Use by Option, (Thousands, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Estimate | Costs | | Benefits | | Net Benefits | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Primary Estimate (6,000 dry cleaning machines; 15-25 year dry cleaning machine useful life) | | | | | | |
| Low Benefits, 2 Percent Discount Rate | $106 | $45 | $1.37 | $0.70 | ($105) | ($45) |
| High Benefits, 2 Percent Discount Rate | $106 | $45 | $3.55 | $1.81 | ($103) | ($43) |
| Low Benefits, 3 Percent Discount Rate | $109 | $44 | $1.09 | $0.55 | ($108) | ($43) |
| High Benefits, 3 Percent Discount Rate | $109 | $44 | $3.00 | $1.53 | ($106) | ($42) |
| Low Benefits, 7 Percent Discount Rate | $128 | $38 | $0.50 | $0.25 | ($127) | ($38) |
| High Benefits, 7 Percent Discount Rate | $128 | $38 | $1.68 | $0.86 | ($126) | ($37) |
| Sensitivity 1: 3,000 Dry Cleaning Machines Estimate | | | | | | |
| Low Benefits, 2 Percent Discount Rate | $53 | $23 | $0.68 | $0.35 | ($53) | ($22) |
| High Benefits, 2 Percent Discount Rate | $53 | $23 | $1.77 | $0.91 | ($51) | ($22) |
| Low Benefits, 3 Percent Discount Rate | $55 | $22 | $0.54 | $0.28 | ($54) | ($22) |
| High Benefits, 3 Percent Discount Rate | $55 | $22 | $1.50 | $0.76 | ($53) | ($21) |
| Low Benefits, 7 Percent Discount Rate | $64 | $19 | $0.25 | $0.13 | ($64) | ($19) |
| High Benefits, 7 Percent Discount Rate | $64 | $19 | $0.84 | $0.43 | ($63) | ($19) |
| Sensitivity 2: 11,000 Dry Cleaning Machines Estimate | | | | | | |
| Low Benefits, 2 Percent Discount Rate | $195 | $83 | $2.51 | $1.28 | ($193) | ($82) |
| High Benefits, 2 Percent Discount Rate | $195 | $83 | $6.51 | $3.32 | ($189) | ($80) |
| Low Benefits, 3 Percent Discount Rate | $200 | $80 | $1.99 | $1.01 | ($198) | ($79) |
| High Benefits, 3 Percent Discount Rate | $200 | $80 | $5.50 | $2.80 | ($195) | ($77) |
| Low Benefits, 7 Percent Discount Rate | $234 | $70 | $0.91 | $0.47 | ($233) | ($69) |
| High Benefits, 7 Percent Discount Rate | $234 | $70 | $3.08 | $1.58 | ($231) | ($68) |
| Sensitivity 3: Dry Cleaning Machine Useful Life Five Years Shorter | | | | | | |
| Low Benefits, 2 Percent Discount Rate | $50 | $33 | $0.40 | - | ($50) | ($33) |
| High Benefits, 2 Percent Discount Rate | $50 | $33 | $1.05 | - | ($49) | ($33) |
| Low Benefits, 3 Percent Discount Rate | $51 | $31 | $0.39 | - | ($50) | ($31) |
| High Benefits, 3 Percent Discount Rate | $51 | $31 | $1.09 | - | ($49) | ($31) |
| Low Benefits, 7 Percent Discount Rate | $53 | $44 | $0.23 | - | ($53) | ($44) |
| High Benefits, 7 Percent Discount Rate | $53 | $44 | $0.78 | - | ($52) | ($44) |
| Sensitivity 4: Dry Cleaning Machine Useful Life Five Years Longer | | | | | | |
| Low Benefits, 2 Percent Discount Rate | $165 | $161 | $2.37 | $0.66 | ($162) | ($161) |
| High Benefits, 2 Percent Discount Rate | $165 | $161 | $6.16 | $1.72 | ($158) | ($159) |
| Low Benefits, 3 Percent Discount Rate | $170 | $58 | $1.88 | $0.52 | ($168) | ($58) |
| High Benefits, 3 Percent Discount Rate | $170 | $58 | $5.19 | $1.45 | ($165) | ($57) |
| Low Benefits, 7 Percent Discount Rate | $204 | $194 | $0.85 | $0.24 | ($203) | ($194) |
| High Benefits, 7 Percent Discount Rate | $204 | $194 | $2.89 | $0.81 | ($201) | ($194) |

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- 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 PCE 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 the 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 PCE was determined. The price for individual products containing alternative chemicals was compared to the price range of the products containing PCE. 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% |
| 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** |  | |

- HSP Theory and Calculations

A solute is the substance being dissolved, and a solvent is the substance that dissolves it. Both substances (solute and solvent) should have similar HSP to dissolve the solute. The HSP approach is based on three distinctive forms of inter-molecular force:

1. Dispersion forces (D): All atoms are surrounded by electron "clouds." The electron cloud is, on average, evenly distributed around the atom. At a given instant, however, the electron distribution may be uneven. This temporary polarization results in attractive interactions with nearby atoms.
2. Polar forces (P): Dipole moments are created when atoms of the same molecule have different electronegativities.
3. Hydrogen bond forces (H): This force exists between hydrogen atoms and other atoms present in adjacent molecules.

These three forces or parameters are used to describe solvent and solute interactions. Each parameter can be used as an axis in three-dimensional solubility space. Instead of the common X, Y, and Z axis, the three-dimensional solubility space will have a Dispersion Force (D) axis, a Polar Force (P) axis, and a Hydrogen Bonding Force (H) axis. Each solvent can be represented as a point in three-dimensional solubility space, and each solute can be represented as a solubility sphere in three-dimensional solubility space.

HSP values are based on the principle that "like dissolves like," meaning that the closer the solute and solvent are in three-dimensional solubility space, the greater the likelihood that the solvent will be effective.

If the solvent is located inside the solute sphere of solubility, then it will dissolve the polymer. If the solvent is located outside the solute sphere of solubility, then it will NOT dissolve the polymer. The distance between HSP points in solubility space is calculated as follows:

Distance = [4 (D1-D2)2 + (P1-P2)2 + (H1-H2)2 ]1/2

As shown in Figure B1 below, the three axes are for the polar force, hydrogen bonding force, and dispersion force. The black dot represents the center point for the solute sphere of solubility. The green dots represent solvents that are inside the solute solubility sphere and will dissolve the solute. The red dots represent solvents that are outside the solute solubility sphere and will NOT dissolve the solute.

This is a diagram showing the three Hansen Solubility Parameters, a sphere of solubility, and solvents located inside and outside of the sphere.


*Figure B1: Solvents and Sphere of Solubility in Hansen Solubility Parameter 3D Space*

In general, the lower the HSP distance between the solvent and the solute, the better the solubility performance. The lower the HSP distance between solvent and the center of the solute solubility sphere, the faster the solute dissolves ([TURI 2020](#_ENREF_53)).

The details of the HSP distance calculations for AC coil cleaner products is provided in this appendix as an example of these calculations. Exhibit B‑1 shows the HSP calculations for the various AC coil cleaner products. (Note: the HSP calculations for all other product categories are still in the HSP Calculations Excel file and have not been imported into Appendix B).

The first column of the table shows the solvent name and the second column shows the chemical CAS number. The third through fifth columns show the three Hansen Solubility Parameters: D value, P value, and H value. The sixth column shows the concentration of the solvent within the product. The last row of each table shows the overall Hansen Solubility Parameters for the entire solvent blend with the product.

| Exhibit B‑1: HSP Calculations for AC coil cleaner products | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Product | Solvent | CAS # | D value | P value | H value | Concentration |
| Nu-Calgon Cal Blast | DCM | 75-09-2 | 17 | 7.3 | 7.1 | 95% |
| D-limonene | 5989-27-5 | 17.2 | 1.8 | 4.3 | 5% |
| PCE | 127-18-4 | 18.3 | 5.7 | 0 | 0% |
| Blend |  | 17.0 | 7.0 | 7.0 | 100% |
| Nu-Calgon Evap Foam | water | 7732-18-5 | 15.5 | 16 | 42.3 | 90% |
| 2-butoxyethanol | 111-76-2 | 16 | 5.1 | 12.3 | 5% |
| Diethylene glycol ethyl ether | 111-90-0 | 16.1 | 9.2 | 12.2 | 5% |
| Blend |  | 15.6 | 15.1 | 39.3 | 100% |
| CRC Foaming Coil Cleaner | water | 7732-18-5 | 15.5 | 16 | 42.3 | 95% |
| 2-butoxyethanol | 111-76-2 | 16 | 5.1 | 12.3 | 5% |
| Diethylene glycol ethyl ether | 111-90-0 | 16.1 | 9.2 | 12.2 | 0% |
| Blend |  | 15.5 | 15.5 | 40.8 | 100% |
| Nu-Calgon Evap Pow r C | water | 7732-18-5 | 15.5 | 16 | 42.3 | 85% |
| 2-butoxyethanol | 111-76-2 | 16 | 5.1 | 12.3 | 15% |
| Diethylene glycol ethyl ether | 111-90-0 | 16.1 | 9.2 | 12.2 | 0% |
| Blend |  | 15.6 | 14.4 | 37.8 | 100% |
| Nu-Calgon Blackhawk | water | 7732-18-5 | 15.5 | 16 | 42.3 | 90% |
| 2-butoxyethanol | 111-76-2 | 16 | 5.1 | 12.3 | 5% |
| Diethylene glycol ethyl ether | 111-90-0 | 16.1 | 9.2 | 12.2 | 5% |
| Blend |  | 15.6 | 15.1 | 39.3 | 100% |
| Sunshine Simple Green | water | 7732-18-5 | 15.5 | 16 | 42.3 | 70% |
| triethanolamine | 102-71-6 | 17.3 | 7.6 | 21 | 15% |
| Propylene Glycol Butyl Ether | 5131-66-8 | 15.3 | 4.5 | 9.2 | 5% |
| Ethoxylated Alcohol | 68439-46-3 | 15.8 | 4.9 | 7.7 | 10% |
| Blend |  | 15.8 | 13.1 | 34.0 | 100% |

**Appendix C: Estimated Costs for Respirator PPE for TSCA Risk Management Economic Analyses**

January 2024

**Submitted to:**

**Economic and Policy Analysis Branch**

Existing Chemicals Risk Management Division

Office of Pollution, Prevention, and Toxics

U.S. Environmental Protection Agency

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- Benefits and Net Benefits Estimated Using the Lowering Factor

This appendix presents a sensitivity analysis for the low benefits estimate using a “lowering factor” adjustment to the excess lifetime risk for cancer. The lowering factor is an adjustment to the excess lifetime risk for cancer to account for the shorter exposure durations being considered and the life stage at which the changes in exposure occur. The excess lifetime risk for cancer is usually defined as an increase in cancer risk over a lifetime of exposure. However, a new policy may affect only a shorter duration of exposure, and that effect can occur at different stages of exposed individuals’ lives.

The lowering factor is calculated as the percentage of incidence of the cancer that occurs within the age range spanning from the age at which the change in exposure is experienced through the end of the expected lifetime. For example, if 85 percent of cancer cases occur in individuals aged 50 or older, the lowering factor for an individual experiencing a one-year change in exposure at age 50 is 85%. As noted in EPA ([2013](#_ENREF_72)), “For example, consider someone who is 50 years old in the year of the analysis and has not yet gotten the cancer. Should the entire excess lifetime risk (the unit risk) be applied to this individual for the remaining expected years of his life? Or should a modified excess risk, conditional on his not having gotten the cancer in his first 49 years, be applied? Because the unit risk provides no information about how excess risk is distributed over the course of a lifetime, there is no clear answer.” Thus, the lowering factors presented in Table D-1 are used in estimating the low estimate for the value of the risk reductions.

|  |  |  |
| --- | --- | --- |
| Table D-1: Lowering Factors, by Sector and Cancer Site | | |
| Affected Population Sector | Cancer Site | Lowering Factor |
| Manufacturing | Liver | 91% |
| Kidney | 87% |
| Brain Gliomas | 56% |
| Testicular | 33% |
| Transportation and Public Utilities | Liver | 91% |
| Kidney | 88% |
| Brain Gliomas | 56% |
| Testicular | 34% |
| Services | Liver | 90% |
| Kidney | 86% |
| Brain Gliomas | 56% |
| Testicular | 34% |
| Source: [Abt Associates 2022b](#_ENREF_3) | | |

Including the lowering factor affects the estimated distribution for the lag between exposure and diagnosis and exposure and mortality (for cancer that is ultimately fatal). Table D-2 presents the estimated values for microrisk reductions that are estimated using the lowering factor.

| Table D-2: Value for Microrisk Reductions (2022$) | | | | |
| --- | --- | --- | --- | --- |
| Affected Population Sector | Cancer Site | Estimated Value for a 1/1,000,000 Reduction in Cancer Risk | | |
| Low Estimate (with lowering factor) | | |
| 2% | 3% | 7% |
| Manufacturing | Liver | $7.32 | $5.86 | $2.83 |
| Kidney | $3.49 | $2.74 | $1.24 |
| Brain Gliomas | $7.35 | $5.95 | $2.98 |
| Testis | $0.69 | $0.58 | $0.32 |
| Transportation and Public Utilities | Liver | $7.30 | $5.84 | $2.81 |
| Kidney | $3.48 | $2.73 | $1.23 |
| Brain Gliomas | $7.33 | $5.93 | $2.98 |
| Testis | $0.69 | $0.57 | $0.32 |
| Services | Liver | $7.10 | $5.63 | $2.65 |
| Kidney | $3.38 | $2.64 | $1.18 |
| Brain Gliomas | $7.20 | $5.81 | $2.91 |
| Testis | $0.68 | $0.56 | $0.31 |
| Source: [Abt Associates 2022b](#_ENREF_3) | | | | |

Table D-3 presents the net annualized benefits using the lower WTP values for each non-fatal cancer endpoint (liver, kidney, brain gliomas, and testis) with and without the lowering factor.

| Table D-3: Total 20-Year Annualized Net Benefits Using Low Benefits Estimates With and Without Lowering Factor by Option, (Thousands, 2022$) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Estimate | Costs | | Benefits | | Net Benefits | |
| Option 1  (Final Rule) | Option 2  (Alternative) | Option 1  (Final Rule) | Option 2  (Alternative) | Option 1  (Final Rule) | Option 2  (Alternative) |
| With Lowering Factor 2 Percent Discount Rate | **$33,654** | **$52,760** | **$19,973** | **$19,914** | **($13.68)** | **($32.85)** |
| Without Lowering Factor 2 Percent Discount Rate | **$33,654** | **$52,760** | **$32,599** | **$32,505** | **($1.05)** | **($20.26)** |
| With Lowering Factor 3 Percent Discount Rate | **$34,907** | **$55,441** | **$15,823** | **$15,773** | **($19.08)** | **($39.67)** |
| Without Lowering Factor 3 Percent Discount Rate | **$34,907** | **$55,441** | **$26,710** | **$26,629** | **($8.20)** | **($28.81)** |
| With Lowering Factor 7 Percent Discount Rate | **$40,363** | **$66,962** | **$7,428** | **$7,401** | **($32.94)** | **($59.56)** |
| Without Lowering Factor 7 Percent Discount Rate | **$40,363** | **$66,962** | **$14,042** | **$13,994** | **($26.32)** | **($52.97)** |

| Table D-4: Total Annualized Benefits by Use Category and Option (20-Year Annualized using Lowering Factor and Low Benefits Estimate, 2022$) | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Use Category | 2 Percent Discount Rate | | 3 Percent Discount Rate | | 7 Percent Discount Rate | | Notes | |
| Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 | Option 1 | Option 2 |
| Manufacturing | $56,484 | $56,484 | $45,077 | $45,077 | $21,458 | $21,458 | WCPP | WCPP |
| Import/Repackage | $823 | $823 | $657 | $657 | $313 | $313 | WCPP | WCPP |
| Reactant/Intermediate | $10,837 | $10,837 | $8,648 | $8,648 | $4,117 | $4,117 | WCPP | WCPP |
| Processing Aid in Petrochemical Manufacturing | $6,149 | $6,149 | $4,907 | $4,907 | $2,336 | $2,336 | WCPP | WCPP |
| Production of Maskant for Chemical Milling | $165 | $165 | $131 | $131 | $63 | $63 | WCPP | WCPP |
| Use as Maskant for Chemical Milling | $285,418 | $285,418 | $227,777 | $227,777 | $108,430 | $108,430 | WCPP | WCPP |
| Vapor Degreasing: Open Top Vapor Degreasing (OTVD)1 | $147,806 | $87,942 | $117,956 | $68,032 | $56,151 | $28,567 | WCPP | Prohibition |
| Vapor Degreasing: Enclosed Vapor Degreasing (EVD)1 | $112 | $193 | $89 | $149 | $42 | $63 | WCPP | Prohibition |
| Vapor Degreasing: Conveyorized Vapor Degreasing (CVD)1 | $38,117 | $38,117 | $30,420 | $30,420 | $14,481 | $14,481 | Prohibition | Prohibition |
| Recycling and Disposal | $779 | $779 | $621 | $621 | $295 | $295 | WCPP | WCPP |
| Incorporation into Adhesive and Sealant Products2 | $3,385 | $3,385 | $2,701 | $2,701 | $1,286 | $1,286 | Prohibition2 | Prohibition |
| Incorp. into Formulation, Mixture, and Reaction Products (Aerosol) | $117,646 | $117,797 | $93,887 | $94,008 | $44,694 | $44,751 | Prohibition except WCPP for EEC | Prohibition |
| Incorp. into Formulation, Mixture, and Reaction Products (Other) | $3,667 | $3,667 | $2,926 | $2,926 | $1,393 | $1,393 | Prohibition | Prohibition |
| Laboratory Chemicals | $0 | $789 | $0 | $630 | $0 | $300 | Prescriptive Controls | WCPP |
| Processing Aid, Except Petrochemical | $191 | $223 | $152 | $178 | $72 | $85 | WCPP | Prohibition |
| Adhesives and Sealants3 | $162,077 | $162,077 | $129,345 | $129,345 | $61,573 | $61,573 | Prohibition | Prohibition |
| Paint and Coatings | $42,437 | $42,437 | $33,867 | $33,867 | $16,122 | $16,122 | Prohibition | Prohibition |
| Aerosol Spray Cleaning/Degreasing except EEC | $6,905,983 | $6,905,983 | $5,468,386 | $5,468,386 | $2,564,992 | $2,564,992 | Prohibition | Prohibition |
| Aerosol Spray Cleaning/Degreasing - EEC | $6,566 | $6,700 | $5,199 | $5,305 | $2,439 | $2,488 | Prescriptive Controls | Prohibition |
| Liquid and Spray Batch Cold Cleaning | $56,312 | $56,312 | $44,940 | $44,940 | $21,393 | $21,393 | Prohibition | Prohibition |
| Photographic Film Use | $18,309 | $18,309 | $14,615 | $14,615 | $6,963 | $6,963 | Prohibition | Prohibition |
| Lubricants and Greases | $210,468 | $210,468 | $167,963 | $167,963 | $79,957 | $79,957 | Prohibition | Prohibition |
| Wipe and Liquid Cleaning and Polishing | $11,874,694 | $11,874,694 | $9,402,775 | $9,402,775 | $4,410,451 | $4,410,451 | Prohibition | Prohibition |
| Inks and Ink Removal | $2,794 | $2,794 | $2,230 | $2,230 | $1,061 | $1,061 | Prohibition | Prohibition |
| Anti-Spatter Welding Aerosol | $20,675 | $20,675 | $16,499 | $16,499 | $7,854 | $7,854 | Prohibition | Prohibition |
| Mold Cleaning, Release and Protectants | $537 | $537 | $428 | $428 | $204 | $204 | Prohibition | Prohibition |
| Dry Cleaning (Dry Cleaning Machines & Spot Removers) | $604 | $195 | $458 | $143 | $177 | $49 | 10-Year Phase Out | 15-Year Phase Out |
| **Total** | **$19,973,035** | **$19,913,950** | **$15,822,656** | **$15,773,360** | **$7,428,317** | **$7,401,044** |  |  |
| 1 25 percent of vapor degreasers are assumed to be eligible for the section 6(g) exemption for aircraft skins and aerospace degreasing, respectively.  2While there are limited exemptions for adhesives and sealants, this analysis assumes all users and formulators switch to alternatives because it is likely to be the most cost-effective option. | | | | | | | | |

1. Annualizing a stream of costs, benefits, or net benefits requires two steps: (1) calculate the present value of the cost, benefit, or net benefit stream, and (2) annualize the resulting present value.  The present value is lower for higher discount rates, because values in the future are lower with a higher discount rate.  In contrast, the annualized values are higher for higher discount rates - the annualized value is simply the annual payment that would be required if one borrowed the present value amount at time zero and then paid that amount back over a given time period with an interest rate equal to the discount rate. Thus, your annual payment is higher for a higher interest rate (which is the discount rate). Thus, when the net benefits are skewed toward the beginning of the analysis time horizon the annualized net benefits will tend to be larger for higher discount rates.  In contrast, when the net benefits are skewed toward the end of the analysis time horizon the annualized net benefits will tend to be smaller for higher discount rates. [↑](#footnote-ref-3)
2. <https://www.epa.gov/sites/default/files/2016-06/documents/ejtg_5_6_16_v5.1.pdf> [↑](#footnote-ref-4)
3. Phifer Inc. makes a wide variety of products, including but not limited to exterior sun control fabrics, outdoor furniture fabrics, and aluminum wire. [↑](#footnote-ref-5)
4. 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. [↑](#footnote-ref-6)
5. 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 2014](#_ENREF_73)) for a discussion on additional sources of market failure identified in the literature. [↑](#footnote-ref-7)
6. Under EPA regulations, a chemical is VOC-exempt if it: (1) has vapor pressure of less than 0.1 millimeters of mercury (at 20 degrees Celsius); Or, (2) if the vapor pressure is unknown and if it: (a) consists of more than 12 carbon atoms; or (b) has a melting point higher than 20 degrees C and does not sublime (*i.e.*, does not change directly from a solid into a gas without melting). [↑](#footnote-ref-8)
7. Note that 3M has recently announced that they will discontinue this product by 2025. [↑](#footnote-ref-9)
8. Note that 3M has recently announced that they will discontinue this product by 2025. [↑](#footnote-ref-10)
9. Note that 3M has recently announced that they will discontinue this product by 2025. [↑](#footnote-ref-11)
10. Note that this excludes small-scale cold cleaning, such as in a five-gallon bucket, which is included under the wipe and liquid cleaning and polishing use category. [↑](#footnote-ref-12)
11. The Freedonia Group is an industry market research firm that notably has published an industry study on the market for solvents. According to Freedonia’s website, industry studies are compiled from primary interviews with industry members, internal proprietary databases, and secondary sources such as trade journals and corporate annual reports. [↑](#footnote-ref-13)
12. 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. [↑](#footnote-ref-14)
13. Note that sections 5.4, 5.5, 5.6 include separate estimates for the PCE market share of adhesives, sealants, and caulk, but EPA uses the adhesives market share since this is believed to be the most prevalent application using PCE. [↑](#footnote-ref-15)
14. Ceballos D, Fellows K et al. Perchloroethylene and dry cleaning: it’s time to move the industry to safer alternatives. *Frontiers in Public Health*, Mar 5 2021, <https://www.frontiersin.org/articles/10.3389/fpubh.2021.638082/full> [↑](#footnote-ref-16)
15. U.S. EPA's Air Pollution Control Cost Manual. Section 3 VOC Controls. Section 3.1 (VOC Recapture Controls), Chapter 1 (Carbon Adsorbers) of the Air Pollution Control Cost Manual (as updated in 2018). https://www.epa.gov/sites/default/files/2018-10/documents/final\_carbonadsorberschapter\_7thedition.pdf [↑](#footnote-ref-17)
16. Measured concentrations of various contaminants are very often found to have frequency distributions that are log-normal, including indoor air contaminants ([Ott 1990](#_ENREF_39)). [Ott (1990)](#_ENREF_39) also provides a physical explanation for why some common processes in nature, including processes relevant to indoor air pollutant concentrations, can explain why log-normal distributions arise naturally. Therefore, EPA believes assuming that exposure levels follow a log-normal distribution is a reasonable approach. [↑](#footnote-ref-18)
17. The APF of a respirator reflects the level of protection that a properly functioning respirator would be expected to provide to a population of properly fitted and trained users. For example, an APF of 10 for a respirator means that a user could expect to inhale no more than one tenth of the airborne contaminant present. [↑](#footnote-ref-19)
18. Measured concentrations of various contaminants are very often found to have frequency distributions that are lognormal, including indoor air contaminants ([Ott 1990](#_ENREF_39)). [Ott (1990)](#_ENREF_39) 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 lognormal distribution is a reasonable approach. [↑](#footnote-ref-20)
19. That is, there are 100 percentile estimates, so each percentile estimate represents the exposure for 1 percent of affected workers. [↑](#footnote-ref-21)
20. The APF of a respirator reflects the level of protection that a properly functioning respirator would be expected to provide to a population of properly fitted and trained users. For example, an APF of 10 for a respirator means that a user could expect to inhale no more than one-tenth of the airborne contaminant present. [↑](#footnote-ref-22)
21. As another example, suppose 50 percent of workers do not wear PPE in the baseline and 50 percent wear APF 10 respirators. The 50 percent wearing APF 10 respirators would have one-tenth 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. [↑](#footnote-ref-23)
22. A dose metric conversion factor is necessary because the benchmark dose modeling was performed on internal dose metrics rather than on the administered concentrations themselves. A PBPK model was used to relate administered concentrations to species-specific internal dose metrics related to each particular cancer site. Benchmark dose modeling was then preformed on the internal dose metric values, rather than the administered concentrations, as the internal dose metrics are a more accurate representation of the relationship between an external exposure and the key health outcomes of interest. Once the benchmark dose modeling has been performed, a dose metric conversion factor is necessary to convert the animal internal dose metrics to a human equivalent internal dose metric, and subsequently to an estimated administered concentration in humans. [↑](#footnote-ref-24)
23. Excess cancer risk is used consistently in EPA assessments of cancer (2012 Toxicological review IRIS ([EPA 2012](https://gbc-word-edit.officeapps.live.com/we/l%20%22_ENREF_64%22%20/o%20%22U.S.%20Environmental%20Protection%20Agency%20(EPA),%202012#94)) and (ORD Staff Handbook draft 2020 Section 8.2 <https://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=350086>). Excess cancer risk is defined as “The increase in risk of experiencing an adverse effect relative to a comparison group,” in EPA 2012, BMD Technical Guidance (<https://www.epa.gov/risk/benchmark-dose-technical-guidance>). Added risk is also defined in Appendix B of the BMD Technical Guidance. [↑](#footnote-ref-25)
24. Note that 10 percent is commonly used because 10 percent is near the low end of the observable range for many common animal toxicity study designs. Levels other than 10 percent extra risk should be considered when supported by the statistical and biological characteristics of the data set (EPA 2012). [↑](#footnote-ref-26)
25. Where 0.003548 is the reduction in the LADC from Table 8‑11, 1.246xE-3 is the excess liver cancer risk from Table ‎8‑12, and 73 percent if the PPE adjustment factor from Table 8‑5. [↑](#footnote-ref-27)
26. The consumer price index increased by 123.91 percent between 1990 and 2022, so $4.8 million (1990$) is converted to $10.75 million (2022$) after adjusting for inflation. GDP per capita increased by 60.16 percent between 1990 and 2022, and this analysis uses EPA’s ([2014](#_ENREF_73)) 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. [↑](#footnote-ref-28)
27. We used [Experian (2023)](#_ENREF_19) data for firms that could be identified in the database and used the [Dun & Bradstreet (2022)](#_ENREF_18) data used for the economic analysis of the proposed rule when a firm could not be identified in the Experian data. [↑](#footnote-ref-29)
28. We used [Experian (2023)](#_ENREF_19) data for firms that could be identified in the database and used the [Dun & Bradstreet (2022)](#_ENREF_18) data used for the economic analysis of the proposed rule when a firm could not be identified in the Experian data. [↑](#footnote-ref-30)
29. We used [Experian (2023)](#_ENREF_19) data for firms that could be identified in the database and used the [Dun & Bradstreet (2022)](#_ENREF_18) data used for the economic analysis of the proposed rule when a firm could not be identified in the Experian data. [↑](#footnote-ref-31)
30. Facilities could also comply by switching to a PCE alternative, but employment impacts would not be expected from switching to a PCE alternative. [↑](#footnote-ref-32)
31. https://www.epa.gov/sites/default/files/2016-06/documents/ejtg\_5\_6\_16\_v5.1.pdf [↑](#footnote-ref-33)
32. Phifer Inc. makes a wide variety of products, including but not limited to exterior sun control fabrics, outdoor furniture fabrics, and aluminum wire. [↑](#footnote-ref-34)
33. This analysis uses 5-year American Community Survey (ACS) data from 2015-2019 retrieved from IPUMS (Manson et al. 2021). The data include approximately 16 million individual ACS responses. The geographic resolution of the data is the Public Use Microdata Area (PUMA) districts defined by the U.S. Census Bureau. PUMAs are the smallest geographic unit for which detailed individual Census data, including employment and industry information, are available. PUMA districts include roughly 100,000-200,000 people with an average of about 140,000 people. The average spatial area of a PUMA is 1,692 square miles. Thus, the spatial resolution of this analysis is much coarser than the community profile information reported above reflecting populations within 1 and 3 miles of each facility. PUMAs are useful as a broad representation of the labor market from which workers may be drawn, but EPA lacks information on how close workers tend to live to their workplaces across these different industries and locations. While the Census provides a “person weight” that indicates how many persons in the U.S. population a sampled individual represents in terms of sex, race, ethnicity, and other characteristics, this analysis presents unweighted summary statistics because of the focus on specific industries that are not accounted for by the person weights. [↑](#footnote-ref-35)